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Review Article

Electroacupuncture for Carpal Tunnel Syndrome: A Review of Randomized Controlled Trials

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ABSTRACT

This study aimed to examine the clinical efficacy of electroacupuncture treatment for carpal tunnel syndrome by reviewing published randomized controlled trials. Among the 186 studies retrieved from 7 online databases (PubMed, Cochrane library, CNKI, NDSL, RISS, OASIS, KMbase) on October 29, 2021, 4 studies were selected according to the inclusion, exclusion criteria, and were evaluated using risk of bias. Control groups for electroacupuncture were wearing a splint at night, traditional acupuncture, and medication. Methods such as total effective, functional status scale, symptom severity scale, electromyography, tip pinch strength, visual analogue scale, numeric rating scale, and ultrasound were used to evaluate the therapeutic effect. Electroacupuncture was reported to have significant treatment results compared with the control group in methods such as total effectiveness, electromyography, and tip pinch strength. However, the quality of the studies (using risk of bias) does not allow reliable conclusions to be made. Many high quality (low risk of bias) randomized controlled trials are needed to examine the efficacy of electroacupuncture treatment for carpal tunnel syndrome.

Introduction

Carpal tunnel syndrome (CTS) presents with symptoms such as numbness, burning or tingling, pain, and abnormal sensation resulting from the distribution of the median nerve in the hand and weakness of the thenar muscle group [1]. CTS has been reported to occur at a frequency of 1 in 10, has a high incidence in the 40-74-year age group, and females have a higher incidence than males [2].

It occurs when the median nerve is compressed in the carpal tunnel due to various factors that can reduce the space of the carpal tunnel, such as malunion distal radius fracture, edema, or tumor caused by infection or trauma [3]. The pain may appear whilst sleeping and awaken the individual, and squeezing the hand aggravates the symptoms. Diagnosis of CTS is usually based on clinical symptoms and physical examination such as Phalen's test, Tinel's sign, and muscle strength evaluation. Electromyography (EMG) and nerve conduction tests are performed to confirm the diagnosis [4].

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When diagnosed with CTS, the treatment advised is conservative management, such as reducing repetitive action at work or in the home, and immobilizing the wrist with a splint [5]. In Western medicine, conservative treatment methods include splinting the wrist, cutting down on any repetitive action, use of nonsteroidal anti-inflammatory drugs, injecting steroids into the carpal tunnel [6,7], and hand exercises. Surgical treatment is sometimes performed to relieve internal pressure [8]. However, the typical use of nonsteroidal anti-inflammatory drugs may cause side effects such as gastrointestinal disorders [9]. In the case of surgical treatment, permanent nerve damage may occur, and the post-surgery recovery period is long [9].

Electroacupuncture is a method of treating conditions/diseases by inserting needles into 2 or more acupuncture points and passing a weak current through the needle to induce electrical stimulation. Electroacupuncture can be applied to relieve pain after surgery, during delivery, and as treatment for acute and chronic pain, and it has also been used as anesthesia [10].

The incidence of CTS is high and can be expected to increase in the future with a growing population. Therefore, reports on randomized controlled trials (RCTs) related to electroacupuncture treatment of CTS were analyzed to determine clinical efficacy.

Materials and Methods

Data sources and eligibility criteria

Two independent researchers searched for studies published before October 20, 2021, in publication databases (PubMed, Cochrane library, CNKI, NDSL, RISS, OASIS, and KMbase). No restrictions were placed on country, language, or publication date. A total of 7 databases were searched for RCT studies where electroacupuncture treatment was given to treat CTS.

Search terms related to CTS, median nerve compression, electroacupuncture, and electrotherapy were combined in Korean databases (NDSL, RISS, and OASIS). The search terms (carpal tunnel syndrome) OR (CTS) OR (median nerve compression OR median nerve entrapment) AND (electro-acupuncture) OR (electrotherapy) OR (electro-acupuncture) OR (electrical stimulation) OR (electrical treatment) were used in international databases (PubMed and Cochrane library). In the Chinese database (CNKI), the search terms used were in Chinese and related to CTS, electroacupuncture, electrotherapy, and electrical stimulation and were combined.

Eligibility criteria

The inclusion criteria included: (1) adults with CTS; (2) a randomized controlled study using electroacupuncture; (3) outcome variables that can determine whether CTS improved; (4) electroacupuncture treatment was conducted in the treatment group and compared with the control treatment; and (5) the control group received Western medicine treatment or a combination of Western medicine treatment and Oriental medicine treatment.

