

Review Article

# A narrative review of clinical studies on thread embedding acupuncture treatment for spasticity after stroke

Sooran Cho<sup>3</sup>, Eunseok Kim<sup>1,2\*</sup>

<sup>1</sup>Department of Acupuncture and Moxibustion Medicine, Pusan National University Korean Medicine Hospital, Yangsan, Republic of Korea

<sup>2</sup>Division of Clinical Medicine, School of Korean Medicine, Pusan National University, Yangsan, Republic of Korea

<sup>3</sup>School of Korean Medicine, Pusan National University, Yangsan, Republic of Korea

**Objectives:** This study aimed to review clinical studies on thread embedding acupuncture (TEA) for the treatment of patients with post-stroke spasticity (PSS)

**Methods:** Clinical studies related to TEA treatment for PSS were searched for in several electronic databases, including PubMed, Cochrane Library, MEDLINE, OASIS, and CNKI. After the selection/exclusion process, information on study design, disease, experimental/control group, intervention, outcome measurement, between-group differences, and adverse events was extracted.

**Results:** A total of 13 randomized controlled trials were included in this review. The usual frequency of TEA treatment was once every 1-2 weeks, and the treatment most commonly included 4 sessions. In the dorsal area, EX-B2 and the acupoints in governing vessel meridian were commonly used. Acupoints in the meridian of the large intestine were most frequently used in the treatment of upper limb spasticity. Except for HT1, PC6, and PC8, all TEA points for treating PSS of the upper limb were on the Yang meridians. For the lower limb spasticity, the most frequently used acupoints were ST36, GB34, GB30, BL60, and BL57 on Yang meridians, and LR3, SP6, SP9, and SP10 on Yin meridians. TEA treatment showed better effects than conventional treatment for PSS in terms of spasticity, motor dysfunction, and activities of daily livings. Nevertheless, the absence of the follow-up observation, lack of sham TEA treatment, and low quality of the included studies necessitated caution in interpreting the results.

**Conclusions:** The results of this review are expected to provide basic data on the modalities of TEA treatment for PSS and provide insights to facilitate well-designed studies in the future.

**Key Words** : Thread embedding acupuncture, Spasticity, Stroke, Narrative review

## Introduction

Post-stroke spasticity (PSS), characterized by muscle stiffness, limited range of motion, and coordination disorder, is one of the most common complications of stroke. Although the pathogenesis

of PSS has not yet been precisely elucidated, PSS is known to be a type of upper motor neuron syndrome caused by hyperexcitability of the stretch reflex<sup>1)</sup>. PSS limits the performance of daily activities, such as eating, dressing, and washing, and increases the patient's dependence

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• Correspondence to : Eunseok Kim

Department of Acupuncture and Moxibustion Medicine, Pusan National University Korean Medicine Hospital  
49, Busandaehak-ro, Mulgeum-eup, Yangsan, Gyeongnam, 50612, Republic of Korea

Tel : +82-55-360-5967, Fax : +82-55-360-5569, E-mail : eskim@pusan.ac.kr

of the patient on others, leading to substantially poorer quality of life<sup>2</sup>). Various treatments, including drugs, physical therapy, neurolysis, and botulinum neurotoxins, have been applied to relieve spasticity and suppress its progression, have been applied in clinical practice, but their safety and long-term effects have not been clarified<sup>3</sup>).

Thread embedding acupuncture (TEA) is a method of embedding suture threads made of catgut or polydioxanone thread into the acupuncture points. Since the continuous stimulation by the embedding thread is added to the effect of acupuncture, TEA treatment is preferentially applied to diseases with chronic and stubborn progress in clinical practice<sup>4-5</sup>). However, we were unable to find any clinical studies in Korea of TEA, nor any reports on the treatment status of TEA, in the treatment of PSS. In the clinical practice guideline of Korean Medicine for stroke developed in 2021, the use of acupuncture, electroacupuncture, pharmacopuncture, moxibustion, and herbal medicine is recommended for PSS<sup>6</sup>). However, recommendations in this guideline do not include TEA for the treatment of PSS.

Nevertheless, through an exploratory search for

clinical studies conducted in China, it was found that TEA is widely applied as a single or combined therapy for PSS. In this study we performed a literature review of clinical studies on TEA published in foreign academic journals to investigate the utilization of TEA to treat PSS. The results of this study are expected to broaden the applications of TEA treatment for PSS and provide preliminary data to facilitate well-designed clinical studies in the future.

## Materials and Methods

### 1. Search strategy and terms

Clinical studies on TEA in the treatment of PSS were searched in foreign online databases, including PubMed, Cochrane Library, MEDLINE, Oriental Medicine Advanced Searching Integrated System (OASIS) and CNKI. Relevant search terms with Boolean operators (AND/OR) were combined and presented in Table 1.

