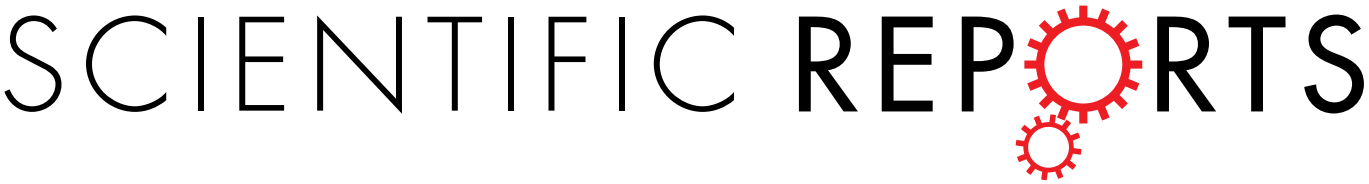

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Sham Electroacupuncture Methods in Randomized Controlled Trials

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Sham electroacupuncture (EA) control is commonly used to evaluate the specific effects of EA in randomized-controlled trials (RCTs). However, establishing an inert and concealable sham EA control remains methodologically challenging. Here, we aimed to systematically investigate the sham EA methods. Eight electronic databases were searched from their inception to April 2015. Ten out of the 17 sham EA methods were identified from 94 RCTs involving 6134 participants according to three aspects: needle location, depth of needle insertion and electrical stimulation. The top three most frequently used types were sham EA type A, type L and type O ordinally. Only 24 out of the 94 trials reported credibility tests in six types of sham EA methods and the results were mainly as follows: sham EA type A (10/24), type B (5/24) and type Q (5/24). Compared with sham EA controls, EA therapy in 56.2% trials reported the specific effects, of which the highest positive rate was observed in type N (3/4), type F (5/7), type D (4/6) and type M (2/3). In conclusion, several sham EA types were identified as a promising candidate for further application in RCTs. Nonetheless, more evidence for inert and concealable sham EA control methods is needed.

A randomized controlled trial (RCT) has been the cornerstone of medical clinical research since the first RCT paper entitled "Streptomycin treatment of pulmonary tuberculosis: a Medical Research Council investigation" was published in 1948[1]. By the late 20th century, RCT was recognized as the gold standard for a clinical trial[2]. To improve the quality of clinical research, the methodology has been refined to avoid any bias over the past several decades. The most important design techniques for avoiding bias in clinical trials are randomization and blinding. Blinding is intended to limit the occurrence of conscious and unconscious bias in clinical trials (performance bias) conduction and interpretation of outcomes (ascertainment bias)[3]. Blinding is crucial for treatment evaluation because lack of blinding can bias the reliable assessment of treatment effects. For RCTs, placebo is a standard control method to blind the participants and health care providers. The purpose of placebo group is to account for the placebo effect, i.e., effects from treatment that do not depend on the treatment itself. However, blinding is difficult to ensure in non-pharmacological treatment trials because fabrication of placebo such as placebo/sham acupuncture controls requires the placebo to be both inert and indistinguishable, which is relatively difficult[4].

RCTs for acupuncture appeared in 1970s[5]. Since then, a number of RCTs on acupuncture have been published[6]. The "sham" acupuncture is identified as the procedure controlling for the acupuncture treatment components with the aim to blind the participants and control for non-specific placebo effects[7]. Since participants are to a large extent ignorant of the components of acupuncture such as needle location, depth of needle insertion, needle stimulation and patient/practitioner interactions, sham acupuncture can be considered to be therapeutically inactive. However, it is difficult to design a standard method for sham acupuncture avoiding all therapeutically active components. Thus, the methodological difficulties in designing appropriate sham acupuncture controls for RCTs remained challenging[8–10].

Electroacupuncture (EA) is an extension technique based on traditional acupuncture combined with modern electrotherapy[11,12]. Owing to its accurate, reproducible and standardized intensity and duration of stimulation with simple, verifiable electrical parameters, EA has been widely used in clinical studies and basic research into underlying mechanisms of acupuncture treatment[13,14]. Currently, EA is being used extensively in China and elsewhere around the world. However, no systematic analyses have yet been published to describe the sham EA procedures. Thus, the objective of this study is to investigate the sham EA methods utilized in EA RCTs.

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Methods

Search strategy. Eight electronic databases, including Cochrane Controlled Trials Register, PubMed, EMBASE, AMED, China National Knowledge Infrastructure (CNKI), VIP Journals Database, Wanfang database, and Chinese Biomedical Database (CBM) were searched from their inceptions to April 2015. The search terms were confined to "Electroacupuncture" AND "sham acupuncture OR placebo acupuncture" AND "randomized controlled trial (RCT)". All searches were limited to studies on human.

Eligibility Criteria. RCTs concerning the effects of EA on any kind of diseases with at least one control group receiving sham EA were included, regardless of publication status and languages. Quasi-RCTs and non-RCTs were excluded.

The studies were eligible if EA therapy alone or adjunct therapy were given in treatment group and secondly, if sham EA or any type of faked manipulation mimicking real EA in aspects of acupoint, penetration and electro-stimulation were given in control group. There were no restrictions on needle parameters or intensity, frequency and mode of stimulation. Studies that compared EA with transcutaneous nerve electrical stimulation (TNES), another acupuncture plus sham EA or placebo medications were excluded. If three or more groups were designed in one study, only real EA versus sham EA groups were included.

Study selection and data extraction. Two authors (ZXC, YL) reviewed the titles and abstracts of the potential references independently. All the potentially relevant studies were marked and their full articles were retrieved. Further examinations were carried out to make a final selection decision. The same two authors performed the data extraction independently for the predefined items: author, year, country, EA indications, sample size, the characteristics of interventions, outcome measures, results and dropouts. The disagreements were resolved through consulting a third part (GQZ).

Risk of bias assessment. Two authors (ZXC and YL) performed the methodological quality assessment of each included trial independently based on the Cochrane Collaboration's tool for assessing risk of bias[14]. The criteria consisted of the following: adequate sequence generation, allocation concealment, blinding of participants, blinding of personnel, blinding of outcome assessor, free of incomplete outcome data, free of selective reporting and free of other bias.

Description of sham EA methods. The sham EA methods used in each control group were examined and the details were extracted according to three respects: needle location, depth of needle insertion and electrical stimulation. Partially based on the previous sham acupuncture type I~V classification published by Dincer *et al.*[8] we summarized seventeen kinds of sham EA methods: (1) Sham EA on therapeutic acupoints plus no skin penetration plus no electrical stimulation (Sham EA type A); (2) Sham EA on therapeutic acupoints plus no skin penetration plus electrical stimulation (Sham EA type B); (3) Sham EA on therapeutic acupoints plus the same depth plus no electrical stimulation (Sham EA type C); (4) Sham EA on therapeutic acupoints plus superficial insertion plus no electrical stimulation (Sham EA type D); (5) Sham EA on therapeutic acupoints plus superficial insertion plus electrical stimulation (Sham EA type E); (6) Sham EA on nonspecific acupuncture points plus the same depth plus electrical stimulation (Sham EA type F); (7) Sham EA on nonspecific acupuncture points plus the same depth plus no electrical stimulation (Sham EA type G); (8) Sham EA on nonspecific acupuncture points plus superficial insertion plus electrical stimulation (Sham EA type H); (9) Sham EA on nonspecific acupuncture points plus superficial insertion plus no electrical stimulation (Sham EA type I); (10) Sham EA on nonspecific acupuncture points plus no skin penetration plus electrical stimulation (Sham EA type J); (11) Sham EA on nonspecific acupuncture points plus no skin penetration plus no electrical stimulation (Sham EA type K); (12) Sham EA on non-acupuncture points plus the same depth plus electrical stimulation (Sham EA type L); (13) Sham EA on non-acupuncture points plus the same depth plus no electrical stimulation (Sham EA type M); (14) Sham EA on non-acupuncture points plus superficial insertion plus electrical stimulation (Sham EA type N); (15) Sham EA on non-acupuncture points plus superficial insertion plus no electrical stimulation (Sham EA type O); (16) Sham EA on non-acupuncture points plus no skin penetration plus electrical stimulation (Sham EA type P); (17) Sham EA on non-acupuncture points plus no skin penetration plus no electrical stimulation (Sham EA type Q).

Assessment of the effectiveness. Considering wildly varying outcome measures across different disease conditions, treatment efficacy was evaluated for each study according to the modified method based on a previous publication[10]. The results of each trial were presented by using the following primary outcome measures: "$T > C$" meaning that real EA treatment group was significantly superior to sham EA control group; "ND" meaning no difference between EA and sham EA groups; "$T < C$" meaning that real EA group was significantly inferior to sham EA group. If the efficacy of a trial was reported as "$T > C$" or "$T < C$" without between-groups comparison having been conducted, we collected the original data by reviewing the articles or contacting the corresponding author. If the original data were available, an effect-size analysis was conducted to reconfirm the between-groups difference. If the original data were not available, the efficacy results were presented as "$T > C$?" or "$T < C$?".

The credibility of blinding. The credibility test was formally performed in validation studies to assess the blinding effect of sham acupuncture based on credibility questionnaire and statistical analysis[15–17]. The information on the credibility test was extracted to explore the relationship between the credibility of blinding and the type of sham EA method.