The exclusion criteria included: (1) adults without CTS; (2) electroacupuncture was not the therapeutic intervention; (3) non-randomized control study, case-control study, single-arm pre- and post-clinical trial, case group and case report, laboratory study, literature review study, study protocol, literature or letters; (4) did not include outcome variables that could determine whether CTS improved; (5) intervention group treatment included electroacupuncture treatment and other treatments, and compared the results with the control treatment.

Data collection and risk of bias

Study retrieval and data extraction were conducted by 3 researchers. In case of disagreement, further review of the studies was performed and discussion, which was sufficient to reach a consensus, was carried out between the 3 researchers. Duplicate studies were removed. Only RCT studies that met the selection and exclusion criteria was selected. In each article, information on individuals and condition/disease characteristics, control and treatment group intervention methods, evaluation and outcome indicators, treatment effects and effectiveness were obtained.

All of the selected articles were randomized through Cochrane's risk of bias tool in accordance with the National Evidence-based Healthcare Collaborating Agency guidelines for the evaluation of RCT bias, the order of randomization, the concealment of the order of assignment, blinded to study participants and researchers, blinded to outcome evaluation, and incomplete Bias evaluation was conducted on 6 items, including result data, selective result report, and other bias [11]. Two investigators used risk of bias through consensus to rate the studies as low risk of bias, high risk of bias, or uncertain risk of bias. In the case of a disagreement between the 2 researchers, intervention by a 3rd researcher was employed for resolution.

Results

As a result of searching 7 databases, 111 articles were retrieved from the Cochrane library, 41 from PubMed, and 34 from CKNI. There were no results in the remaining 4 databases, so a total of 186 articles were reviewed, amongst which there were 5 duplicate studies. Primarily based on the title and the abstract, 62 studies were not related to CTS, 12 studies did not use electroacupuncture as an intervention method, 85 studies were not RCTs, 7 studies used electroacupuncture and other treatments in the intervention group, and 4 studies included individuals with mixed conditions/diseases. There was 1 study excluded because it was not a study in humans. A total of 10 articles were reviewed in full. As a result of reviewing the original text, 2 studies used electroacupuncture treatment as a control group and were excluded, 2 studies used a combination of electroacupuncture and other treatment methods, 1 study used electroacupuncture treatment for rehabilitation after surgery for CTS, and 1 study had unclear outcome indicators. A total of 4 studies were selected (Fig. 1).

Years of publication

All reviewed studies were published after 2010. The annual distributions were: 1 published in 2012, 1 in 2016, and 2 in 2018

(Table 1).

Diagnostic criteria

All 4 reviewed studies diagnosed CTS according to each diagnostic criterion. In the RCT by Xie et al [12], individuals with mild to moderate condition/disease stage according to the diagnostic criteria for condition/disease in the Department of Orthopedics were studied. In the RCT by Kumnerddee and Kaewtong [13], individuals who met the American Academy of Neurology clinical diagnostic criteria were studied. In the RCT by Chung et al [14], individuals were classified according to the Katz hand diagram, and were required to meet at least 2 of the 3 clinical tests (i.e., Phalen maneuver test, Tinel sign test, and the wrist flexion and median nerve compression test) [12]. In the study by Zhao et al [16], cases were studied where ① numbness of the median nerve or hand and ② pain or decreased sensation or other abnormalities in the hand where present, as well as ③ numbness and pain or swelling, numbness in the hand at night or early in the morning, or ④ a history of numbness and pain in the wrist (aggravated by repeated movement which may be relieved by shaking hands; heavier in winter than in summer), or ⑤ weakness in clenching the fist or holding objects, or ⑥ muscle atrophy, or ⑦ a positive Tinel sign or Phalen sign.