### 2. Eligibility Criteria

Clinical studies that evaluating the effectiveness of TEA for PSS were included. Animal studies, review articles, protocols, and dissertations were

Table 1. Searching strategy

Intervention1	"thread" OR "polydioxanone" OR "catgut" OR "PGLA" OR "PDO"
Intervention2	"embedding" OR "implantation" OR "embed"
Disease	"stroke" OR "cerebral infarction" OR "cerebral hemorrhage" OR "intracranial hemorrhage" OR "cerebrovascular disorder" OR "cerebrovascular accident" OR "cerebrovascular attack"
Disease sequelae	"spasticity" OR "spastic" OR "spasm" OR "tension" OR "hypertonia"
Searching strategy	(SU="thread"+"polydioxanone"+"catgut"+"PGLA"+"PDO") AND (SU="embedding"+"implantation"+"embed") AND (SU="stroke"+"cerebral infarction"+"cerebral hemorrhage"+"intracranial hemorrhage"+"cerebrovascular disorder"+"cerebrovascular accident"+"cerebrovascular attack") AND (SU="spasticity"+"spastic"+"spasm"+"tension"+"hypertonia")

excluded. The selection/exclusion process was conducted by comparing the results of searches performed independently by two investigators. If the eligibility did not match, the final inclusion was decided by the two researchers coming to an agreement. After excluding studies that did not meet the selection criteria through an initial review of the titles and abstracts, the full texts of the remaining studies were reviewed. Studies in which TEA was applied as part of a complex intervention along with other treatments were excluded if the effect of TEA could not be confirmed.

### 3. Data Extraction

The two investigators extracted and cross-checked data from the eligible studies. The extracted data included authors, year of publication, the number of participants, interventions, outcome measures, treatment periods and sessions, details on the TEA device used, acupuncture points, and adverse reactions. Additionally, we extracted the evaluation tool outcomes for spasticity, motor dysfunction, and daily life performance. If the information extracted from a selected study was inconsistent, a final decision was made through the two researchers reaching a consensus.

## Results

### 1. The selection of eligible studies

A total of 27 potentially relevant clinical studies were retrieved through database searching. There were five studies found in PubMed, 21 in CNKI, and one in OASIS. Twenty-five studies were reviewed after excluding two duplicated

studies. Nine studies were excluded by reviewing the title and abstract, of which six did not include human subjects and three were not related to TEA treatment. Through a full-text review, a total of 13 studies were finally obtained, excluding two studies that did not use evaluation tools for spasticity and one study found in OASIS, in which it was not confirmed that the subjects had PSS (Fig 1).

All 13 studies were randomized controlled trials conducted in China and were written in Chinese. Six studies focused on upper and lower limb spasticity, four on upper limb spasticity, two on lower limb spasticity, and one on finger spasticity. An overview of the selected clinical studies is shown in Table 2.

### 2. Intervention for the experimental/control group

There was one study (7.7%) in which TEA treatment was used as a single intervention in the experimental group, and 12 studies (92.3%) in which TEA treatment was used in combination with other Traditional Chinese Medicine treatments, such as acupuncture (n=3, 23.1%), herbal medication (n=3, 23.1%), and moxibustion (n=1, 7.7%), or with Western conventional medicine treatments (n=5, 38.5%), including rehabilitation treatment and nerve electrical stimulation. Regarding control group interventions, there were four studies (30.8%) that provided only Traditional Chinese Medicine treatment; five studies (38.5%) used Western conventional treatment, such as medication and rehabilitation treatment, and the other four studies (30.8%) combined Traditional Chinese Medicine treatment and Western conventional