Results

Study selection. A total of 679 potentially relevant articles were identified. By reviewing titles and abstracts, 374 papers were excluded for at least one of following reasons: (1) not clinical trials; (2) case report, comment,

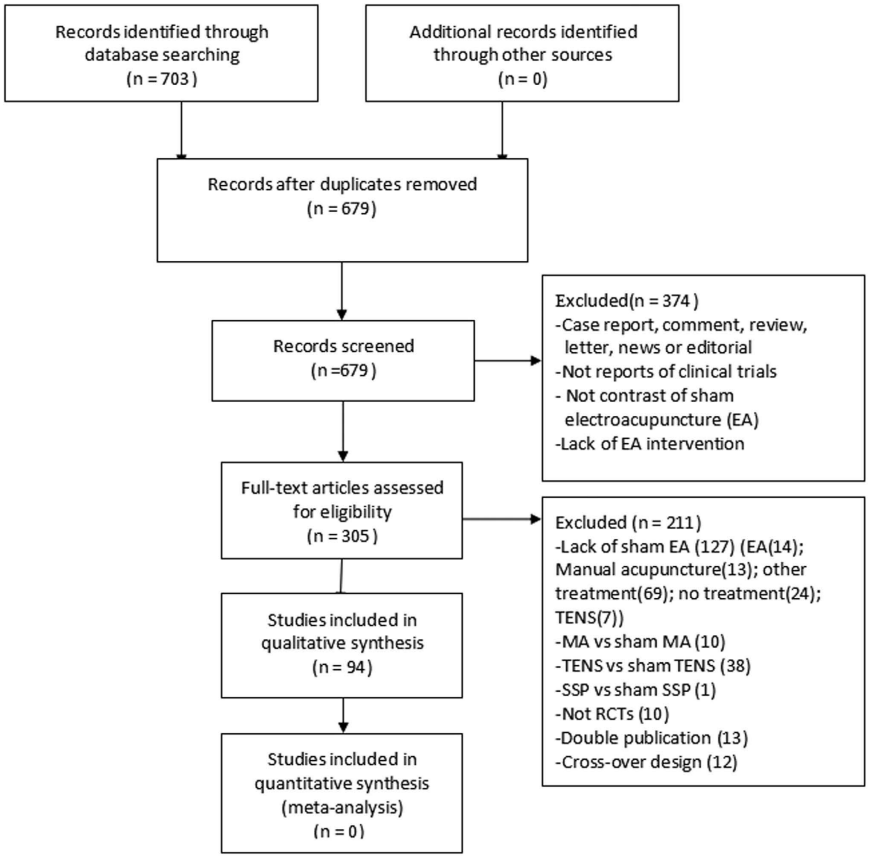

Figure 1. Flow diagram.

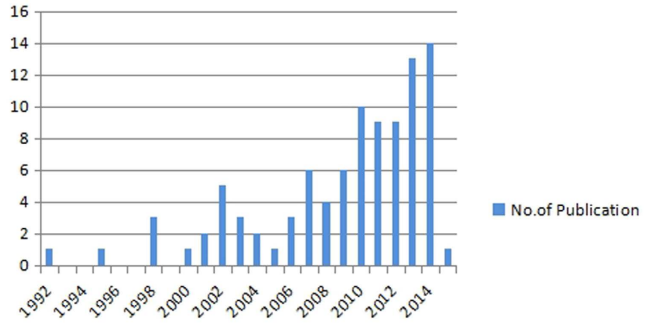

Figure 2. The time distribution of the included articles.

review, letter, news or editorial; (3) not in contrast with sham EA; (4) lack of EA intervention. After examining the full content of the remaining 305 articles, we removed 211 records, of which 127 articles were due to lack of sham EA controls, including electro-acupuncture (14 studies), manual acupuncture (13 studies), TNES (7 studies), other treatment (69 studies) or no treatment (24 studies); 49 articles removed for lack of real EA groups, with their target intervention designed as manual acupuncture (10 studies), TNES (38 studies) or periosteal stimulation therapy (PST) (1 study); 10 articles were not RCTs; 13 articles were double publications; 12 articles were cross-over design. Ultimately, 94 studies[18–111] involving 6134 participants were selected (Fig. 1).

Characteristics of included studies. The 94 included articles were published from 1992 to 2015. Among them, 5 studies[29,54,90,95,107] were published between 1992 and 1999; 33 studies[22,24,25,27,30,31,38,45,47,52,53,56–58,67,68,71–74,77,78,81,83,84,92,93,97,104–106,110,111] were published between 2000 and 2010; the remaining 56 studies[18–21,23,26,28,32–37,39–44,46,48–51,55,59–66,69,70,75,76,79,80,82,85–89,91,94,96,98–103,108,109] were reported from 2010 to 2015 (Fig. 2). Indications for EA included pain (32 studies)[18,19,21,24,26,27,31,33,36,37,40,42,45,47,51,52,56,60,66,67,72,76,82,84,88,90,92,96,97,103,110,111], anesthesia (8 studies)[46,50,73,74,86,89,94,102], stroke (7 studies)[25,28,29,34,62,105,106], depression (6 studies)[23,53,59,65,68,80], obesity (4 studies)[32,49,54,70], primary dysmenorrheal/menstrual pain (4 studies)[61,98,99,101],

substance abuse (heroin or smoking) (3 studies)[64,95,107], osteoarthritis (2 studies)[22,104], migraine (2 studies)[39,78], nausea and vomiting (2 studies)[38,57], postoperative ileus (2 studies)[35,91], insomnia (2 studies)[63,81], benign prostate hyperplasia (2 studies)[79,87], diabetic mellitus related diseases (2 studies)[83,109], carpal tunnel syndrome (1 study)[100], rheumatoid arthritis (1 study)[93], whiplash-associated disorders (1 study)[69], constipation (1 study)[48], multiple sclerosis (1 study)[41], tinnitus (1 study)[20], auditory hallucination (1 study)[30], attention deficit hyperactivity disorder (1 study)[44], polycystic ovary syndrome (1 study)[55], hot flushes (1 study)[58], postpartum insufficient lactation (1 study)[71], cardiac ischemia-reperfusion injury (1study)[75], stress-related symptoms (1 study)[108]. The rest three studies[43,77,85] reported the effects of EA on healthy subjects.

EA treatment alone was adopted in 55 trials[19–26,28–31,34–39,42,43,53,55,58,60,61,66,68,69,71,72,75,77–80,83–91,95,98–101,103,104,107,-108,110,111], while the interventions of the remaining 39 trials were a combination of EA and western conventional medicine (WCM). Four trials[24,47,54,100] were designed as two groups of EA, and seven trials[38,43,61,63,98,99,101] were conducted with two groups of sham EA. Compared with sham EA group, real EA group in 83 studies selected the same number of acupoints; nine studies[25,46,66,89,90,105,106,108,111] used more number of acupoints; one study[20] used less number of acupoints; one study[52] did not report the number of acupoints. Eight studies[26,49,54,76,95–97,110] identified acupoints by using a point detector. The "*deqi*" sensation was required in 65 real EA groups[18–26,29–31,33–36,39–41,43,44,47,48,50,51,56–64,66,67,69,71,75,77–83,85–87,90,91,93,98–102,104–106,109,111] and 3 sham EA groups selected nonspecific acupoints[61,78,101]. Eight studies utilized pricking sensation to mimic needle sensation and blind participants in control group[20,21,23,52,60,63,67,81]. Forty-two studies[19–22,26–28,31–35,37,39,40,42–44,46,47,50,51,58,60–62,64–66,70,71,77–79,83,85,89,92,100,104–106] applied EA at high intensity with maximum tolerance, and seventeen studies[24,29,54,56,59,80,82,86,87,90,95,98,99,102,107,108,111] applied EA with low intensity below pain threshold or at a comfortable level with presence or absence of muscle contractions. The other trials were lacking in details on the intensity of stimulation. The duration of each session ranged from 5 minutes[100] to 72 hours[96]; the total number of treatment sessions varied from 1[33,37–39,46,47,50–52,72,73,77,82,84,86,88,89,94–97,100–102,109] to 72[44]; the total duration of treatment ranged from 5 minutes[100] to 6 months[111]. Ten studies[27,46,72,76,77,79,89,90,97,102] did not report the duration of each session. In one study[76], the total number of treatment session was not mentioned. Eight studies[27,46,72,76,77,89,97,102] did not provide any information on the total duration of treatment. The characteristics of the studies were listed in Table 1.

Characteristics of sham EA. Ten different types of sham EA methods used in the trials were identified as follows: (1) sham EA type A were used in twenty-six control groups[18–22,31,33,37,40,60,66,67,73,74,76,81,94,96,97,102–104,106,108–110]; (2) sham EA type B were used in seven control groups[23,24,59,65,84,88,105]; (3) sham EA type C were used in seven control groups[28,44,47,49,51,75,82]; (4) sham EA type D were used in six control groups[29,43,62,64,72,93]; (5) sham EA type F were used in seven control groups[38,61,71,78,98,99,101]; (6) sham EA type L were used in seventeen control groups[26,27,39,43,46,48,50,53,54,61,77,79,85,89,98,99,101]; (7) sham EA type M were used in three control groups[42,68,69]; (8) sham EA type N were used in four control groups[63,83,90,95]; (9) sham EA type O were used in fourteen control groups[30,32,35,41,45,56–58,70,80,86,87,91,92]; and (10) sham EA type Q were used in ten control groups[25,34,36,38,52,55,63,100,107,111].

For the needle location, 48 sham EA groups[25–27,30,32,34–36,38,39,41–43,45,46,48,50,52–58,61,63,68–70,77,79,80,83,85–87,89–92,95,98–101,107,111] chose non-acupoints that were either located away from the therapeutic acupoints with a distance ranging from 1 cm to 40 cm or devised in advance to avoid any known meridian or extra-point. Seven sham EA groups[38,61,71,78,98,99,101] received nonspecific acupuncture points which were thought to be ineffective for treating the diseases. For the depth of needle insertion, 34 sham EA groups[26–28,38,39,42–44,46–51,53,54,61,68,69,71,75,77–79,82,85,89,98,99,101] conducted the needle insertion to the same depth as corresponding real EA groups. Twenty-four sham EA groups[29,30,32,35,41,43,45,56–58,62–64,70,72,80,83,86,87,90–93,95] performed either superficial or subcutaneous needle insertion with depth varying from 0.5 mm to 2 cm, whereas one study[93] retracted the needle after superficial penetration. The remaining 43 sham EA groups had sham EA without skin penetration. Forty-one out of 43 trials did not apply any needle insertion by using Streitberger needles[21,23,25,31,36,55,59,63,65,66,81], contractible placebo needles with dull tips and tubes[24,37,52], placebo needles with blunted tips[19,20,40,60,67,100], verum needles fixed by tapes or rings without piercing[18,22,34], leading wires alone without needles[33,38,76,97] and mock laser pen[103] or electrodes[73,74,94,96,102,104–111]. Two sham EA groups[84,88] did not describe any details on the sham needles. For electrical stimulation, 35 sham EA groups[23,24,26,27,38,39,43,46,48,50,53,54,59,61,63,65,71,77–79,83–85,88–90,95,98,99,101,105] used electrical stimulation, whereas two sham EA groups stimulated with current just at the beginning of sham procedure. The other sham EA groups[18–22,25,28–38,40–45,47,49,51,52,55–58,60,62–64,66–70,72–76,80–82,86,87,91–94,96,97,100,102–104,106–111] did not receive any electrical stimulation through inactivated EA device or disconnected cables. The details of sham EA were described in Table S1.