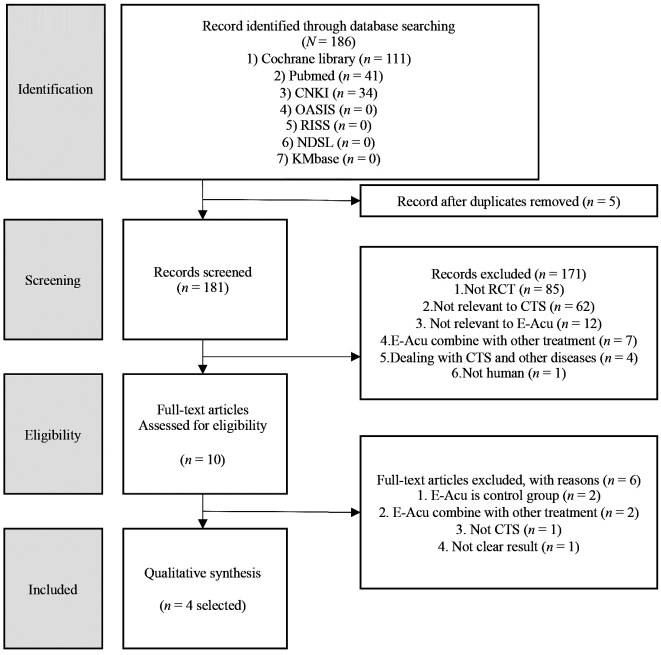

Fig. 1. Flow diagram according to the diagram of PRISMA.

Exclusion criteria

The criteria for exclusion in the 4 RCTs included in this review was individuals who have recently undergone surgical or pharmacological treatment related to carpal tunnel occlusion, or who have a medical condition that may interfere with the evaluation of CTS symptoms, such as pregnancy, neuropathy, muscular atrophy, polyneuropathy, or alcoholism.

Study sample sizes and treatment numbers and periods

The number of individuals of the selected study varied from a minimum of 50, to a maximum of 181, and all 4 studies had a higher proportion of women. There were 3 studies that indicated the minimum, maximum, mean, and standard deviation (SD) for age, and 1 study displayed only the mean. The duration of morbidity ranged from 20 days up to 23 months, with 2 studies showing only the mean and SD. In the study by Xie et al [12], the minimum–maximum, mean, and SD were all indicated. In the study by Chung et al [16], only ≤ 1 year and > 1 year were indicated. All

Table 1. General Characteristics of Selected Studies.

First author (y)	*n*	Age (Mean y)	Sex (male/female, *n*)	Periods of illness (mean)
Xie (2018) [12]	86 T: 43 C: 43	T:22–64 (41.26 ± 6.78) C:21–65 (41. ± 6.49)	T:18/25 C:19/24	T: 20 d–22 mo (5.17 mo ± 3.48) C: 22 d–23 mo (4.89 mo ± 3.52)
Kumnerddee (2010) [13]	61 T: 30 C: 30*	T: 50.37 ± 9.01 C: 51.73 ± 8.92	T: 86.67 C: 93.33	T: 12.12 mo ± 15.71 C: 8.32 mo ± 7.68
Chung (2016) [14]	181 T: 90 C: 91	T: 51 ± 10.2 C: 51 ± 8.7	T: 13/77 C: 10/81	> 1 y T: 69 / C: 59 ≤ 1 y T: 21 / C: 32
Zhao (2012) [16]	50 T: 25 C: 25	T: 43.68 ± 8.83 C: 43.52 ± 9.52	T: 11/14 C: 8 /17	T: 56.72† ± 18.08 C: 58.32† ± 17.83

T, treatment group; C, control group.
* One person dropped out for surgery.
† This study does not indicate units of Periods of illness.

4 RCT studies reported that there were no statistically significant differences in gender, age, or duration of condition/disease of the individuals between the treatment group and the control group.

Control group treatments

There were 2 studies including drug treatment as an intervention method for the control group. In the study by Xie et al [12], diclofenac sodium tablet (25 mg), methylcobalamin (vitamin B12) tablet (0.5 mg), vitamin B1 tablet (10 mg), vitamin B6 tablet (10 mg), and dibazole tablet (10 mg) were administered orally for 4 weeks each day. In the study by Zhao et al [16], mecobalamin (vitamin B12 (500 μg) was taken 3 times a day for 5 weeks, and traditional acupuncture was performed. The other 2 studies applied wrist splints overnight. In the study by Kumnerddee and Kaewtong [13], a prefabricated volar neutral wrist splint was used during the night for 5 weeks. In the study by Chung et al [14], a prefabricated wrist splint with neutral positioning was used overnight for 17 weeks (Table 2).

Table 2. Results of Selected Studies.