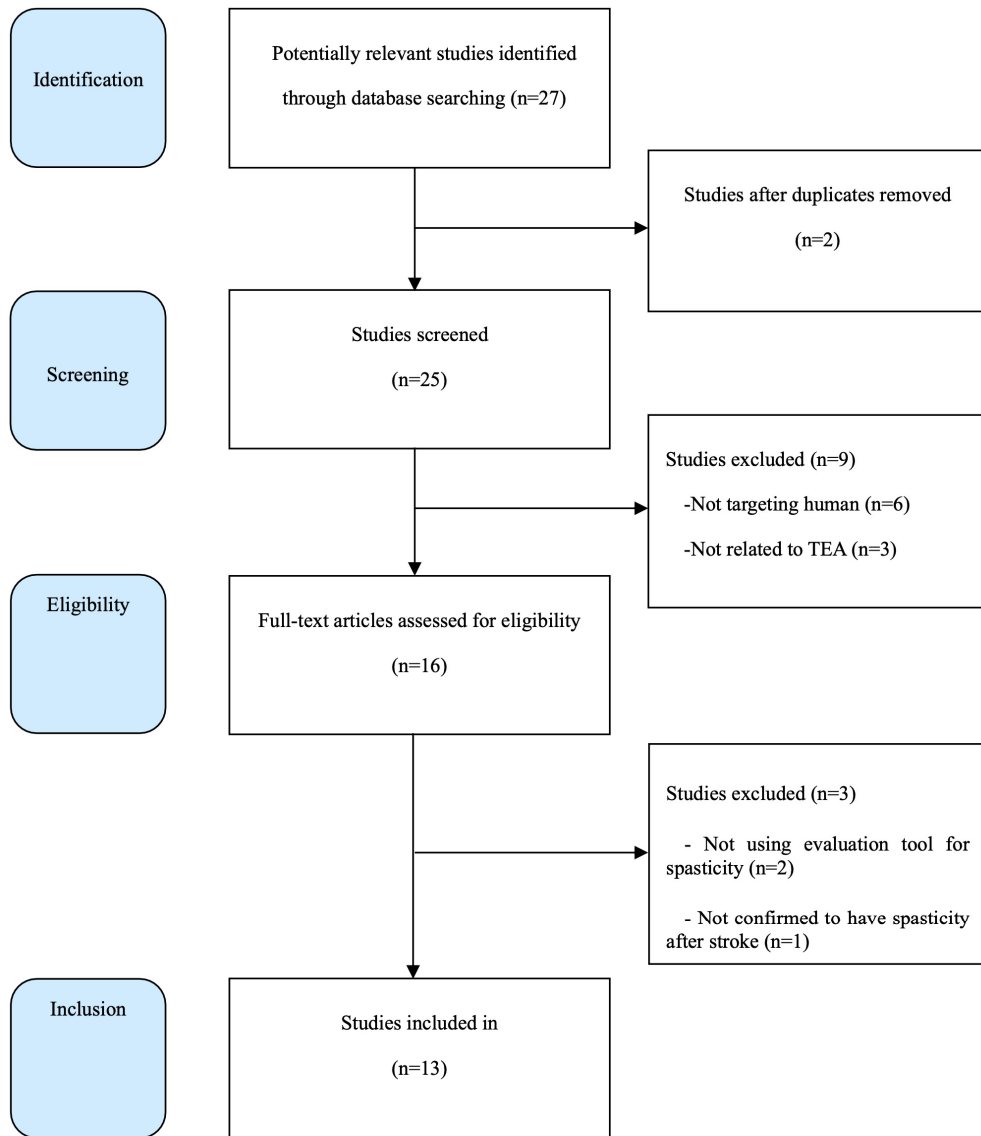


Fig 1. Study flow chart

treatment.

### 3. Outcome measures

As evaluation tools for spasticity, Modified Ashworth scale (MAS) was adopted in 10 studies and the Ashworth spasticity scale (ASS) in two

studies. In the remaining study by LEI, 2018<sup>13</sup>, the Fugl-Meyer motor assessment (FMA), which evaluates motor dysfunction due to spasticity and weakness, was used as the primary outcome measure without MAS or ASS. In the study by GAO, 2013<sup>18</sup>, hemoglobin and albumin levels in