Risk of bias assessment. The number of items complied with the criteria varied from 3/8 to 7/8 with the average of 5.2. All 94 studies declared randomization and 63 studies reported the details. Among them, 49 studies[18,19,22–25,27,29,35–38,42–45,47,49,51,55,59–67,70–72,81,88,90–93,96–99,102,106–111] described a computer-generated randomization; 11 studies[32,40,41,50,52,57,69,73,74,85,86] were based on random number Table; 3 studies[83,87,101] used the lot. Adequate allocation concealment was found in 43 studies[18–20,23,25,29,30,35–37,43–45,55,57,58,60,61,63–67,69,71,72,76,79,81,84,86,88,90,91,93,98,99,105–107,109–111] with sequentially numbered, opaque, sealed envelopes or independent administrator. The remaining 51 studies did not provide the details on allocation concealment. Blinding of participant was described in all 94 studies. Among these, 23 studies[22,23,25,34,36,45,52,57,59,60,63,65,72,81,88,97,102,103,105–108,110] proved their success of blinding by credibility test, while one study[66] failed in blinding of participant after testing by statistical analysis. No study mentioned blinding of acupuncturists. Ninety-two out of the 94 studies reported blinding of assessor, whereas one study[54] did not contain any information on assessor blinding and another study[66] was sorted as "no" due to its unsuccessful assessor blinding. Eighteen studies[25,30,45,60,65,69,79,80,91–93,97–99,103,105–107] conducted intention-to-treat analysis. Seventy-five studies[18–22,24–41,43,44,46,47,49–68,70–79,81–92,94–97,100–105,108–111] were free of incomplete outcome data; eleven studies[23,42,45,48,69,80,93,98,99,106,107] assessed as "no" due to high dropout rate or statistically significant

Reference (author, year and country)	Diseases	No. of acupoint (T/C)	Sample size (T/C)	dropout (T/C)	Primary outcome measures	Difference between groups	Characteristic of sham electro-acupuncture (EA) methods			
							needle location	degree of needle insertion	electrical stimulation	The type of sham EA method
Ntritsou *et al.* 2014 USA[18]	Pain	4/4	37/38	5(2/3)	NRS and SF_MPQ scores	T > C	therapeutic acupoints	no penetration	no electrical stimulation	Sham EA type A
Chu *et al.* 2012 Hong Kong[19]	Pain perception in Irritable Bowel Syndrome	6/6	15/15	0(0/0)	FMRI	T > C	therapeutic acupoints	no penetration	no electrical stimulation	Sham EA type A
Wang *et al.* 2010 Denmark[20]	Tinnitus	4/14	20/20	9(4/5)	The frequency of tinnitus occurrence and the tinnitus loudness	ND	therapeutic acupoints	no penetration	no electrical stimulation	Sham EA type A
Zyloney *et al.* 2010 USA[21]	Pain	2/2	N/N	29(N/N)	FMRI and MASS ratings	T > C	therapeutic acupoints	no penetration	no electrical stimulation	Sham EA type A
Jubb *et al.* 2008 UK[22]	Osteoarthritis	6/6	34/34	4(2/2)	WOMAC pain score	T > C	therapeutic acupoints	no penetration	no electrical stimulation	Sham EA type A
Chung *et al.* 2012 Hong Kong[23]	Postpartum Depression	18/18	10/10	6(5/1)	EPDS, HADS, $HDRS_{17}$ and CGI scores	ND	therapeutic acupoints	no penetration	electrical stimulation	Sham EA type B
Barlas *et al.* 2006 UK[24] 1	Pain	4/4	12/12	N(N/N)	Pressure pain threshold	T > C	therapeutic acupoints	no penetration	electrical stimulation	Sham EA type B
Barlas *et al.* 2006 UK[24] 2	Pain	4/4	12/12	N(N/N)	Pressure pain threshold	ND	therapeutic acupoints	no penetration	electrical stimulation	Sham EA type B
Wayne *et al.* 2005 US[25]	Stroke Rehabilitation	14–22/2–3	16/17	9(3/6)	FMA score	ND	non-acupuncture points	no penetration	no electrical stimulation	Sham EA type Q
Sahin *et al.* 2010 Turkey[26]	Pain	14/14	15/16	2(2/0)	VAS scores	ND	non-acupuncture points	the same depth	electrical stimulation	Sham EA type L
Fanti *et al.* 2003 Italy[27]	Pain	10/10	10/10	0(0/0)	VAS scores	ND	non-acupuncture points	the same depth	Electrical stimulation	Sham EA type L
Hsing *et al.* 2012 Brazil[28]	Stroke recovery	11–14/11–14	31/31	0(0/0)	NIHSS, Barthel Index and modified Rankin scales scores	T > C	therapeutic acupoints	the same depth	no electrical stimulation	Sham EA type C
Gosman-Hedström *et al.* 1998 Sweden[29]	Stroke	4/4	37/34	3(2/1)	The neurological score and the Barthel and Sunnaas index scores	ND	therapeutic acupoints	superficial penetration	no electrical stimulation	Sham EA type D
Jing *et al.* 2009 China[30]	Auditory hallucination	6/6	30/30	7(4/3)	The Psychotic Symptom Rating Scales and Auditory Hallucination Subscale total score	T > C	non-acupuncture points	superficial penetration	no electrical stimulation	Sham EA type O
Kong *et al.* 2009 USA[31]	Pain	2/2	N/N	29(N/N)	Gracely Sensory and Affective scales scores and fMRI	ND	therapeutic acupoints	no penetration	no electrical stimulation	Sham EA type A
Darbandi *et al.* 2013 Iran[32]	Obesity	4/4	47/47	8(5/3)	BW, BMI and BFM	ND	non-acupuncture points	superficial penetration	no electrical stimulation	Sham EA type O
Yang *et al.* 2012 China[33]	Pain	12/12	40/40	0(0/0)	the consumption of sevoflurane and the recovery profile	T > C	therapeutic acupoints	no penetration	no electrical stimulation	Sham EA type A
Liu *et al.* 2013 China[34]	Post-stroke detrusor overactivity	10/10	35/36	5(2/3)	maximum cystometric capacity and bladder compliance	T > C	non-acupuncture points	no penetration	no electrical stimulation	Sham EA type Q
Zhang *et al.* 2014 China[35]	Postoperative ileus	2/2	20/20	1(1/0)	Time of the first bowel sounds and passage of flatus	T > C	non-acupuncture points	superficial penetration	no electrical stimulation	Sham EA type O
Mao *et al.* 2014 USA[36]	Aromatase Inhibitor-Related Arthralgia	4/4	22/22	6(3/3)	BPI	ND	non-acupuncture points	no penetration	no electrical stimulation	Sham EA type Q
Leung *et al.* 2011 Hong Kong[37]	Pain	3/3	20/20	0(0/0)	the maximal tolerable pressure, VAS score and beta-endorphin level	T > C	therapeutic acupoints	no penetration	no electrical stimulation	Sham EA type A
Rusy *et al.* 2002 USA[38] a	Postoperative Nausea and Vomiting	1/1	40/40	0(0/0)	occurrence of nausea and vomiting, and use of antiemetic rescue medication	T > C	nonspecific acupuncture points	the same depth	electrical stimulation	Sham EA type F
Rusy *et al.* 2002 USA[38] b	Postoperative Nausea and Vomiting	1/1	40/40	0(0/0)	occurrence of nausea and vomiting, and use of antiemetic rescue medication	T > C	non-acupuncture points	no penetration	no electrical stimulation	Sham EA type Q
Yang *et al.* 2014 China[39]	Migraine	3/3	10/10	0(0/0)	VA S scores	ND	non-acupuncture points	the same depth	Electrical stimulation	Sham EA type L