First author (y)	Control group methods	Treatment group methods	Treatment periods	Treatment frequency	Outcomes	Results
Xie (2018) [12]	Conventional treatment	Acu+E-Acu	5 d + 5 d (2 d rest)	1 ×/ d	1. Total Effective	1. T > C ($p < 0.05$)
					2. FSS and SSS	2. FSS and SSS 1) FSS T > C (none) 2) SSS T > C (none)
					3. EMG	3. EMG 1) Median nerve DML T > C ($p < 0.05$) 2) APM CMAP amp. T > C ($p < 0.05$) 3) MF-C SCV T > C ($p < 0.05$) 4) T-C SNAP T > C ($p < 0.05$) MF-C SNAP T > C ($p < 0.05$)
					4. Ultrasound	4. Ultrasound 1) PSMC ≥ 10 mm^2 T > C ($p < 0.05$) 2) RTLC > 3 AT > B ($p > 0.05$)
Kumnerddee (2010) [13]	Night splint	Acu+E-Acu	5 wk	2 ×/wk	1. BCTS	1.1) SSS T > C ($p > 0.05$) 2) FSS T > C ($p > 0.05$)
					2.VAS	2. VAS T > C ($p < 0.05$)
Chung (2016) [14]	Night splint	Night splint +Acu+E-Acu	> 17 wk	1-2 ×/wk	1. BCTS 2. DASH 3. NRS 4. SWMT SD 5.B-DMMPUT 6. Tip Pinch	1.1) SSS T > C ($p > 0.05$) 2) FSS T > C ($p > 0.05$) 2. T > C ($p < 0.05$) 3. T > C ($p > 0.05$) 4. AT > BT ($p > 0.05$) 5. T > C ($p < 0.05$) 6. T > C ($p < 0.05$)
Zhao (2012) [16]	Conventional treatment +Acu	Conventional treatment +Acu+E-Acu	30 d	1 ×/1 d	1. EMG 2. Total effective	1. T > C ($p < 0.05$) 2. T > C ($p < 0.01$)

Acu, acupuncture treatment; amp., amplitude; APM, abductor pollicis muscle; AT, after treatment; B-DMMPUT, blinded time to complete Dellon-modified Moberg pick-up test; BCTS, Boston Carpal Tunnel Outcome Scales; BT, before treatment; C, control group; CMAP, compound muscle action potential; DASH, disabilities of the arm, shoulder and hand; DML, distal motor latency; E-Acu, electric acupuncture treatment; EMG, electro muscle graphy; FSS, functional status scale; MF-C, middle finger-carpal; NRS, numeral rating scale; PSMC≥10 mm^2, Proximal end swelling of the median nerve of the carpal canal≥10 mm^2; RTLC>3, ratio of transverse longitudinal.diameter of carpal tunnel>3; SCV, sensory nerve conduction velocity; SD, sensation diameter; SNAP, sensory nerve action potential; SSS, Symptom severity scale; SWMT, Semmes-Weinstein Monofilament Test; T, treatment group; T-C, Thumb-carpal; Tip pinch, tip pinch strength; VAS, visual analog scale.

Electroacupuncture treatments

All studies performed electroacupuncture at traditional acupuncture points. The most frequently used acupuncture point was PC7, which was used in 4 cases, and LI4, LI5, and TE5 were the 2nd most frequently used acupuncture points, each used in 3 cases. Among the meridians used, PC meridians were the most common, and LI meridians were 2nd most common (Table 3).

In the study by Xie et al [12], PC7 and PC6 were connected according to symptoms LU8, LU6 or LI5, LI4 or PC6, TE5, and EX-UE2 with continuous waves of 5-15 V and 2-20 Hz for 20 minutes. In the study by Kumnerddee and Kaewtong [13], 1 Hz continuous direct current wave was connected to LI4, LI11, PC7, PC8, and EX-UE9 for 30 minutes. In the study by Chung, TE5, PC7, HT3, PC3, SI4, LI5, LI10, and LU5 on the affected side. A continuous wave of 10-20 mA and 20-40 Hz was connected for 20 minutes with 4 combinations of (1) TE5 + PC7, (2) SI4 + LI5, (3) LI10 + LU5, and 4) HT3 + PC3. In the study by Zhao et al [16], 500 μg of mecobalamin (B12) was taken 3 times a day for 5 weeks, simultaneously with PC7 and TE5 pulse width t: (0.5 ± 0.15) ms, pulse repetition frequency f1 = (1 ± 0.5) Hz to (100 ± 10) Hz. While continuous wave was connected for 30 minutes, general acupuncture was applied to LI5, PC6, LI4, and PC8 (Tables 2 and 4).

The treatment period varied from a minimum of 12 days to a maximum of 17 weeks, and the treatment frequency also varied from once a day to twice a week (Table 2).