**Table 2. General Characteristics of Selected Clinical Studies**

Author year	Target Symptom	Intervention by Group (n)	Main outcome (p-value) <sup>†</sup> 1. Spasticity <sup>‡</sup> 2. Motor function 3. ADL 4. Others	Between-group difference	AE	Treatment period (frequency, # of session)	TEA treatment		
							Thread	Needle	Fixed points γ Individualized points
YANG 2022	Spastic hemiplegia	EG: TEA+dorsal moxibustion therapy (44)	1. MAS 4.32±0.61 → 2.24±0.56 (p<0.05) 2. FMA 53.42±7.35 → 78.64±8.12 (p<0.05) 3. MBI 42.65±7.14 → 67.21±6.75 (p<0.05)	1. EG>CG (p<0.05) 2. EG>CG (p<0.05) 4. EG>CG (p<0.05)	NR	* TEA: 4 weeks (once a week, 4 sessions), 5-10 points per session * Moxibustion: 4 weeks (every other day)	Caigut (NR)	No.7	∩ LI4, LI10, LI11, Jianmao (肩髃), GB34, ST36, SP10, BL40 γ LI14, ST39, KB3, GB39, HT1, LU5, PC6, Shuxi (腧穴), SP6, SP9
		CG: dorsal moxibustion therapy (43)	1. MAS 4.26±0.64 → 2.75±0.60 (p<0.05) 2. FMA 56.12±7.43 → 68.71±8.36 (p<0.05) 3. MBI 44.13±7.23 → 60.45±7.34 (p<0.05)						
HOU 2022	Upper limb spasticity	EG: TEA+FA+CRT (60)	1. MAS total effective rate 86.67 2. FMA 20.23±6.55 → 39.06±5.49 (p<0.05) 3. ADL 58.57±6.33 → 70.01±5.19 (p<0.05)	1. EG>CG (p<0.05) 2. EG>CG (p<0.05) 3. EG>CG (p<0.05)	NR	* TEA: 4 weeks (once a week, 4 sessions) * FA: 20 days (every other day, 10) * CRT: during intervention phase (6 days a week)	Caigut (NR)	NR	∩ bilateral EX-B2 (C3-7, T1-3) γ None
		CG: FA+CRT (60)	1. MAS total effective rate † 63.33% 2. FMA 19.97±6.54 → 27.35±5.14 (p<0.05) 3. ADL 58.43±6.24 → 63.24±5.24 (p<0.05)						
CUI 2021	Upper limb spasticity	EG: TEA+CRT (43)	1. MAS 3.87±0.95 → 1.01±0.91 (p<0.05) 2. FMA 16.17±9.82 → 55.63±9.27 (p<0.05) 3. BI 31.23±11.38 → 71.29±12.04 (p<0.05)	1. EG>CG (p<0.05) 2. EG>CG (p<0.05) 4. EG>CG (p<0.05)	None	* TEA: 4 weeks (once a week, 4 sessions) * Acupuncture & CRT: 4 weeks (6 days a week)	Caigut (1cm)	No.7	∩ EX-UE12, LI15, GB21, SI10, PC2, TE13, TE12, LI13 γ None
		CG: acupuncture+CRT (42)	1. MAS 3.76±0.97 → 2.11±0.92 (p<0.05) 2. FMA 16.56±9.95 → 41.37±9.35 (p<0.05) 3. BI 32.19±12.65 → 59.36±11.85 (p<0.05)						
LI 2021	Spastic hemiplegia	EG: TEA (30)	1-1. ASS total effective rate 83.33% 1-2. Proportion of subjects by ASS grade(p<0.05) 2. FMA 38.76±9.51 → 88.33±13.12 (p<0.05) 3. BI 29.74±8.38 → 72.66±10.34 (p<0.05)	1-1. EG>CG (p<0.05) 1-2. EG>CG (p<0.05) 2. EG>CG (p<0.05) 3. EG>CG (p<0.05)	NR	* TEA: 2 months (once every 2 weeks, 4 sessions) * Acupuncture: 2 months (every weekday)	Caigut (2cm)	NR	∩ Upper limb: LI15, LI11, LI10, TE5, LI4, SB Lower limb: ST-31, ST32, BL37, GB34, ST41, BL40, BL57, SP10, SP6, LR3 γ None
		CG: acupuncture (30)	1-1. ASS total effective rate 63.33% 1-2. Proportion of subjects by ASS grade(p<0.05) 2. FMA 37.64±7.01 → 67.23±9.63 (p<0.05) 3. BI 29.61±8.05 → 57.26±8.29 (p<0.05)						