Continued

Reference (author, year and country)	Diseases	No. of acupoint (T/C)	Sample size (T/C)	dropout (T/C)	Primary outcome measures	Difference between groups	Characteristic of sham electro-acupuncture (EA) methods			
							needle location	degree of needle insertion	electrical stimulation	The type of sham EA method
Chen *et al.* 2013 China[40]	Pancreatic cancer pain	10/10	30/30	1(0/1)	NRS	T > C	therapeutic acupoints	no penetration	no electrical stimulation	Sham EA type A
Quispe-Cabanillas *et al.* 2012 Brazi[41]	Multiple sclerosis	9/9	16/15	0(0/0)	EDSS, pain VASscore and quality of life FAMS	T > C	non-acupuncture points	superficial penetration	no electrical stimulation	Sham EA type O
Aranha *et al.* 2015 Brazil[42]	Pain	7–8/7–8	24/23	17(7/10)	VAS scores and cervical movements	T > C	non-acupuncture points	the same depth	no electrical stimulation	Sham EA type M
Yu *et al.* 2013 Hong Kong[43] a		2/2	12/12	0(0/0)	C-MMASS and HR, MAP	ND	non-acupuncture points	the same depth	Electrical stimulation	Sham EA type L
Yu *et al.* 2013 Hong Kong[43] b		2/2	12/12	0(0/0)	C-MMASS and HR, MAP	T > C	therapeutic acupoints	superficial penetration	no electrical stimulation	Sham EA type D
Li *et al.* 2010 Chin[44]	Attention deficit hyperactivity disorder	15–16/15–16	92/88	10(6/4)	relapse rate	T > C	therapeutic acupoints	the same depth	no electrical stimulation	Sham EA type C
Zheng *et al.* 2007 Australia[45]	Chronic pain	4/4	17/18	12(8/4)	the dosage reduction of OLM, the incidence of side effect, and VAS score	ND	non-acupuncture points	superficial penetration	no electrical stimulation	Sham EA type O
Li *et al.* 2013 China[46]	General anesthesia	10/6	9/10	0(0/0)	the levels of TNF-α, IL-8 and IL-10	ND	non-acupuncture points	the same depth	Electrical stimulation	Sham EA type L
Lin *et al.* 2002 Taiwan[47] 1	Postoperative pain	2/2	25/25	0(0/0)	VAS score	ND	therapeutic acupoints	the same depth	no electrical stimulation	Sham EA type C
Lin *et al.* 2002 Taiwan[47] 2	Postoperative pain	2/2	25/25	0(0/0)	VAS score	ND	therapeutic acupoints	the same depth	no electrical stimulation	Sham EA type C
Chen *et al.* 2013 Taiwan[48]	Constipation	6/6	30/30	30 (16/14)	the defecation rate	T > C	non-acupuncture points	the same depth	Electrical stimulation	Sham EA type L
Schukro *et al.* 2014 Austria[49]	Obesity	3/3	28/28	14(7/7)	the relative reduction of body weight	T > C	therapeutic acupoints	the same depth	no electrical stimulation	Sham EA type C
Yu *et al.* 2014 China[50]	General anesthesia	2/2	20/20	0(0/0)	The serum cortisol and ACTH	T > C ?	non-acupuncture points	the same depth	Electrical stimulation	Sham EA type L
Xie *et al.* 2014 China[51]	Postoperative pain	2/2	20/20	0(0/0)	VAS score, Total Doses of Sufentanil and Dezocine	T > C	therapeutic acupoints	the same depth	no electrical stimulation	Sham EA type C
Sim *et al.* 2002 Singapore[52]	Intraoperative pain	N/N	30/30	0(0/0)	The total intraoperative usage of alfentanil, The total morphine consumption and VAS score	ND	non-acupuncture points	no penetration	no electrical stimulation	Sham EA type Q
Song *et al.* 2009 China[53]	Depression	2/2	31/32	10(3/7)	HDRS and CGI	T > C	non-acupuncture points	the same depth	Electrical stimulation	Sham EA type L
Shafshak 1995 Egypt[54] 1	Obesity	2/2	10/10	N(N/N)	the success rate of going on the diet trigmen	T > C	non-acupuncture points	the same depth	Electrical stimulation	Sham EA type L
Shafshak 1995 Egypt[54] 2	Obesity	2/2	10/10	N(N/N)	the success rate of going on the diet trigmen	T > C	non-acupuncture points	the same depth	Electrical stimulation	Sham EA type L
Franasiak *et al.* 2012 USA[55]	Polycystic Ovary Syndrome	8/8	46/50	16(9/7)	Serum LH and FSH. The monthly rates of ovulation	ND	non-acupuncture points	no penetration	no electrical stimulation	Sham EA type Q
Naslund *et al.* 2002 Sweden[56]	Idiopathic anterior knee pain	6/6	30/28	1(0/1)	one leg vertical jump, functional score, daily VAS recording and skin temperature	ND	non-acupuncture points	superficial penetration	no electrical stimulation	Sham EA type O
Shen *et al.* 2000 US[57]	Chemotherapy–Induced Emesis	4/4	37/33	1(1/1)	Total number of emesis episodes occurring	T > C	non-acupuncture points	superficial penetration	no electrical stimulation	Sham EA type O
Wyon *et al.* 2004 Sweden[58]	Hot flushes in postmenopausal women.	6/6	15/15	7(4/3)	The number of flushes/24 h	ND	non-acupuncture points	superficial penetration	no electrical stimulation	Sham EA type O
Zhang *et al.* 2012 Hong Kong[59]	Depression	12/12	38/35	10(7/3)	score of HAMD-17 and SDS	T > C	therapeutic acupoints	no penetration	electrical stimulation	Sham EA type B
Zheng *et al.* 2010 Australia[60]	Pain	2/2	12/12	0(0/0)	SPT and TST	T > C	therapeutic acupoints	no penetration	no electrical stimulation	Sham EA type A
Ma *et al.* 2010 China[61] a	Menstrual Pain	2/2	13/14	1(1/0)	VAS scores	T > C	nonspecific acupuncture points	the same depth	electrical stimulation	Sham EA type F
Ma *et al.* 2010 China[61] b	Menstrual Pain	2/2	13/12	1(1/0)	VA S scores	T > C	non-acupuncture points	the same depth	Electrical stimulation	Sham EA type L

Continued

Reference (author, year and country)	Diseases	No. of acupoint (T/C)	Sample size (T/C)	dropout (T/C)	Primary outcome measures	Difference between groups	Characteristic of sham electro-acupuncture (EA) methods			
							needle location	degree of needle insertion	electrical stimulation	The type of sham EA method
Wang *et al.* 2014 Taiwan[62]	Chronic stroke	4/4	10/10	5(1/4)	R1, R2 and R2–R1	T > C	therapeutic acupoint	superficial penetration	No electrical stimulation	Sham EA type D
Yeung *et al.* 2011 Hong Kong[63] a	Insomnia	8/8	26/26	7(4/3)	ISI and PSQI	ND	non-acupuncture points	superficial penetration	electrical stimulation	Sham EA type N
Yeung *et al.* 2011 Hong Kong[63] b	Insomnia	8/8	26/26	7(4/3)	ISI and PSQI	T > C	non-acupuncture points	No penetration	No electrical stimulation	Sham EA type Q
Chan *et al.* 2014 Taiwan[64]	Heroin Addicts	4/4	30/30	2(1/1)	the daily consumption of methadone	T > C	therapeutic acupoint	superficial penetration	no electrical stimulation	Sham EA type D
Man *et al.* 2014 Hong Kong[65]	Post-stroke depression	20/20	23/20	10(4/6)	HAMD-17 and CGI-S	T > C	therapeutic acupoint	No penetration	electrical stimulation	Sham EA type B
Oh *et al.* 2013 Australia[66]	Pain	16/12	16/16	3(2/1)	WOMAC, BPI-SF and FACT-G instrument	ND	therapeutic acupoint	No penetration	No electrical stimulation	Sham EA type A
Wong *et al.* 2006 Hong Kong[67]	Pain	4/4	13/14	2(0/2)	VAS pain score	ND	therapeutic acupoint	No penetration	No electrical stimulation	Sham EA type A
Song *et al.* 2007 USA[68]	Depression	2/2	N/N	N(N/N)	24-item HAMD and the level of G protein α subtypes in the platelet membrane	ND	non-acupuncture points	the same depth	no electrical stimulation	Sham EA type M
Cameron *et al.* 2011 Australia[69]	Whiplash-associated Disorders	8/8	64/60	8(0/8)	VAS	T > C	non-acupuncture points	the same depth	no electrical stimulation	Sham EA type M
Darbandi *et al.* 2014 Iran[70]	Obesity	4/4	20/20	0(0/0)	BMI, TFM, WC and HC	T > C	non-acupuncture points	superficial penetration	no electrical stimulation	Sham EA type O
Wei *et al.* 2008 China[71]	Postpartum Insufficient Lactation	2/2	46/46	0(0/0)	total therapeutic effect, 24-hour milk secretion quantity, prolactin level	T > C	nonspecific acupuncture points	the same depth	electrical stimulation	Sham EA type F
Wang *et al.* 2007 USA[72]	Pain	4/4	29/27	0(0/0)	intraprocedural alfentanil consumption, VAS score	T > C	therapeutic acupoint	superficial penetration	no electrical stimulation	Sham EA type D
Kvorning *et al.* 2003 Sweden[73]	Anaesthesia	12/12	23/23	1(1/0)	Physiological reactions to skin incision	T > C	therapeutic acupoint	No penetration	no electrical stimulation	Sham EA type A
Kvorning *et al.* 2003 Sweden[74]	Anaesthesia	6/6	23/23	0(0/0)	The minimal alveolar concentration of sevoflurane	T < C	therapeutic acupoint	No penetration	no electrical stimulation	Sham EA type A
Yang *et al.* 2010 China[75]	Cardiac ischemia-reperfusion injury	6/6	30/30	0(0/0)	levels of serum cardiac troponin I	T > C	therapeutic acupoint	the same depth	no electrical stimulation	Sham EA type C
Sahmeddini *et al.* 2010 Iran[76]	Perioperative Pain	4/4	45/45	0(0/0)	score on VAS-100	ND	therapeutic acupoint	no penetration	no electrical stimulation	Sham EA type A
Wang *et al.* 2007 China[77]		1/1	9/5	3(3/0)	BOLD fMRI	T > C	non-acupuncture points	the same depth	electrical stimulation	Sham EA type L
Jia *et al.* 2009 China[78]	Migraine	2/2	138/138	1(0/1)	VAS score and the plasma 5-HT level	T > C	nonspecific acupuncture points	the same depth	electrical stimulation	Sham EA type F
Wang *et al.* 2013 China[79]	Benign prostate hyperplasia	2/2	50/50	23(9/14)	IPSS	T > C	non-acupuncture points	the same depth	electrical stimulation	Sham EA type L
Andreescu *et al.* 2011 Canada[80]	Depression	2/2	28/29	11(4/7)	HDRS score	ND	non-acupuncture points	superficial penetration	No electrical stimulation	Sham EA type O
Yeung *et al.* 2009 Hong Kong[81]	Insomnia	8/8	30/30	3(1/2)	ISI	ND	therapeutic acupoint	no penetration	no electrical stimulation	Sham EA type A
Chen *et al.* 2014 Taiwan[82]	Pain	1/1	25/24	0(0/0)	VAS scores and the dosage of opium derivative analgesic	ND	therapeutic acupoint	the same depth	no electrical stimulation	Sham EA type C
Wang *et al.* 2008 China[83]	Diabetic Gastroparesis	4/4	11/12	4(2/2)	GCSI score	T > C	non-acupuncture points	superficial penetration	electrical stimulation	Sham EA type N
Meissner *et al.* 2004 Germany[84]	Pain	6/6	8/8	0(0/0)	SEPs	T > C	therapeutic acupoint	no penetration	electrical stimulation	Sham EA type B
Zhou *et al.* 2012 China[85]		2/2	11/11	0(0/0)	MVC strength	ND	non-acupuncture points	the same depth	electrical stimulation	Sham EA type L
Yeh *et al.* 2012 Taiwan[86]	Shivering during regional anesthesia	4/4	40/40	0(0/0)	Shivering score and tympanic temperature	T > C	non-acupuncture points	superficial penetration	no electrical stimulation	Sham EA type O
Yu *et al.* 2011 Taiwan[87]	Benign Prostate Hyperplasia	6/6	21/21	5(3/2)	The change of the maximum flow rate, average flow rate, void volume	T > C	non-acupuncture points	superficial penetration	no electrical stimulation	Sham EA type O