Evaluation indices

As outcome indicators used in each study, total effectiveness rate, functional status scale (FSS), and symptom severity scale (SSS) were the most common in 3 cases. In the 3 studies using the total effectiveness rate, 1 used standards set by each individual [13], 1 cited standards used in another study [14], and 1 cited "Diagnostic Efficacy Criteria for Diseases and Syndromes of Traditional Chinese Medicine" by the Ministry of Traditional Chinese Medicine [15].

In studies using EMG, distal motor latency (DML) of the median nerve, compound muscle action potential (CMAP) of abductor pollicis muscle, thumb-carpal sensory nerve conduction velocity (SCV), middle finger-carpal SCV, and thumb-carpal sensory nerve action potential (SNAP), the median nerve DML, CMAP, SCV, median nerve initial latency DML and M wave amplitude (amp), and the distance between wrist and palmar stimulation cathode electrodes were measured and combined with conventional conduction sensing to calculate the cross-wrist motion conduction velocity. In addition, motor nerve conduction velocity (MCV), disabilities of the arm, shoulder and hand (DASH), pain intensity measured using the numeric rating scale (NRS), sensation was measured using the Semmes-Weinstein monofilament test (SWMT) and the sensation diameter was measured in mm at Week 17, dexterity measured using the Dellon-modified pick-up test (DMMPUT and maximal tip pinch strength (time in seconds to complete the DMMPUT at Week 17 was measured). In addition, there was a study that measured the radio of proximal swelling of median nerve of carpal tunnel ≥ 10 mm using ultrasound treatment. There was also 1 study measuring VAS.

Table 3. Frequency of Acupoints for Electroacupuncture Treatment.

Frequency	Acupoint
4	PC7
3	LI4, LI5, TE5
2	PC6, PC8
1	SI4, PC3, LU8, LU6, LU5, LI11, LI10, HT3, EX-UE9, E X-UE2

Table 4. Instrument and Manipulation Method Used in Electroacupuncture.

First author (y)	Voltage Or Ampere	Hz
Xie (2018) [12]	5-15 V	2-20 Hz Continuous wave
Kumnerddee (2010) [13]	None	1 Hz continuous direct current
Chung (2016) [14]	10-20 mA	20-40 Hz Continuous wave
Zhao (2012) [16]	None	1 ± 0.5 Hz -100 ± 10 Hz, Continuous wave

Therapeutic effect

In the study by Xie et al [12], the total effectiveness rate for the treatment group (T) 97.67 was statistically significant greater than the control group (C) 81.40, ($p < 0.05$). The FSS was T 20.42 ± 2.75→9.92 ± 1.42 ($p < 0.05$)/C 20.17 ± 2.68→14.28 ± 2.26 ($p < 0.05$), and the SSS was T 31.47 ± 4.72→15.28 ± 2.35 ($p < 0.05$)/C 31.05 ± 4.67→20.73 ± 3.18 ($p < 0.05$). In both evaluations, the improvement in the treatment group was higher, but the comparison value for the status after treatment was not presented. The results evaluated using EMG are as follows: median nerve DML (ms) was T 3.67 ± 0.74 < C 4.32 ± 0.93 ($p < 0.05$), abductor hallucis CMAP amp (mV) was T 8.94 ± 1.46 > C 5.97 ± 2.03 ($p < 0.05$), thumb-carpal SCV (m/s) was 44.79 ± 5.08 > 40.23 ± 5.87 ($p < 0.05$), middle finger-carpal SCV (m/s) was 48.25 ± 6.37 > 44.18 ± 6.33 ($p < 0.05$), thumb-carpal SNAP amp (μV) was 13.26 ± 3.11 > 10.54 ± 3.07 ($p < 0.05$), and middle finger-carpal SNAP amp (μV) was 13.15 ± 2.86 > 10.68 ± 2.94 ($p < 0.05$). All 6 results evaluated by EMG showed better treatment effect in the treatment group. Ultrasound examination is as follows. Proximal end swelling of the median nerve of the carpal canal ≥ 10 mm^2 was T 12 (27.91) < C 24 (55.81; $p < 0.05$), ratio of transverse longitudinal diameter of carpal tunnel > 3 mm^2 was T 26 (60.47) > 25 (58.14) [*n* (%)]; $p > 0.05$. There was a difference in the swelling of the median nerve, but there was no statistically significant difference in the diameter of the carpal tunnel.