**Table 2.** General Characteristics of Selected Clinical Studies

Author year	Target Symptom	Intervention by Group (n)	Main outcome (p-value <sup>†</sup> ) 1. Spasticity <sup>‡</sup> 2. Motor function 3. ADL 4. Others	Between-group difference	AE	Treatment period (frequency, # of session)	TEA treatment			
							Thread	Needle	Ω Fixed points γ Individualized points	
ZHAO 2021	Upper arm flexor spasticity	EG: TEA+CRT (31)  CG: baclofen+CRT (31)	1-1. MAS total effective rate 87.10% 1-2. Proportion of subjects by MAS grade(p<0.01) 2. FMA 19.58±10.14 → 33.03±11.79 (p<0.05) 4. MESSS 9.39±1.59 → 7.06±2.08 (p<0.01)	1-1. EG=CG (p<0.05) 1-2. EG@CG (p>0.05)  2. EG>CG (p<0.05)	NR  * TEA: 4 weeks (once a week, 4 sessions) * Oral baclofen: 4 weeks (3 times a day)	* TEA: 4 weeks (once a week, 4 sessions)  * CRT (Bobath handshaking exercise) during intervention phase	Caigut (1cm)	No.7	Ω EX-UJ12, LJ14, LJ11, LJ10, LJ4 γ None	
ZHU 2019	Upper limb spasticity	EG: TEA+NES+CRT (30)	1. Proportion of subjects by MAS grade (p<0.05) 2. FMA 24.87±4.81 → 54.87±8.14 (p<0.05) 4. sEMG (RMS) 8.89±2.04 → 3.53±1.09 (p<0.05)	1. EG>CG1, CG2 (p<0.05) 2. EG>CG1, CG2 (p<0.05)	None  * TEA: 6 weeks (once every 2 weeks, 3 sessions)	* TEA: 6 weeks (once every 2 weeks, 3 sessions)	Caigut (2cm)	NR	Ω TEJ13, TEJ12, LJ11, TE5 γ None	
LEI 2018	Spastic hemiplegia	CG1: TEA+CRT (30)  CG2: NES+CRT (30)  EG: TEA+Scalp acupuncture (30)	1. Proportion of subjects by MAS grade (p<0.05) 2. FMA 20.07±6.23 → 41.60±7.38 (p<0.05) 4. sEMG (RMS) 9.17±2.37 → 7.89±1.92 (p<0.05)  1. Proportion of subjects by MAS grade (p<0.05) 2. FMA 27.37±5.76 → 41.27±6.99 (p<0.05) 4. sEMG (RMS) 9.15±1.83 → 6.89±1.20 (p<0.05)  2. FMA 61.9±12.6 → 94.1±4.6 (p<0.05) 4. Total effective rate (based on Brunnstrom Stage) 93.3%	1. EG>CG1, CG2 (p<0.05) 2. EG>CG1, CG2 (p<0.05)  4. EG>CG1>CG2 (p<0.05)	NR  * TEA: 2 months (once every 2 weeks, 4 sessions)  * Scalp acupuncture (GV20 to EX-HN5) & Body acupuncture: 2 months (3 times a week)	* TEA: 2 months (once every 2 weeks, 4 sessions)	PDO (NR)	NR	Ω Upper limb: LJ15, LJ11, TE5, LJ4, Lower limb: ST34, ST36, GB34, ST41, BL60, ST44, LR3 γ None	
		CG1: Scalp+Body acupuncture (30)  CG2: Scalp acupuncture (30)	2. FMA 64.6±12.2 → 83.6±6.9 (p<0.05) 4. Total effective rate (based on Brunnstrom Stage) 86.7%  2. FMA 63.3±12.3 → 77.1±14.5 (p<0.05) 4. Total effective rate (based on Brunnstrom Stage) 73.3%							

