Am J Transl Res 2024;16(5):1484-1498
www.ajtr.org /ISSN:1943-8141/AJTR0155344

Review Article

Transcutaneous electrical acupoint stimulation for rehabilitation after total knee arthroplasty: a systematic review and meta-analysis

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Received January 8, 2024; Accepted April 17, 2024; Epub May 15, 2024; Published May 30, 2024

Abstract: Background: Rehabilitation after total knee arthroplasty (TKA) has become an indispensable part of the treatment strategy for degenerative joint disease. Despite some current research demonstrating efficacy of transcutaneous electrical acupoint stimulation (TEAS) for post-TKA rehabilitation, the evidence is not conclusive. Objective: To systematically assess the evidence supporting TEAS for rehabilitation after TKA. Methods: A literature search of the PubMed, Embase, The Cochrane Library, Chinese National Knowledge Infrastructure, Chinese Biomedical Literature Database, Wanfang, and Chinese Scientific Journal Data databases for relevant studies published up to October 16, 2023, was performed. Main indicators included visual analog scale (VAS) and functional scores; secondary indicators included range of motion (ROM), interleukin-6 (IL-6) and C-reactive protein (CRP) levels, and analgesia-related adverse events. Risk of bias was evaluated using the Cochrane Tool, and meta-analysis was performed using Review Manager version 5.4. Results: Twenty RCTs with 1295 participants were included. TEAS improved several outcomes compared to control groups. The TEAS group had significantly greater pain reduction at postoperative 6 h, 12 h, 24 h, 48 h, 72 h, 7 days, and 14 days. Moreover, TEAS significantly improved the Hospital for Special Surgery Knee Score, Knee Society Score, and ROM. Patients who underwent TEAS exhibited a lower incidence of analgesia-related adverse events and lower IL-6 and CRP levels. Conclusions: Available evidence indicates that the application of TEAS in patients undergoing TKA is related to postoperative pain alleviation, functional improvement, and fewer adverse events associated with analgesia.

Keywords: Transcutaneous electrical acupoint stimulation, total knee arthroplasty, rehabilitation, post-operative pain, function, systematic review

Introduction

Knee osteoarthritis (KOA) is a prevalent degenerative joint illness in middle-aged and elderly patients, characterized by joint pain, swelling, and mobility impairment [1]. As KOA worsens, the cartilage destruction leads to loss of joint function, which seriously affects people's quality of life [2]. Total knee arthroplasty (TKA) is regarded as the optimum therapy for severe KOA, and is widely used to recover function and alleviate pain in the patients with advanced KOA [3]. Nonetheless, there are some complications after TKA, for instance post-operative pain, functional limitation, and analgesia-related side effects, which, to some extent, significantly affect postoperative rehabilitation [4]. As previously reported, postoperative pain is the main hurdle to recovery of motion and return to activity after TKA [5].

Currently, post-operative pain relief is a crucial aspect of rehabilitation, which can be achieved by using pharmacologic interventions, including nonsteroidal anti-inflammatory drugs [6], opioids [7], and steroids [8]. However, the adverse reactions caused by drugs includingnausea, vomiting, respiratory depression and addiction

https://doi.org/10.62347/VZLG2317

are frequently reported, which limit clinical application [9, 10]. Therefore, many alternative therapies have been developed, including sports therapy [11], acupuncture [12], transcutaneous electrical nerve stimulation (TENS) [13], and transcutaneous electrical acupoint stimulation (TEAS) [14], in order to complement or replace conventional pharmacological interventions.

As a non-invasive treatment, TEAS achieves its therapeutic effect by placing electrodes - rather than needles - on the surface of the skin where acupuncture points are located [15]. TEAS combines the benefits of traditional Chinese acupuncture and TENS, which is widely accepted and applied worldwide [16, 17]. In recent years, studies have provided evidence supporting many positive benefits of TEAS, including improved postoperative cognitive function, alleviation of pain, and promotion of recovery after surgery [18-20]. In view of this, we evaluated the influence of TEAS for rehabilitation after TKA by analyzing all presently available randomized controlled trials (RCTs). This study evaluated the effectiveness of TEAS for rehabilitation after TKA using various indicators including a visual analog scale (VAS), Hospital for Special Surgery Knee Score (HSS), Knee Society Score (KSS), range of motion (ROM) of the knee, C-reactive protein (CRP), and interleukin-6 (IL-6). Our study aims to provide effective and reliable treatment recommendations for postoperative rehabilitation of TKA.

Methods

This study was performed in accordance with the Preferred Reporting Items for Systematic Review and Meta-Analysis (i.e., "PRISMA") guidelines [21]. This systematic review was registered with the International Prospective Register of Systematic Reviews (i.e., "PROSPERO") under accession ID number CRD42023424323 (https://www.crd.york.ac.uk/PROSPERO/display_record.php?RecordID=424323).