In the study by Kumnerddee and Kaewtong [13], the SSS and the FSS evaluated using the behavioral change therapy score (BCTS), the SSS difference between T and C [95% confidence interval (CI)]

was 0.11 (−0.10 to 0.33; $p > 0.05$), and that for the FSS was 0.05 (−0.16 to 0.25; $p > 0.05$). This is not a significant result. In the VAS, difference between T and C (95% CI) was 9.63 (1.07 to 18.20; $p < 0.05$), A statistically significant result was obtained.

In the study by Chung, change from baseline, mean (95% CI) BCTS, the SSS was −0.20 (−0.36 to −0.03; $p < 0.05$). The FSS was −0.22 (−0.38 to −0.05; $p < 0.05$). DASH score was −6.72 (−10.9 to −2.57; p < 0.05). NRS on pain intensity was −0.70 (−1.34 to −0.06; $p < 0.05$). SWMT sensation diameter at Week 17, for the thumb measured in mm was −0.05 (−0.21 to 0.11; $p > 0.05$), first finger −0.08 (−0.22 to 0.06; $p > 0.05$), middle finger −0.11 (−0.26 to 0.04; $p > 0.05$), and little finger −0.02 (−0.16 to 0.12; $p > 0.05$). Thus, the SWMT for sensation did not show a statistically significant difference between test intervention and control intervention. The time to complete the DMMPUT at Week 17, was −6.13 s (−10.6 to −1.63 s) by participants blinded to the study ($p < 0.05$). Tip pinch strength measured in pounds at Week 17 was 1.17 (0.48 to 1.86; $p < 0.05$; Table 2). Both the treatment and control groups showed significant treatment effects in BCTS, DASH, and NRS scores, and time to complete the DMMPUT. However, when comparing the control group with the treatment group, (except for the DASH score and the DMMPUT completion time by the participants blinded to the study), differences were not statistically significant.

In the study by Zhao, the values of the wrist motion cross-transmission rate MCV2 were 40.56 ± 3.0276 in the treatment group and 31.00 ± 6.5706 in the control group. The treatment effect of the treatment group was significantly superior to that of the control group. The total effectiveness rates were T 81% and C 64% ($p < 0.05$), and the treatment effect of the treatment group was significantly superior to that of the control group (Table 5).

Risk of bias assessment

For all 4 RCT studies, risk of bias was evaluated using Cochrane's Risk of bias tool which measures: (1) Random sequence generation; (2) allocation concealment; (3) blinding of participants and personnel; (4) blinding of the outcome; (5) incomplete data; (6) other bias.

All studies mentioned the randomization method; 3 were evaluated as low risk of bias, but 1 as high risk because it adopted a randomization method according to the visit date, and did not provide detailed methods. None of the 4 studies mentioned the blinding method for the researchers. Two studies had missing values for dropouts, but they did not include study results that included missing values and were evaluated as low risk of bias, because they were judged to be unavoidable reasons such as surgery rather than intentional

Table 5. Evaluation Method and Results.

First author (y)	Evaluation	Result		
		Treatment group	Control group	Outcome
Xie (2018) [12]	1. Total Effective	97.67	81.40	T > C ($p < 0.05$)
	2. FSS and SSS			
	1) FSS	20.42 ± 2.75→9.92 ± 1.42 ($p < 0.05$)	20.17 ± 2.68→14.28 ± 2.26 ($p < 0.05$)	T > C (none)
	2) SSS	31.47 ± 4.72→15.28 ± 2.35 ($p < 0.05$)	31.05 ± 4.67→20.73 ± 3.18 ($p < 0.05$)	T > C (none)
	3. EMG			
	1) Median nerve DML	3.67 ± 0.74	4.32 ± 0.93	T > C ($p < 0.05$)
	2) APM CMAP amp	8.94 ± 1.46	5.97 ± 2.03	T > C ($p < 0.05$)
	3) T-C SCV	44.79 ± 5.08	40.23 ± 5.87	T > C ($p < 0.05$)
	4) MF-C SCV	48.25 ± 6.37	44.18 ± 6.33	T > C ($p < 0.05$)
	5) T-C SNAP	13.26 ± 3.11	10.54 ± 3.07	T > C ($p < 0.05$)
	6) MF-C SNAP	13.15 ± 2.86	10.68 ± 2.94	T > C ($p < 0.05$)
	4. Ultrasound			
	1) PSMC ≥ 10 mm^2 [n (%)]	12 (27.91)	24 (55.81)	T > C ($p < 0.05$)
	2) RTLC > 3 [n (%)]	AT 26 (60.47) > BT 25 (58.14)	none	AT > BT ($p > 0.05$)
Kumnerddee (2010) [13]		Difference between T and C (95% CI)		Outcome
	1. BCTS			
	1) SSS	0.11 (−0.10 to 0.33)		T > C ($p > 0.05$)
	2) FSS	0.05 (−0.16 to 0.25)		T > C ($p > 0.05$)
	2. VAS	9.63 (1.07 to 18.20)		T > C ($p > 0.05$)

Table 5. (continued).