**Table 2. General Characteristics of Selected Clinical Studies**

Author year	Target Symptom	Intervention by Group (n)	Main outcome (p-value <sup>†</sup> )	Between-group difference	AE	Treatment period (frequency, # of session)	TEA treatment		
							Thread	Needle	
TANG 2017	Spastic hemiplegia	EG: TEA+CRT (30)	1. Spasticity <sup>†</sup> 2. Motor function 3. ADL 4. Others MAS total effective rate 66.7% 1-2. Proportion of subjects by MAS grade(p<0.05) 2. FMA 57.2±12.3 → 76.0±14.5 (p<0.05) 4. Proportion of subjects by Brunnstrom stages (p<0.05)	1-1. EG>CG (p<0.05) 1-2. EG>CG (p<0.05) 2. EG>CG (p<0.05)	NR	* TEA: 3 months (once every 15 days, 6 sessions) * CRT: NR	No.8 Caigut (2-3cm)	Q Fixed points γ Individualized points	
		CG: CRT (30)	1-1. MAS total effective rate 53.3% 1-2. Proportion of subjects by MAS grade(p<0.05) 2. FMA 56.1±14.5 → 61.3±13.2 (p<0.05) 4. Proportion of subjects by Brunnstrom stages (p<0.05)	2. EG>CG (p<0.05)					
GU 2015	Lower limb spasticity	EG: TEA+herbal decoction (40)	1. Proportion of subjects by MAS grade(p<0.05)	1. EG>CG (p<0.05)	NR	* TEA: 2 months (NR) Herbal decoction: 2months (NR)	Caigut length 1.5 cun	Q GB34, ST36, SP6 γ None	
		CG: WMT (muscle relaxants) (40)	1. Proportion of subjects by MAS grade(p<0.05) 2. Proportion of subjects by severity of dyskinesia on FMA score after each intervention	2. EG>CG (p<0.05)		* WMT: 2 months (3 times a day)			
LJ 2015	Spastic hemiplegia	EG: TEA+herbal formula (33)	1. Proportion of subjects by ASS grade(p<0.05) 2. FMA 8.48±0.36 → 19.04±1.03 (p<0.05)	1. EG>CG1>CG2 (p<0.05)	NR	* TEA: 60 days (1,2,3,6, and 9th week, 5 sessions) * Herbal formula: 60 days (twice daily, every day)	Caigut No.3, 4 (1-1.5cm)	Q 1st day: GB20, BL10, GB12, LI14, TE5, LI10, GB29, BL57, ST40, ST36 7th day: LR3, BL60, SP-9, GB30, LI4, LI11, LI15, GV20 14th day: KI3, SP6, SP10, HT1, LU5, PC6, BL18, BL23 γ None	
		CG1: Acupuncture (33)	1. Proportion of subjects by ASS grade(p<0.05) 2. FMA 8.58±0.40 → 15.46±1.43 (p<0.05)	2. EG>CG1>CG2 (p<0.05)		* Acupuncture: 60 days (6 consecutive days, 7th day off)			
		CG2: WMT (31)	1. Proportion of subjects by ASS grade(p<0.05) 2. FMA 8.30±1.08 → 12.58±0.73 (p<0.05)			* WMT: 60 days (3 times a day)			
LIU 2014	Spastic hemiplegia	EG: TEA+CRT (30)	1. Proportion of subjects by MAS grade(p<0.05) 2. FMA 36.37±16.60 → 83.30±8.49 (p<0.05) 3. BI 30.83±14.02 → 69.17±12.46 (p<0.05)	1. EG>CG (p<0.05)	NR	* TEA: 2 months (once every 15 days, 4 sessions)	Caigut (NR)	No.9 Q GV14, GV9, GV8, GV4, GV3, CV12, CV4 γ None	
		CG: massage+CRT (31)	1. Proportion of subjects by MAS grade(p<0.05) 2. FMA 37.61±16.21 → 69.03±13.38 (p<0.05) 3. BI 30.65±11.53 → 58.87±9.10 (p<0.05)	2. EG>CG (p<0.05) 3. EG>CG (p<0.05)		* Massage: 2 months (once every 15 days) * CRT: 60 days (every day)			

**Table 2.** General Characteristics of Selected Clinical Studies

Author year	Target Symptom	Intervention by Group (n)	Main outcome (p-value) <sup>†</sup> 1. Spasticity <sup>‡</sup> 2. Motor function 3. ADL 4. Others	Between-group difference	AE	Treatment period (frequency, # of session)	TEA treatment			
							Thread	Needle	Fixed points Individualized points	
GAO 2013	Lower limb spasticity	EG: TEA+Boyang-Hwano -Tang (45)	1-1. MAS total effective rate (changes in the action potential of EMG were also considered) =95.56%	1-1. EG>CG (p<0.05)	None	* TEA: 40 days (once every 20 days, 2 sessions)	Catgut (2-3cm)	No.7	Q GV14, GV9, GV13, GV8, ST36, GB34	
			1-2. Hemoglobin 11.20±4.10→3.85±3.83(p<0.05) 1-3. Albumin 11.39±3.70 → 6.40±4.05 (p<0.05)	1-2. EG>CG (p<0.05)	* Herbal decoction: 40 days (every day)					
YU 2013	Finger spasticity	CG: Myonal (muscle relaxants) (45)	1-1. MAS total effective rate (changes in the action potential of EMG were also considered) =80.00%	1-3. EG>CG (p<0.05)		* Myonal: 40 days (3 times a day)				
			1-2. Hemoglobin 10.87±4.03→9.28±4.02(p<0.05)							
			1-3. Albumin 10.96±3.73 → 10.35±3.61 (p<0.05)							
YU 2013	Finger spasticity	EG: TEA+balance acupuncture (42) CG: conventional acupuncture (42)	1. MAS 2.32±0.12 → 1.59±0.09 (p<0.001)	1. EG>CG (p<0.05)	NR	* TEA: 28 days (once every 14 days, 2 sessions)	NR	NR	Q SI3, PC8	
			2. FMA 7.80±0.26 → 9.59±0.29 (p<0.001)	2. EG>CG (p<0.05)		* Acupuncture: 28 days (3 consecutive days, 4th day off, 21 sessions)				γ None
			1. MAS 2.28±0.12 → 1.82±0.10 (p<0.001)							
			2. FMA 7.78±0.27 → 8.79±0.26 (p<0.001)							