Research strategy

A literature search of the PubMed, Embase, Cochrane Central Register of Controlled Trials (Central), Chinese Biomedical Literature Database (CBM), China National Knowledge Infrastructure (CNKI), Chinese Scientific Journal Data (VIP), and Wanfang databases was performed for potentially eligible trials published up to October 16, 2023. The search strategy used medical subject heading (MeSH) terms combined with free text, including: "transcutaneous electrical acupoint stimulation", "TEAS", "TAES", "total knee replacement", "knee replacement arthroplasty", "total knee replacement", "TKA", and "placebo". Detailed search strategies are presented in Supplementary Table 1.

Eligibility criteria

RCTs investigating the use of TEAS for rehabilitation after TKA were retrieved. The inclusion criteria were as follows: Patients, individuals undergoing primary TKA for KOA; Intervention, TEAS alone or in combination with other treatments; Comparator(s), sham intervention, other treatments, or no therapy; Outcomes, visual analog scale (VAS) and functional scores as the primary outcomes and secondary outcomes including ROM, C-reactive protein (CRP), interleukin-6 (IL-6), and nausea/vomiting (adverse reactions associated with analgesia); and Study design, RCTs. Studies including experimental and/or control groups that included other interventional therapies with Chinese medicine (e.g., Chinese herbal medicine and electrical acupuncture) and those that did not report the primary outcomes were excluded. In addition, protocols, reviews, animal studies, duplicate studies, and those with unavailable full-text or complete data were also excluded.

Data extraction

Using a pre-designed data extraction form (spreadsheet), 2 investigators (LZ and ZMZ) independently extracted essential content from the included studies: lead author; year of publication; patient age and gender; type of intervention; intervention parameters; acupoints; stimulation frequency; and outcomes, among others. Any discrepancies in the cross-checking procedure were resolved through a consensus discussion or, otherwise, arbitrated by a third researcher (ZHC).

Quality assessment

In accordance with the standards recommended in the Cochrane manual [22], the methodologic quality of all included literature was evalu-

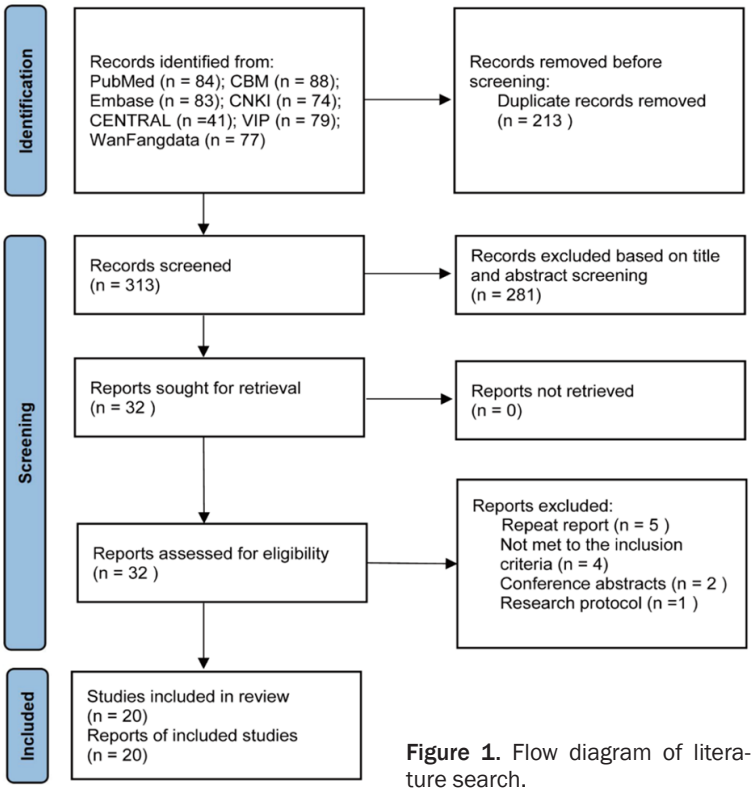

Figure 1. Flow diagram of literature search.

ated independently by two reviewers (LZ and ZMZ). Discussion with the third author (ZHC) resolved any discrepancies. Risk of bias for each trial was assessed from seven perspectives: sequence generation, allocation concealment, participant and personnel blinding, outcome assessment blinding, incomplete outcome data, selective reporting, and other bias. There are three levels of risk: high, low, or unclear, based on the evaluation result for each item.