First author (y)	Evaluation	Result	
		Difference between T and C (from baseline, mean 95% CI)	Outcome
Chung (2016) [14]	1. BCTS		
	1) SSS	−0.20 (−0.36 to −0.03)	T > C (p > 0.05)
	2) FSS	−0.22 (−0.38 to −0.05)	T > C (p > 0.05)
	2. DASH	−6.72 (−10.9 to −2.57)	T > C (p > 0.05)
	3. NRS	−0.70 (−1.34 to −0.06)	T > C (p > 0.05)
	4. SWMT SD		
	1) Thumb	−0.05 (−0.21 to 0.11)	T > C (p > 0.05)
	2) First finger	−0.08 (−0.22 to 0.06)	T > C (p > 0.05)
	3) Middle finger	−0.11 (−0.26 to 0.04)	T > C (p > 0.05)
	4) Little finger	−0.02 (−0.16 to 0.12)	T > C (p > 0.05)
	5. B-DMMPUT	−6.13 (−10.6 to −1.63)	T > C (p > 0.05)
	6. Tip Pinch	1.17 (0.48 to 1.86)	T > C (p > 0.05)
Zhao (2012) [16]		Treatment group	Control group	Outcome
	1. The values of the wrist motion cross-transmission rate MCV2	40.56 ± 3.0276	31.00 ± 6.5706	1. T > C (p > 0.05)
	2. The total effectiveness rates	81%	64%	2. T > C (p > 0.05)

T, treatment group; C, control group; FSS, functional status scale; SSS, symptom severity scale; EMG, electro muscle graphy; DML, distal motor latency; APM, abductor pollicis muscle; CMAP, compound muscle action potential; amp., amplitude; MF-C, middle finger-carpal; SCV, sensory nerve conduction velocity; T-C, thumb-carpal; SNAP, sensory nerve action potential; PSMC≥10 mm^2, proximal end swelling of the median nerve of the carpal canal≥10 mm^2; RTLC>3 , ratio of transverse longitudinal diameter of carpal tunnel>3; BCTS , Boston Carpal Tunnel Outcome Scales; VAS, visual analog scale; DASH, disabilities of the arm, shoulder and hand; NRS, numeral rating scale; SWMT, Semmes-Weinstein Monofilament Test; SD, sensation diameter; B-DMMPUT, blinded time to complete Dellon-modified Moberg pick-up test; Tip pinch, tip pinch strength; AT, after treatment; BT, before treatment.

missing values. There were 3 studies which have a high risk of bias because the outcome measurement was not blinded (Fig. 2).

Adverse reactions

No adverse reaction was reported in any of the 4 studies.

Discussion

Acupuncture is effective for the treatment of CTS, and the effect and mechanism are known to some extent [13], but research on electroacupuncture is insufficient. This study aimed to determine the therapeutic effect of electroacupuncture on CTS by reviewing RCT studies using electroacupuncture for CTS. A total of 186 studies were retrieved from 7 databases, and 4 RCT studies of electroacupuncture for the treatment of CTS were included in this review. There was a total of 378 individuals over the 4 studies included in this study, and the average age range was between 40 and 50 years. The sex ratio was higher in women, and the duration of morbidity varied from a minimum of 20 days to a maximum of 23 months. The studies diagnosed CTS using items such as stage of condition/disease according to diagnostic criteria for disease in the Department of Orthopedics, clinical diagnostic criteria of American