ADL, Activities of daily living; ASS, Ashworth spasticity scale; BI, Barthel Index; CG, control group; CRT, Conventional rehabilitation treatment; EG, experimental group; FA, fire acupuncture; FMA, Fugl-Meyer motor assessment; MAS, Modified Ashworth scale; MBI, Modified Barthel Index; MESSS, Modified Eatinburgh-Scandinavian Stroke Score; NES, neuromuscular electrical stimulation; NIHSS, National institute of health stroke scale; NR, not reported; RMS, Root mean square; PDQ, polydioxanone; sEMG, surface electromyography; TEA: Thread embedding acupuncture; WMT, western medicine treatment  
<sup>†</sup> for the within-group differences before and after treatment, † Total effective rate = {markedly effective (decreased by >2 grade) + effective (decreased by 2 grade) + improved (decreased by 1 grade)} / n x 100



the blood were also used as the secondary endpoint for spasticity. In all 12 studies evaluating motor dysfunction, the FMA was adopted. Activities of daily living (ADL) were measured in five studies using the Barthel Index (BI), Modified Barthel Index (MBI), and ADL index. Other assessments included Brunnstrom stage, Modified Edinburgh–Scandinavian Stroke Score (MESSS), and surface electromyography (sEMG).

#### 4. Overview of the study results

All experimental groups in the selected studies showed statistically significant within-group differences between before and after the allocated treatment. All the control groups in the selected studies were the active control groups, and significant within-group differences between before and after the treatment were found in all studies, except for the study by LIU, 2014<sup>17)</sup>, which applied massage and conventional rehabilitation treatment. In all studies, except for that by ZHAO, 2021<sup>11)</sup>, which compared TEA + conventional rehabilitation treatment (CRT) with oral baclofen + CRT for upper limb spasticity, the experimental groups showed statistically significant better improvements in spasticity, motor dysfunction, and ADL compared to the control group.

For spasticity, changes in the proportion of subjects by MAS or ASS grade were presented in four studies. In three studies, MAS was presented as mean±standard deviation, and the mean differences in MAS before and after the treatment are shown in Table 2. The remaining five studies presented the total effective rate, which was calculated as {markedly effective (decreased by >

2 grade) + effective (decreased by 2 grade) + improved (decreased by 1 grade)} / n × 100. The total effective rates in the experimental groups of the five studies ranged from 66.7% to 95.6%. Three studies (23.1%) reported no adverse events, and the remaining 10 studies (76.9%) did not report any adverse events post-TEA treatment.

#### 5. Details of TEA treatment

In 13 studies, TEA treatments were performed an average of 3.83 times for an average of 6.54 weeks. Regarding the number of TEA treatments, seven studies (58.3%) had four sessions, two studies (16.7%) had two sessions, and three studies had three, five, and six sessions each. In one study, no information on TEA treatment sessions was reported. Regarding the frequency of TEA treatment, four studies (30.8%) performed treatment once a week, five studies (38.5%) every 2 weeks, one study (7.7%) with once every 20 days, one study (7.7%) used five sessions over 9 weeks, and two studies (15.4%) provided no information relating to the frequency. TEA needles of No. 3 to No. 9 were used, and suture thread materials were catgut (n=11, 84.6%), polydioxanone (n=1, 7.7%), and unspecified (n=1, 7.7%). There were two studies with suture thread lengths of 2-3 cm, two studies with 2-cm length, two studies with 1-cm lengths, one study with 1~1.5 cm, and five studies without information regarding thread length.

In four studies (30.8%), TEA treatment was performed on dorsal area acupoints, including EX-B2, GV4, GV8, GV9, and GV14. In nine studies (69.2%), TEA treatment focused on the acupoints of the affected extremities. The most

frequently used acupoints in the upper limb were LI4, LI10, LI11; TE5 in the forearm; and EX-UE12, Jiannao (肩髃), LI14, and LI15 in the upper arm and shoulder region. Except for HT1, PC6, and PC8, all acupoints used in the upper limbs were on the Yang meridians. The most frequently used acupoints in the lower limb were ST36, GB34, GB30, BL60, and BL57 on the Yang meridians, and LR3, SP6, SP9, and SP10 on the Yin meridians.

## Discussion

Treatment for PSS is controversial, because some argue that spasticity is beneficial in maintaining posture and preserving bone density and muscle mass<sup>20</sup>. However, treatment for spasticity is still needed because the disturbances in ADL and personal hygiene and deterioration in mobility impair the quality of life of the patients and their caregivers. Spasticity is also considered a risk factor for post-stroke pain, as stretching of contracted muscles acts as a noxious stimulus through muscle fibers disruption<sup>21</sup>. In the treatment of patients with PSS, non-pharmacological approaches, including stretching of the spastic muscles, neuromuscular electrical stimulation, electroacupuncture, and moxibustion, are usually combined with pharmacological approaches. Therefore, we conducted this study to review modalities of TEA treatment as a single or combined therapies for PSS so that this information may be utilized when designing future clinical research studies.