Continued

Reference (author, year and country)	Diseases	No. of acupoint (T/C)	Sample size (T/C)	dropout (T/C)	Primary outcome measures	Difference between groups	Characteristic of sham electro-acupuncture (EA) methods			
							needle location	degree of needle insertion	electrical stimulation	The type of sham EA method
Ma *et al.* 2011 China[88]	Pain	2/2	116/117	0(0/0)	VAS score	T > C	therapeutic acupoint	no penetration	no electrical stimulation	Sham EA type B
Li *et al.* 2013 China[89]	Intraoperative immunosuppression	10/6	19/19	0(0/0)	the levels of TNFα, IL-8, IL-10, IgM, IgA, IgG and full blood count	ND	non-acupuncture points	the same depth	electrical stimulation	Sham EA type L
Deluze *et al.* 1992 Switzerland[90]	Fibromyalgia	4-10/4	36/34	15(8/7)	Pain threshold, number of analgesic tablets used, VAS score	T > C	non-acupuncture points	superficial penetration	electrical stimulation	Sham EA type N
Ng *et al.* 2013 Hong Kong[91]	Postoperative ileus	4/4	55/55	0(0/0)	Time to defecation	T > C	non-acupuncture points	superficial penetration	no electrical stimulation	Sham EA type O
Lee and Lee 2009 Republic of Korea[92]	Chronic Prostatitis / Chronic Pelvic Pain Syndrome	6/6	13/13	5(2/3)	NIH-CPSI	T > C	Non-acupuncture points	superficial penetration	no electrical stimulation	Sham EA type O
Tam *et al.* 2007 Hong Kong[93]	Rheumatoid arthritis	6/6	12/12	5(0/5)	VAS	ND	Therapeutic acupoint	Superficial penetration	No electrical stimulation	Sham EA type D
Kvorning and Akeson 2010 Sweden[94]	Anaesthesia	12/12	22/23	0(0/0)	Plasma levels of adrenaline	T > C	Therapeutic acupoint	No penetration	No electrical stimulation	Sham EA type A
Waite and Clough 1998 UK[95]	Smoking cessation	2/2	40/38	0(0/0)	Biochemically validated total cessation of smoking	T > C	Non-acupuncture points	superficial penetration	Electrical stimulation	Sham EA type N
Holzer *et al.* 2011 Austria[96]	Postoperative pain	3/3	20/20	0(0/0)	VAS scores and the consumption of piritramide	ND	Therapeutic acupoint	No penetration	No electrical stimulation	Sham EA type A
Sator-Katzenschlager *et al.* 2006 Austria[97]	Perioperative pain	3/3	32/30	1(0/1)	VAS scores, adverse event and analgesic drug consumption	T > C	Therapeutic acupoint	No penetration	No electrical stimulation	Sham EA type A
Liu *et al.* 2011 China[98] a	Primary dysmenorrhea	1/1	50/50	5(3/2)	VAS scores	ND	Nonspecific acupuncture points	The same depth	Electrical stimulation	Sham EA type F
Liu *et al.* 2011 China[98] b	Primary dysmenorrhea	1/1	50/46	6(3/3)	VAS scores	ND	Non-acupuncture points	The same depth	Electrical stimulation	Sham EA type L
Liu *et al.* 2014 China[99] a	Primary dysmenorrhea	2/2	167/167	6(4/2)	VAS scores	T > C	Nonspecific acupuncture points	The same depth	Electrical stimulation	Sham EA type F
Liu *et al.* 2014 China[99] b	Primary dysmenorrhea	2/2	167/167	6(4/2)	VAS scores	T > C	Non-acupuncture points	The same depth	Electrical stimulation	Sham EA type L
Maeda *et al.* 2013 USA[100] 1	Carpal tunnel syndrome	2/2	22/19	0(0/0)	functional MRI, VAS scores	T > C	Non-acupuncture points	No penetration	No electrical stimulation	Sham EA type F
Maeda *et al.* 2013 USA[100] 2	Carpal tunnel syndrome	2/2	18/19	0(0/0)	functional MRI, VAS scores	T > C	Non-acupuncture points	No penetration	No electrical stimulation	Sham EA type F
Shi *et al.* 2011 China[101] a	Primary dysmenorrhea	1/1	10/10	0(0/0)	VAS scores, The plasma PGE_2, PGF_{2a}, TXB_2, and 6-keto PGF_{1a} levels	ND	Nonspecific acupuncture points	The same depth	Electrical stimulation	Sham EA type F
Shi *et al.* 2011 China[101] b	Primary dysmenorrhea	1/1	10/10	0(0/0)	VAS scores, The plasma PGE2, PGF2a, TXB2, and 6-keto PGF1a levels	ND	Non-acupuncture points	The same depth	Electrical stimulation	Sham EA type L
Dias *et al.* 2010 Brazil[102]	Local anaesthesia	8/8	16/17	0(0/0)	VAS scores	ND	Therapeutic acupoint	No penetration	No electrical stimulation	Sham EA type A
Zhang *et al.* 2013 Hong Kong[103]	Chronic neck Pain	5/5	103/103	46(19/27)	NPQ scores	ND	Therapeutic acupoint	No penetration	No electrical stimulation	Sham EA type A
Sangdee *et al.* 2002 Thailand[104]	Osteoarthritis of the knee	4/4	48/47	4(2/2)	VAS score, and Lequesne's functional index	T > C	Therapeutic acupoint	No penetration	No electrical stimulation	Sham EA type A
Johansson *et al.* 2001 Sweden[105]	Stroke rehabilitation	9–10/4	48/51	20(11/9)	The scores of Barthel Index, the Rivermead Mobility Index and NHP, the time needed to walk 10 meters	ND	Therapeutic acupoint	No penetration	Electrical stimulation	Sham EA type B
Hopwood *et al.* 2008 UK[106]	Stroke recovery	8–10/6	57/48	13(10/3)	The scores of Barthel Index	ND	Therapeutic acupoint	No penetration	No electrical stimulation	Sham EA type A

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Reference (author, year and country)	Diseases	No. of acupoint (T/C)	Sample size (T/C)	dropout (T/C)	Primary outcome measures	Difference between groups	Characteristic of sham electro-acupuncture (EA) methods			
							needle location	degree of needle insertion	electrical stimulation	The type of sham EA method
White *et al.* 1998 England[107]	Tobacco addiction	2/2	38/38	24 (11/13)	VAS score	ND	Non-acupuncture points	No penetration	No electrical stimulation	Sham EA type Q
Dias *et al.* 2014 Brazil[108]	Stress-related symptoms	13/8	33/20	5(3/2)	The scores of MSQ, PSQI and MBI-SS	T > C	Therapeutic acupoint	No penetration	No electrical stimulation	Sham EA type A
Lin *et al.* 2013Taiwan[109]	Insulin Resistance	2/2	16/15	1(1/0)	Plasma glucose	ND	Therapeutic acupoint	No penetration	No electrical stimulation	Sham EA type A
Michalek-Sauberer *et al.* 2007 Austria[110]	Perioperative pain	3/3	76/36	24(16/8)	5-point verbal rating scale, Time and amount of analgesic intake	ND	Therapeutic acupoint	No penetration	No electrical stimulation	Sham EA type A
Carlsson and Sjolund 2001 Sweden[111]	Chronic Low Back Pain	4/2	16/16	0(0/0)	VAS scores, Intake of analgesics, Sleep quality and level of activity	T > C?	Non-acupuncture points	No penetration	No electrical stimulation	Sham EA type Q

Table 1. Characteristics of 94 included studies. T, treatment group/real EA group; C, control group/sham EA group; NS, not stated; T > C, EA treatment group was significantly superior to sham EA control group; ND, no difference between EA and sham EA group; T < C, real EA group was significantly inferior to sham EA group; T > C?, the efficacy result of trial was reported as "T > C" without conducting the between-group analysis and with the original data not available; NRS, Numerical Rating Scale; SF_MPQ, Short-Form McGill Scale; FMRI, Functional magnetic resonance imaging; MASS, the Massachusetts General Hospital Acupuncture Sensation Scale; WOMAC, The Western Ontario and McMaster University Osteoarthritis Index; EPDS, Edinburgh Postnatal Depression Scale; HADS, Hospital Anxiety and Depression Scale; $HDRS_{17}$, 17-item Hamilton Rating Scale for Depression; CGI, Clinical Global Impression; FMA, Fugl-Meyer Assessment; VAS, Visual Analog Scale; NIHSS, the National Institutes of Health Stroke Scale. BW, body weight; BMI, body mass index; BFM, body fat mass; BPI, Brief Pain Inventory; EDSS, Expanded Disability Status Scale; FAMS, Functional Assessment of multiple Sclerosis; C-MMASS, Modified Massachusetts General Hospital Acupuncture Sensation Scale – Chinese version; HR, Heart rate; MAP, mean arterial blood pressure; OLM, opioid-like medication; TNF-α, tumor necrosis factor-α; IL-8, interleukin-8; IL-10, interleukin-10; HDRS, Hamilton Depression Rating Scale; HAMD-17, the 17-item Hamilton Rating Scale for Depression; SDS, the Chinese-version Self-rating Depression Scale; SPT, single pain threshold; TST, temporal summation thresholds; R1, angle of muscle reaction; R2, passive range of motion; R2–R1, dynamic component; ISI, The Insomnia Severity Index; PSQI, the Pittsburgh Sleep Quality Index; CGI-S, the Clinical Global Impression - Severity scale; BPI-SF, Brief Pain Inventory Short Form; FACT-G instrument, the Functional Assessment of Cancer Therapy-General instrument; 24-item HAMD, the 24-item Hamilton Depression Rating Scale; TFM, Trunk Fat Mass; WC, Waist Circumference; HC, Hip Circumference; VAS-100, a 100-mm visual analogue scale; BOLD fMRI, blood oxygen level dependent functional magnetic resonance imaging; IPSS, the International Prostate Symptom Score; GCSI, the Gastroparesis Cardinal Symptom Index; SEPs, somatosensory evoked potentials; MVC, maximal voluntary contraction; NIH-CPSI, NIH-Chronic Prostatitis Symptom Index; NPQ, the Northwick Park Neck Pain Questionnaire; NHP, the Nottingham Health Profile; MSQ, Mini-Sleep Questionnaire; MBI-SS, the Maslach Burnout Inventory—Student Survey. Note: Sham EA type A: sham EA on therapeutic acupoints plus no penetration plus no electrical stimulation; Sham EA type B: sham EA on therapeutic acupoints plus no penetration plus electrical stimulation; Sham EA type C: sham EA on therapeutic acupoints plus the same depth plus no electrical stimulation; Sham EA type D: sham EA on therapeutic acupoints plus superficial penetration plus no electrical stimulation; Sham EA type F: sham EA on nonspecific acupuncture points plus the same depth plus electrical stimulation; Sham EA type L: sham EA on non-acupuncture points plus the same depth plus electrical stimulation; Sham EA type M: sham EA on non-acupuncture points plus the same depth plus no electrical stimulation; Sham EA type N: sham EA on non-acupuncture points plus superficial penetration plus electrical stimulation; Sham EA type O: sham EA on non-acupuncture points plus superficial penetration plus no electrical stimulation; Sham EA type Q: sham EA on non-acupuncture points plus no penetration plus no electrical stimulation.