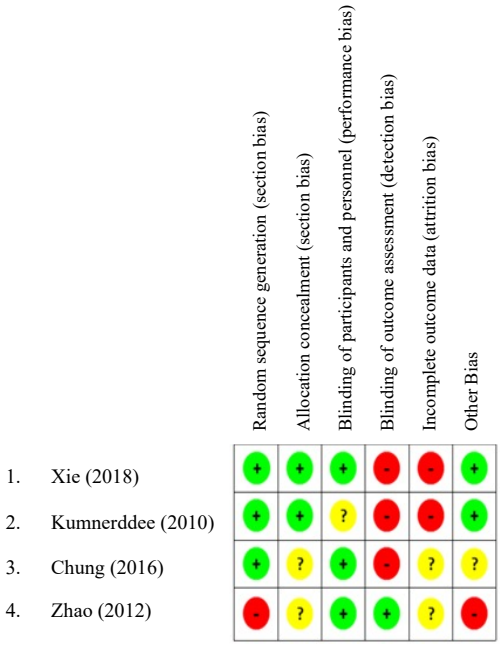

Fig. 2. Risk of RCT bias summary.
(+) : Low risk of bias.
(−) : High risk of bias.
(?) : Unclear of bias.

Academy of Neurology, Phalen maneuver test, Tinel sign test, wrist flexion and median nerve compression test.

As a control group, traditional acupuncture, wearing a splint at night, and pharmacological treatment were used as a conservative treatment. Wearing a splint at night is a treatment not commonly used in Korea. However, Werner et al [14] reported it was an effective conservative treatment that can be used for the treatment of CTS.

Total Effectiveness was mainly used as an evaluation tool, and EMG was used to evaluate median nerve DML, abductor pollicis muscle CMAP amp, middle finger-carpal SCV, thumb-carpal SNAP, and middle finger-carpal SNAP. Methods using ultrasound included the detection of proximal-end swelling of the median nerve of the carpal canal ≥ 10 mm^2, and ratio of transverse longitudinal diameter of carpal tunnel > 3 mm^2.

Methods using a questionnaire included the FSS and the SSS, and the VAS, and the NRS using BCTS. Motion tests included DASH, the SWMT using sensation diameter, time to complete the DMMPUT by the participants blinded to the study, and tip pinch strength. In general, electroacupuncture showed a significant therapeutic effect on CTS. However, the ratio of transverse longitudinal diameter of carpal tunnel > 3 mm^2 was used in the study by Xie et al [12], the FSS was used in the study by Kumnerdde and Kaewtong [13], the SSS was used in the study by Kumnerdde and Kaewtong [13], and the SWMT using sensation diameter was used in the study by Chung, no significant effect was observed. In general, electroacupuncture treatment showed a greater significant therapeutic effect than the control group, but the FSS, the SSS, and tip pinch tests used in the study by Chung, did not show a significant difference compared with the control group.

In this study, the risk of bias was assessed in 6 domains using the Cochrane risk of bias tool. The risk assessment of bias for randomization in 1 study was evaluated as high risk because the randomization method was determined according to the visit date, the other studies had a low risk of bias. Allocation concealment in the studies had either a low (n = 2) or unclear (n = 2) risk of bias. Due to the characteristics of electroacupuncture, the risk of performance bias was low (n = 1) or unclear (n = 3) because it was difficult to blind both the patients and medical staff. In the assessment of attrition bias, the studies were rated as having either an unclear bias (n = 2) or high risk of bias (n = 2); 1 study included 1 individual who dropped out for surgery, but no study had any individual intentionally dropping out. The blinding of outcome assessment provided a high (n = 3) or low risk of bias (n = 1). Other bias had a low risk of bias (n = 2), unclear (n = 1), or a high risk of bias (n = 1).

Analysis of overall risk of bias revealed that, in most studies, descriptions of study methods were either overly concise or did not account for random sequence generation, assignment concealment, or selective reporting areas. Therefore, bias could not be avoided.

This study has several limitations. Firstly, the number of included studies was very small; secondly, the included studies were of low quality with a high risk of bias in 1 or more domains. For this reason, it is difficult to draw a definitive conclusion on the efficacy of electroacupuncture treatment for the treatment of CTS.

Electroacupuncture is a treatment that can be easily combined with conventional acupuncture and is expected to be helpful in the treatment of CTS. In the future, high-quality research on electroacupuncture treatment for CTS is needed.

Conclusion

In conclusion, although electroacupuncture treatment for CTS was reported to be effective and showed a significant difference from the control group, in some evaluation items no significant differences were observed. The quality and the number of studies included in this review was limiting, therefore an accurate evaluation of the efficacy of electroacupuncture treatment for CTS was not possible.

Conflicts of Interest

The authors have no conflicts of interest to declare.

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None.

Ethical Statement

This research did not involve any human or animal experiments.

Data Availability

All relevant data are included in this manuscript.

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