In terms of TEA treatment details, the usual frequency of TEA treatment was once every 1 to

2 weeks, and the most common TEA treatment session frequency was four sessions. The suture thread material in the selected studies was most commonly catgut, which is generally used in China. The size of the TEA needles in the studies ranged from No. 3 (0.3 mm diameter) to No. 9 (0.9 mm diameter). Considering that 26-30 gauge of TEA needles are commonly used in Korea, it was confirmed that thicker needles are used in China than in Korea. The length of the suture thread varied from 1 to 3 cm, and in China, the TEA treatment method involves the practitioner cutting the suture and combining it with a needle tip. In 12 of the 13 selected studies, TEA treatment was applied as a combined treatment, reflecting the clinical reality that TEA treatment is mainly applied in combination with other Korean Medicine treatments or Western conventional medicine.

Regarding the TEA points used in the studies, EX-B2 and acupoints in governing vessel (GV) meridian were commonly used in the dorsal area. In EX-B2, the TEA points corresponding to the level of the segment that dominate the affected upper or lower extremities were selected. Among the acupoints in the GV meridian, GV8, which is located below the spinous process of the ninth thoracic vertebra, has been used to relieve stiffness and spasm of muscles and tendons. GV14 is one of the acupoints known as the “seven acupoints for stroke” and has been found to improve cerebral blood flow in several studies<sup>22-24</sup>. Acupoints in the meridian of the large intestine are most frequently used in the treatment of upper limb spasticity. Except for HT1 in the axillary region and PC6 and PC8 in

the medial forearm region, all TEA points for treating upper limb spasticity in the included studies were on the Yang meridians. A study by Sim, 2003<sup>25)</sup> also found that electroacupuncture on the acupoints of the Yang meridians were more effective than electroacupuncture on those of the Yin meridian in the treatment of elbow spasticity after stroke. In contrast, in the lower extremities, the TEA points in the Yang and Yin meridians were utilized to a similar degree. The most frequently used acupoints in the lower limb were ST36, GB34, GB30, BL60, and BL57 on the Yang meridians, and LR3, SP6, SP9, and SP10 on the Yin meridians. TEA treatment of both the flexor and extensor muscles may be effective in treating lower limb spasticity, but additional research is needed to establish scientific evidence for this.

In the assessments of PSS by MAS or ASS grades, the total effective rate was adopted most frequently. The total effective rate in the studies was defined as the sum of the number of subjects divided by the total number of subjects in each case. Classifications were as follows: markedly effective (decreased by > 2 grade), effective (decreased by 2 grade), and improved (decreased by 1 grade). The total effective rates of the experimental groups of the five studies were ranged from 66.7% to 95.6%. However, other studies present the results for PSS as the mean±standard deviation or the proportion of subjects by MAS/ASS grade, which causes difficulties in quantitatively synthesizing the results of these studies. In the included studies, TEA treatment in the experimental groups showed better improvements than those in the control

groups in terms of spasticity, as well as motor dysfunction and ADL. This is thought to be because the improvement in PSS after TEA treatment has a positive effect on motor function and performance of activities of daily life.

However, two main limitations commonly found in the selected studies make it difficult to confirm the clinical effect of TEA in the treatment of PSS. First, none of the studies evaluated the persistence of the effect of TEA treatment through follow-up observations after the intervention phase. In the treatment of PSS, one of the factors thought to contributed to the superiority of TEA over conventional Korean Medicine treatment is the long-term and continuous stimulation by the embedded threads. However, no studies collected data on changes in the degree of spasticity during the follow-up period to evaluate the effect of this factor. Second, none of the studies used sham TEA as an intervention. By comparing real TEA to sham TEA in which there is no suture thread attached to the needle, the magnitude of the effect due to the embedded thread in PSS can be measured. However, no sham TEA device was used in any of the included studies. In addition, information on the randomization procedure, allocation concealment, and blinding of outcome assessment (detection bias) was not reported in the most studies.

In this review of selected clinical studies, TEA treatment showed statistically better effects than conventional PSS treatment. However, caution was required in the interpretation because of the absence of the follow-up observation, lack of sham TEA treatment, and the low quality of the

studies. Despite these limitations, the results of this review are expected to provide basic data on TEA treatment modalities for PSS and insights to facilitate large scale clinical studies in the future.

### Conflicts of interest

The authors have no conflicts of interest to declare.

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#### ORCID

Sooran Cho <https://orcid.org/0000-0002-1547-7843>

Eunseok Kim <https://orcid.org/0000-0002-9342-3082>