differences between groups in withdrawals from the treatment. The rest were unclear due to lack of information on this aspect. Sixteen studies[36,39,41,42,44,59,63,64,75,79,80,86,91,93,98,99] were free of selective reporting; one study[65] was sorted as "no" due to an incomplete outcome measurement report that had been registered in protocol; the others were unclear because such details were not found. Of the 91 trials that provided the information on other bias, 77 studies[18–56,60–68,70,72–76,79,80,83–89,91–97,99,101,103–105,109,111] were free of other bias; 14 studies[57–59,69,78,81,82,90,98,102,106–108,110] were assessed as "no" due to the statistical differences in baseline variables regarding as the most important prognosis. The details on the risk of bias studies were summarized in Table 2.

Reference (author, year and country)	A	B	C	D	E	F	G	H
Ntritsou *et al.* 2014 USA[18]	+	+	+	−	+	+	?	+
Chu *et al.* 2012 Hong Kong[19]	+	+	+	−	+	+	?	+
Wang *et al.* 2010 Denmark[20]	+	+	+	−	+	+	?	+
Zyloney *et al.* 2010 USA[21]	+	−	+	−	+	?	?	+
Jubb *et al.* 2008 UK[22]	+	−	+	−	+	+	?	+
Chung *et al.* 2012 Hong Kong[23]	+	+	+	−	+	−	?	+
Barlas *et al.* 2006 UK[24]	+	−	+	−	+	?	?	+
Wayne *et al.* 2005 US[25]	+	+	+	−	+	+	?	+
Sahin *et al.* 2010 Turkey[26]	+	+	+	−	+	+	?	+
Fanti *et al.* 2003 Italy[27]	+	−	+	−	+	+	?	+
Hsing *et al.* 2012 Brazil[28]	+	−	+	−	+	+	?	+
Gosman-Hedström *et al.* 1998 Sweden[29]	+	+	+	−	+	+	?	+
Jing *et al.* 2009 China[30]	+	+	+	−	+	+	?	+
Kong *et al.* 2009 USA[31]	+	−	+	−	+	?	?	+
Darbandi *et al.* 2013 Iran[32]	+	?	+	−	+	?	?	+
Yang *et al.* 2012 China[33]	+	?	+	−	+	+	?	+
Liu *et al.* 2013 China[34]	+	+	+	−	+	+	?	+
Zhang *et al.* 2014 China[35]	+	+	+	−	+	+	?	+
Mao *et al.*2014 USA[36]	+	+	+	−	+	+	+	+
Leung *et al.* 2011 Hong Kong[37]	+	+	+	−	+	+	?	+
Rusy *et al.* 2002 USA[38]	+	?	+	−	+	+	?	+
Yang *et al.* 2014 China[39]	+	?	+	−	+	+	+	+
Chen *et al.* 2013 China[40]	+	?	+	−	+	+	?	+
Quispe-Cabanillas *et al.* 2012 Brazil[41]	+	?	+	−	+	+	+	+
Aranha *et al.* 2015 Brazil[42]	+	?	+	−	+	−	+	+
Yu *et al.* 2013 Hong Kong[43]	+	+	+	?	+	+	?	+
Li *et al.* 2010 China[44]	+	+	+	−	+	+	+	+
Zheng *et al.* 2007 Australia[45]	+	+	+	−	+	−	?	+
Li *et al.* 2013 China[46]	+	?	+	?	+	+	?	+
Lin *et al.* 2002 Taiwan[47]	+	?	+	?	+	+	?	+
Chen *et al.* 2013 Taiwan[48]	+	?	+	−	+	−	?	+
Schukro *et al.* 2014 Austria[49]	+	?	+	?	+	+	?	+
Yu *et al.* 2014 China[50]	+	?	+	−	+	+	?	+
Xie *et al.* 2014 China[51]	+	?	+	?	+	+	?	+
Sim *et al.* 2002 Singapore[52]	+	?	+	−	+	+	?	+
Song *et al.* 2009 China[53]	+	?	+	?	+	?	?	+
Shafshak 1995 Egypt[54]	+	?	+	?	?	?	?	+
Franasiak *et al.* 2012 USA[55]	+	+	+	−	+	+	?	+
Naslund *et al.* 2002 Sweden[56]	+	?	+	−	+	?	?	+
Shen *et al.* 2000 US[57]	+	+	+	−	+	+	?	−
Wyon *et al.* 2004 Sweden[58]	+	+	+	−	+	+	?	−
Zhang *et al.* 2012 Hong Kong[59]	+	?	+	−	+	+	+	−
Zheng *et al.* 2010 Australia[60]	+	+	+	−	+	+	?	+
Ma *et al.* 2010 China[61]	+	+	+	−	+	+	?	+
Wang *et al.* 2014 Taiwan[62]	+	?	+	−	+	+	?	+
Yeung *et al.* 2011 Hong Kong[63]	+	+	+	−	+	+	+	+
Chan *et al.* 2014 Taiwan[64]	+	+	+	−	+	+	+	+
Man *et al.* 2014 Hong Kong[65]	+	+	+	−	+	+	−	+
Oh *et al.* 2013 Australia[66]	+	+	−	−	−	+	?	+
Wong *et al.* 2006 Hong Kong[67]	+	+	+	−	+	+	?	+
Song *et al.* 2007 USA[68]	+	?	+	?	+	?	?	+
Cameron *et al.* 2011 Australia[69]	+	+	+	−	+	−	?	−
Darbandi *et al.* 2014 Iran[70]	+	?	+	−	+	+	?	+
Wei *et al.* 2008 China[71]	+	+	+	?	?	+	?	?
Wang *et al.* 2007 USA[72]	+	+	+	−	+	+	?	+
Kvorning *et al.* 2003 Sweden[73]	+	?	+	−	+	+	?	+

Continued

Reference (author, year and country)	A	B	C	D	E	F	G	H
Kvorning *et al.* 2003 Sweden[74]	+	?	+	−	+	+	?	+
Yang *et al.*2010 China[75]	+	?	+	−	+	+	+	+
Sahmeddini *et al.*2010 Iran[76]	+	+	+	?	+	+	?	+
Wang *et al.* 2007 China[77]	+	?	+	−	+	+	?	?
Jia *et al.* 2009 China[78]	+	?	+	?	+	+	?	−
Wang et al. 2013 China[79]	+	+	+	−	+	+	+	+
Andreescu *et al.* 2011 Canada[80]	+	?	+	−	+	+	+	+
Yeung *et al.* 2009 Hong Kong[81]	+	+	+	−	+	+	?	−
Chen *et al.* 2014 Taiwan[82]	+	?	+	?	+	+	?	+
Wang *et al.* 2008 China[83]	+	?	+	−	+	+	?	+
Meissner *et al.* 2004 Germany[84]	+	+	+	−	+	+	?	+
Zhou *et al.* 2012 China[85]	+	?	+	−	+	+	?	+
Yeh *et al.* 2012 Taiwan[86]	+	+	+	−	+	+	+	+
Yu *et al.* 2011 Taiwan[87]	+	?	+	−	+	+	?	+
Ma *et al.* 2011 China[88]	+	+	+	−	+	+	?	+
Li *et al.* 2013 China[89]	+	?	+	?	+	+	?	+
Deluze *et al.* 1992 Switzerland[90]	+	+	+	−	+	+	?	−
Ng *et al.* 2013 Hong Kong[91]	+	+	+	−	+	+	+	+
Lee and Lee 2009 Republic of Korea[92]	+	?	+	−	+	+	?	+
Tam *et al.* 2007 Hong Kong[93]	+	+	+	−	+	−	+	+
Kvorning and Akeson 2010 Sweden[94]	+	?	+	−	+	+	?	+
Waite and Clough 1998 UK[95]	+	?	+	?	+	+	?	+
Holzer *et al.* 2011 Austria[96]	+	?	+	−	+	+	?	+
Sator-Katzenschlager *et al.* 2006 Austria[97]	+	?	+	−	+	+	?	+
Liu *et al.* 2011 China[98]	+	+	+	−	+	+	+	−
Liu *et al.* 2014 China[99]	+	+	+	−	+	+	+	+
Maeda *et al.* 2013 USA[100]	+	?	+	−	+	+	?	?
Shi *et al.* 2011 China[101]	+	?	+	?	+	+	?	+
Dias *et al.* 2010 Brazil[102]	+	?	+	?	+	+	?	−
Zhang *et al.* 2013 Hong Kong[103]	+	?	+	?	+	+	?	+
Sangdee *et al.* 2002 Thailand[104]	+	?	+	−	+	+	?	+
Johansson *et al.* 2001 Sweden[105]	+	+	+	−	+	+	?	+
Hopwood *et al.* 2008 UK[106]	+	+	+	−	+	−	?	−
White *et al.* 1998 England[107]	+	+	+	−	+	−	?	−
Dias *et al.* 2014 Brazil[108]	+	?	+	−	+	+	?	−
Lin *et al.* 2013Taiwan[109]	+	+	+	−	+	+	?	+
Michalek-Sauberer *et al.* 2007 Austria[110]	+	+	+	−	+	+	?	−
Carlsson and Sjolund 2001 Sweden[111]	+	+	+	−	+	+	?	+

Table 2. Risk of bias of included studies. Note: A, Adequate sequence generation; B, Allocation Concealment; C, Blinding (participants); D, Blinding (personnel); E, Blinding (outcome assessor); F, Incomplete outcome data addressed; G, Free of selective reporting; H, Free of other bias. +, Yes; −, No; ?, Unclear.

Credibility of blinding. Only 24 out of the 94 studies reported the credibility of blinding in participants by conducting the creditability test in six types of sham EA methods. Twenty-three studies[22,23,25,34,36,45,52,57,59,60,63,65,72,81,88,97,102,103,105–108,110] proved to be successful and one study[66] proved to be failure. All six types of sham EA methods were claimed to be successful in blinding. They are sham EA type A (10/24 with 1 failure)[22,60,66,81,97,102,103,106,108,110], type B (5/24)[23,59,65,88,105], type Q (5/24)[25,34,36,52,107], sham EA type O (2/24)[45,57], sham EA type D (1/24)[72], and sham EA type N (1/24)[63].

Efficacy results of the included studies. All 94 studies involving 105 comparisons of real and sham EA groups provided the information for between-groups analyses. Among them, 59 real EA groups[18,19,21,22,24,28,30,33–35,37,38,40–44,48,49,51,53,54,57,59–65,69–73,75,77–79,83,84,86–88,90–92,94,95,97,99,100,104,108] reported significant superiority over corresponding sham EA groups; forty-three real EA groups were not statistically better than sham EA groups; one study[74] showed that sham EA group was superior to the real EA group; the remaining two studies[50,111] lacked original data for between-groups analyses and were stated as "T > C?". The efficacy results of the studies are listed in Table 1 and summarized in Table 3 according to different types of sham EA methods and EA indications.

Compared with sham EA controls, EA therapy in about 56.2% (59/105 comparisons) of comparisons reported the specific effect. Correspondingly, the real EA was superior to sham EA for type N (75%, 3/4 comparisons), type

electro-acupuncture (EA) indications	The type of sham EA method										The NO. of reference included
	Sham EA type A 26 control groups	Sham EA type B 7 control groups	Sham EA type C 7 control groups	Sham EA type D 6 control groups	Sham EA type F 7 control groups	Sham EA type L 17 control groups	Sham EA type M 3 control groups	Sham EA type N 4 control groups	Sham EA type O 14 control groups	Sham EA type Q 10 control groups	
Pain 32 RCTs	T > C 8 comparisons ND 7 comparisons	T > C 3 comparisons ND 1 comparison	T > C 1 comparison ND 3 comparisons	T > C 1 comparison		ND 2 comparisons	T > C 1 comparison	T > C 1 comparison	T > C 1 comparison ND 2 comparisons	ND 2 comparisons T > C? 1 comparison	T > C 16 ND 17 T > C? 1
Obesity 4 RCTs			T > C 1 comparison			T > C 2 comparisons			T > C 1 comparison ND 1 comparison		T > C 4 ND 1
Anesthesia 8 RCTs	T > C 2 comparisons ND 1 comparison T < C 1 comparison					ND 2 comparisons T > C? 1 comparison			T > C 1 comparison		T > C 3 ND 3 T < C 1 T > C? 1
Stroke 7 RCTs	ND 1 comparison	ND 1 comparison	T > C 1 comparison	T > C 1 comparison ND 1 comparison						T > C 1 comparison ND 1 comparison	T > C 3 ND 4
Depression 6 RCTs		T > C 2 comparisons ND 1 comparison				T > C 1 comparison	ND 1 comparison		ND 1 comparison		T > C 3 ND 3
Primary dysmenorrhea and (or) Menstrual Pain 4 RCTs					T > C 2 comparisons ND 2 comparisons	T > C 2 comparisons ND 2 comparisons					T > C 4 ND 4
Substance abuse 3 RCTs				T > C 1 comparison				T > C 1 comparison		ND 1 comparison	T > C 2 ND 1
Healthy 3 RCTs				T > C 1 comparison		T > C 1 comparison ND 2 comparisons					T > C 2 ND 2
Osteoarthritis 2 RCTs	T > C 2 comparisons										T > C 2
Migraine 2 RCTs					T > C 1 comparison	ND 1 comparison					T > C 1 ND 1
Nausea and Vomiting 2 RCTs					T > C 1 comparison				T > C 1 comparison	T > C 1 comparison	T > C 3
Postoperative ileus 2 RCTs									T > C 2 comparisons		T > C 2
Insomnia 2 RCTs	ND 1 comparison							ND 1 comparison		T > C 1 comparison	T > C 1 ND 2
benign prostate hyperplasia 2 RCTs						T > C 1 comparison			T > C 1 comparison		T > C 2
Diabetic mellitus 2 RCTs	ND 1 comparison							T > C 1 comparison			T > C 1 ND 1
Carpal tunnel syndrome 1 RCTs										T > C 2 comparisons	T > C 2
Rheumatoid arthritis 1 RCTs				ND 1 comparison							ND 1
Whiplash-associated disorders 1 RCTs							T > C 1 comparison				T > C 1
Constipation 1 RCTs						T > C 1 comparison					T > C 1
Multiple sclerosis 1 RCTs									T > C 1 comparison		T > C 1
Tinnitus 1 RCTs	ND 1 comparison										ND 1
Auditory hallucination 1 RCTs									T > C 1 comparison		T > C 1
ADHD (Attention deficit hyperactivity disorder) 1 RCTs			T > C 1 comparison								T > C 1

Continued

electro-acupuncture (EA) indications	The type of sham EA method										The NO. of reference included
	Sham EA type A 26 control groups	Sham EA type B 7 control groups	Sham EA type C 7 control groups	Sham EA type D 6 control groups	Sham EA type F 7 control groups	Sham EA type L 17 control groups	Sham EA type M 3 control groups	Sham EA type N 4 control groups	Sham EA type O 14 control groups	Sham EA type Q 10 control groups	
PCOS (Polycystic Ovary Syndrome) 1 RCTs										ND 1 comparison	ND 1
hot flushes in postmenopausal women 1 RCTs									ND 1 comparison		ND 1
Postpartum Insufficient Lactation 1 RCTs					T > C 1 comparison						T > C 1
Cardiac ischemia-reperfusion injury 1 RCTs			T > C 1 comparison								T > C 1
Stress-related symptoms 1 RCTs	T > C 1 comparison										T > C 1
The positive rate of efficacy result	T > C 13 ND 12 T < C 1 T > C? 0 53.8% (14/26 comparisons)	T > C 5 ND 3 62.5% (5/8 comparisons)	T > C 5 ND 3 62.5% (5/8 comparisons)	T > C 4 ND 2 66.7% (4/6 comparisons)	T > C 5 ND 2 71.4% (5/7 comparisons)	T > C 8 ND 9 T > C? 1 44.4% (8/18 comparisons)	T > C 2 ND 1 66.7% (2/3 comparisons)	T > C 3 ND 1 75% (3/4 comparisons)	T > C 9 ND 5 64.3% (9/14 comparisons)	T > C 5 ND 5 T > C? 1 45.5% (5/11 comparisons)	T > C 59 ND 43 T < C 1 T > C? 2 57.1% (60/105 comparisons)

Table 3. Summary of effect result within different type of sham electro-acupuncture methods and electro-acupuncture indications. NOTE: T > C, EA treatment group was significantly superior to sham EA control group; ND, no difference between EA and sham EA group; T < C, real EA group was significantly inferior to sham EA group; T > C?, the efficacy result of trial was reported as "T > C" without conducting the between-group analysis and with the original data not available.

F (71.4%, 5/7 comparisons), type D (66.7%, 4/6 comparisons) and type M (66.7%, 2/3 comparisons). The lowest percentage of positive efficacy result was 44.4% (8/18 comparisons) in sham EA type L. The positive rate of efficacy for the three most often used sham EA methods were 50% (13/26 comparisons) for sham EA type A, 44.4% (8/18 comparisons) for sham EA type L and 64.3% (9/14 comparisons) for sham EA type O.

The type of sham EA methods varied across different EA indications. The sham EA type A was most commonly used in RCTs for pain, anesthesia and osteoarthritis. The sham EA type D and sham EA type Q were applied mainly in stroke studies. The sham EA type B was commonly applied to RCTs on depression. The sham EA type L and sham EA type O were commonly performed in trials on obesity. The sham EA type F and sham EA type L were commonly used in studies on primary dysmenorrhea.

Discussion

To our knowledge, this is the first systematic analysis to address sham EA methods in RCTs. The numbers of publications and sham EA methods have been increasing every decade. We summarized seventeen kinds of sham EA methods according to three aspects as needle location, depth of needle insertion and electrical stimulation, whereas only ten types of sham EA methods were identified from 94 included RCTs involving 6134 participants. The three predominant types of sham EA methods used were sham EA type A, type L and type O ordinally. Only 24 out of 94 trials reported credibility test with the results of 23 success and 1 failure using six types of sham EA methods mainly as follows: sham EA type A (10/24 with 1 failure), type B (5/24) and type Q (5/24). The remaining 3 sham EA methods were only tested in 4 trials. About 56.2% of comparisons provided the evidence of specific effect of EA therapy, and the four types of Sham EA controls with highest positive rate of efficacy result were type N (75%, 3/4 comparisons), type F (71.4%, 5/7 comparisons), type D (66.7%, 4/6 comparisons) and type M (66.7%, 2/3 comparisons) ordinally. However, all types of Sham EA controls were used in a small number of trials. Thus, the evidence was insufficient to recommend any type of sham EA control despite of the high positive rate. The sham EA control was frequently used in RCTs for pain, anesthesia, stroke, depression, obesity and primary dysmenorrheal/menstrual pain, suggesting that these diseases are particularly worthy of further EA RCTs.

The ideal design of sham acupuncture method remains methodologically challenging[112]. Consequently, a great variety of emerging sham acupuncture methods have found their ways into present RCTs by using non-traditional Chinese medicine acupoint[26,27,113], no or superficial penetration[29] and no or suboptimal stimulation[28]. The sham procedures in acupuncture RCTs were previously summarized by He *et al.*[9] as seven types. A previous review by Dincer *et al.*[8] reported the classification of sham acupuncture as sham type I~V based on three respects as needle location, insertion and stimulation. In the present study, we focused on the sham EA methods according to three aspects as needle location, depth of needle insertion and electrical stimulation, and summarized seventeen types of sham EA methods. Ten types of sham EA methods were actually used in the included RCTs.

The main purpose of RCTs on EA is to evaluate its specific effect. An optimal sham acupuncture technique must be biologically inactive and psychologically credible[114]. A lot of practice has been done to make the sham

components of EA less perceptually and operationally distinguishable from real EA intervention for the purpose of keeping the blinding status of the participants. Streitberger needles, blunted needles and verum needles were frequently used with foam, tape or tube for hiding acupuncture loci from subjects[18,19,21,22]. Furthermore, a pricking sensation was elicited by dull tips for concealing the perceptual differences[20,21,23,52,60,63,67,81]. The sham EA device was often accompanied by indicator light or with sound signals for confusing the participants[18,22,37]. In the present study, six types of sham EA method were tested as concealable control in terms of blinding of participants.

The top three types of sham EA methods used were sham EA type A, type L and type O. The most frequently applied sham EA method was type A, accounting for a popular belief in its inertness based on its absence of key EA components as needle stimulation and electrical stimulation as well as its indistinguishable manipulation on same therapeutic acupoints. In the present study, the validation of credible participant blinding of this sham EA type was reported by most credibility tests. The debate emerged over the past decades over the inertness of non-penetrating procedure since the slight acupressure effects and physiological activity might be evoked by the tactile stimulation from blunt needle tips even without skin penetration[112,115]. Takayama *et al.*[116] argued that non-penetrating placebo needle is at least clinically inert for pain alleviation based on their cross-over study reporting no analgesic effects of the skin-touch placebo needle over that of the no-touch placebo or that of the no-treatment control. However, conclusive evidence are out of our awareness up to now whether non-penetrating but skin-touch placebo needle plays a specific therapeutic role in other medical condition. Thus, the sham EA type A may be an promising candidate control for further RCTs on analgesic effects of EA and relative further researches are called for in aspect of any other conditions.

Sham EA type Q is deemed to be the most inert type of sham EA control because it avoids all therapeutic components, which also probably makes this sham method perceptually and operationally distinguishable from real EA intervention and to some extent results in problematic credibility of blinding in participant. In the present study, the credibility of participant blinding of this sham EA type was endorsed by five studies with credibility test[25,34,36,52,107]. However, mechanical non-penetration can evoke brain responses in healthy subjects. Thus, controversy raised regarding whether this type of sham EA method is physiologically inert control[117]. Moreover, four-fifth of the studies were conducted on acupuncture naïve participants. There is a possibility that previous experience of acupuncture treatments might have an impact on present perception of verum and sham EA intervention, which should be rigorously controlled in EA RCTs to avoid bias from unblinding. With the informed consent lack of explicit information on the sham method, debates emerged over ethical acceptability of the study.

The second commonly used sham EA method was type L. It was found that the differential effects of real EA and sham EA, which were attributed to point location, was not consistent across studies and conditions within this sham EA type, suggesting that EA on non-acupoints might be efficacious as EA on therapeutic acupoints. Furthermore, the improvements from baseline were also observed by Sahin *et al.*[26], Li *et al.*[46] and Yu *et al.*[43] The similar findings were previously presented by Moffet *et al.*[118] showing that sham acupuncture at non-acupoints was as efficacious as true acupuncture. It seemed that in the above studies the specificity of acupoints does not exit and to some extent were in violation of traditional acupuncture theories. Li *et al.*[46] stated that the specificity of acupoints was not present in EA treatment. However, Wang *et al.*[79] argued for the specificity of acupoints in EA treatment based on the better effects of EA at acupoints than that at non-acupoints on certain clinical outcomes. From the heterogeneous evidence of acupoint specificity, no definitive conclusion could be drawn based on the paucity of available high-quality clinical trials[119]. The main issue in this sham EA type might lie in the accurate identification of non-acupoint rather than a rough location nearby traditional acupoint that might be responsible for specific effects, which rises the challenge of conducting appropriate sham control in EA clinical trials especially in the presence or absence of the mechanism of acupoint specificity and the consistency in finding actual point across the different practitioners. Nevertheless, it is unclear whether this type is a concealable control for participant blinding since this sham EA tested credibility in the present study. Therefore, it demonstrates that sham EA type L might not be adequately controlled from inert or concealable perspective only if the mechanisms of acupoints were explicitly explored or the validation of so-called non-acupoint was verified by further researches. Cautions should be taken for eliminating bias from this sham EA control type.

The third commonly used sham EA was type O. During the procedure, the shallow insertion was applied to simulate deep skin penetration and to ensure the blinding of participant. In the present study, the validation of participant blinding of this sham EA type was endorsed by two studies[45,57]. As for the issue of inertness, a few studies reported that sham EA control improved baseline in certain clinical parameters compared with conventional group[32,46,56–58]. Moffet *et al.*[118] stated that shallow needling at non-acupoints might be as efficacious as real acupuncture. Lund *et al.*[120] reported that minimal acupuncture based on superficial insertion was not a valid control from a physiological perspective. Hróbjartsson *et al.*[121] held the view that sham EA type was not inert control from Chinese medicine perspective. A sham EA procedure with superficial needling at non-acupoints might have subliminal effects since the locations of points was nearby true acupoints or myotome. Moreover, it is likely that the superficial insertion was not consistently applied since the needling depth varied across differentacupoints on different body parts and the relatively deep insertions might be conducted for taking the weight of the attached electrodes. Thus, this sham EA type may be concealable control but far from inert control in RCTs for EA, unless the extent to which the sham procedure could be regarded as physiologically inert has been clarified.

In the present study, six types of sham EA method were reported as successful in blinding. However, further investigations are needed for confirmation, since half of the tested types of sham EA controls were reported in a small number of trials. It should be noted that studies included did not provide sufficient evidence of blinding in acupuncturist. Vase *et al.*[122] stated that it was hard to get acupuncture intervention fully double-blinded. Although non-penetrating needle was previously reported as potential sham control to mask both participants and practitioners in acupuncture research[123–125], a previous review demonstrated that the acupuncture intervention was not fully double-blinded[122]. New strategies should be implemented for the development of double-blind sham EA control in terms of both participants and acupuncturists.

RCTs are generally recognized as the gold standard for the efficacy of clinical interventions by excluding the non-specific effect via a placebo control[126]. However, one study reported that the effect of EA therapy was merely the non-specific effect[63]. In the present study, the number of real EA group with superiority to, no difference from and inferiority to corresponding sham EA group was 59, 43 and 1, respectively. Thus, more than half comparisons demonstrated that EA therapy existed specific effects. Within all types of sham EA methods, the highest effective rate were type N (75% 3/4 comparisons), type F (71.4%, 5/7 comparisons), type D (66.7%, 4/6 comparisons) and type M (66.7%, 2/3 comparisons) successively. Considering the small number of included studies within corresponding sham EA type, the evidence are still insufficient to recommend any type of sham EA control despite of the high positive rate.

In the present study, 43/105 comparisons reported that EA has no specific effects compared with sham EA controls[20,23–27,29,31,32,36,39,43–47,52,55,56,58,63,66–68,76,80–82,85,89,93,96,98,101–103,105–107,109,110]. For a reason, the extent to which the individual component of EA intervention plays its therapeutic influences on the final outcomes is not clear during clinical treatment[7]. The debate consequently emerges regarding the therapeutic inactivity of sham EA control which is partially comprised of real EA components, such as suboptimal manual or electrical stimulation[110]. The probability in the specific effects of EA may be reduced by the potential activity produced by sham EA control. On the other hand, EA is a complex intervention method. Its therapeutic effects consist of specific effects from needling and stimulation components as well as moderately large nonspecific effects, which means that the efficacy results of RCTs for EA are more likely to be influenced by a variety of factors, such as patient/practitioner interaction and patient expectations[127,128]. In the clinical use, EA may be more effective than manual acupuncture in some situations such as when strong, continued stimulation is required, and when treating pain, anesthesia, stroke, depression, obesity and primary dysmenorrhea/menstrual pain, suggesting that further RCTs with appropriate sham EA control are in need to verify the specific effects on above conditions.

There are several weaknesses in the present study. Firstly, the search and screen procedure were limited to randomized, parallel-controlled trials published in English. Thus, those trials with cross-over design or published in other than English language were omitted. Secondly, with the aim of evaluating the sham method in RCTs on EA, a generous criterion was established to select eligible studies. Therefore, it was not easy to examine the specific effect of EA by data synthesis from different outcomes and indications because of the heterogeneity of trials. Finally, the reported credibility test addressed blinding effects in participant rather than in both participant and acupuncturist. The credibility tests were not reported in all studies and the number of studies using sham EA types was small, and therefore the conclusion should be interpreted with cautions.

Conclusion

Ten types of sham EA methods were identified based on our scheme classification. Generally, sham EA type A, type L and type O were frequently used. Yet, further clinical trials are recommended to maintain standard methodology of concealable and inert placebo EA techniques. Only 24 out of 94 trials were reported as positive credibility test in six types of sham EA methods, where sham EA type A, type B and type Q were highly practiced. It is worthy to study further about the importance of concealable sham EA types. EA therapy in approximately, 56.2% of comparisons provided the specific effects. The four types of sham EA (N, F, D and M respectively) represented the highest positive rate of efficacy results. However, progressive evidences on specific effects are mandatory. The sham EA control was observed frequently in pain, anesthesia, stroke, depression, obesity and primary dysmenorrhea RCTs. Also, broader studies in these predominant diseases are advised.

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Author Contributions

Z.-X.C., Y.L., X.-G.Z., S.C., W.-T.Y., X.-W.Z. and G.-Q.Z. participated in its design, searched databases, extracted and assessed studies and drafted the manuscript. Z.-X.C., Y.L., X.-G.Z., S.C., W.-T.Y., and X.-W.Z. analyzed

data and carried out the statistical analysis. G.-Q.Z. acted as an arbitrator in the review. G.-Q.Z. conceived and designed the article, supervised the study and contributed to finalize the manuscript. All authors reviewed the manuscript.

Additional Information

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