Statistical analysis

The Review Manager 5.4 was applied to all meta-analyses of observational indicators in the selected literatures, and the corresponding results were intuitively displayed on the forest map. In this review, we used mean difference (MD) to pool continuous variables. If each original study outcome indicator unit is inconsistent, the standard mean difference (SMD) alternative MD should be selected. Dichotomous variables were pooled using the odds ratio (OR). All pooling effects are reported with 95% confidence intervals (95% CI). A *P* value of less than 0.05 was considered significant. The test for heterogeneity was performed using the I^2 statistic and the Cochran Q testing. High heterogeneity was indicated by an I^2 statistic > 50%. Fixed effects model was used for I^2 statistic < 50%, otherwise random effects model was selected. If there was substantial heterogeneity, subgroup analysis was used to examine the sources of heterogeneity. Sensitivity analysis tested the stability of the results. Stata 14 (USA, Stata Corp LP, 2015) was used to estimate publication bias using Begg's and Egger's tests.

Results

Study selection

In total, the database search identified 526 relevant clinical trials. After eliminating 213 repeated studies and removing 293 papers by the prescreening, viewing abstracts, and full articles, 20 RCTs [23-42] involving 1, 295 TKA patients were qualified to extract data. A flowchart of the selection process is shown in **Figure 1**, and the basic information of each included article is presented in **Table 1**. With the exception of one study [33] in South Korea, the remaining studies were conducted in China. In the present review, nineteen studies [23-32, 34-42] were written in Chinese, and only one study [33] was published in English. Of the 20 reported interventions, 15 trials [24, 26-29, 31, 32, 34-38, 40-42] were treated with 2~100 Hz, and two studies [23, 30] applied 5 or 100 Hz. Of 20 RCTs, the most commonly used acupoints were "Hegu" (LI4), "Neiguan" (PC6), and "Yinlingquan" (SP9), etc. Study evaluation time points ranged from 1 to 30 days after surgery.

Risk of bias

All included trials were reported as randomized. Of these, 13 studies [23, 24, 26, 28, 29, 32, 35-38, 40-42] were conducted with a random number table, 2 trials [31, 34] adopted randomized block design and 1 [33] was performed through the throw of dice. Two studies

Table 1. Characteristics of included randomized clinical trials

First author (year)	Age (years)		Gender (Male/Female)		Sample size		Intervention			Outcomes (Time points for evaluation)
	EG	CG	EG	CG	EG	CG	EG	CG	Acupoints/Stimulation frequency/time	
Liang et al. 2017 [23]	65.90 ± 4.17	64.40 ± 4.14	11/29	9/31	40	40	TEAS, routine rehabilitation	Routine rehabilitation	SP10, ST34, ST31, ST32/5 HZ/20 min, once daily, 2 days after surgery	KSS (on 28 d), HSS (on 28 d)
Wu et al. 2017 [24]	70.75 ± 8.23	70.55 ± 7.44	44/16	46/14	60	60	TEAS, routine rehabilitation	Routine rehabilitation	SP9, GB34, SP10, ST36, ST33, ST34/2~100 HZ/30 min, once daily, 1 day after surgery	VAS (30 d), HSS (30 d)
Bai 2018 [25]	66.75 ± 6.32	66.80 ± 7.35	3/17	3/17	20	20	TEAS, cocktail therapy	Cocktail therapy	SP10, SP9, GB34, ST36/NR/30 min, twice daily, 1 day after surgery	VAS (12, 24, 48, 72 h), ROM of knee (24, 48, 72 h), Analgesia-Related Adverse Effects (72 h)
Zhang et al. 2019 [26]	69.2 ± 3.0	68.6 ± 3.2	14/26	11/29	40	40	TEAS, analgesia pump	Sham TEAS, Analgesia pump	LI4, PC6/2~100 HZ/30 min before anesthesia, through completion of surgery	VAS (1, 6, 24, 48 h), Analgesia-Related Adverse Effects (2 d)
Zhuang 2019 [27]	65.60 ± 6.34	66.90 ± 6.77	5/25	7/23	30	30	TEAS, routine rehabilitation	Routine rehabilitation	SP9, GB34, SP10, ST36, ST40, BL60, GB39, SP6/2~100 HZ/30 min, once daily, 1 day after surgery	VAS (1, 3, 7 d), HSS (7 d)
Chen et al. 2019 [28]	65.92 ± 7.60	65.64 ± 7.15	5/20	4/21	25	25	TEAS, analgesia pump, routine rehabilitation	Analgesia pump, routine rehabilitation	PC6, LI4, SP10, ST34, SP9, ST36/2~100 HZ/30 min preoperative and 30 min before postoperative rehabilitation	VAS (1, 2, 3, 5, 7 d), ROM of knee (3, 5, 7 d), Analgesia-Related Adverse Effects (3 d)
Zhang(b) 2019 [29]	66.10 ± 6.03	67.48 ± 5.43	2/28	5/25	30	30	TEAS	Blank	LI4, PC6/2~100 HZ/30 min before anesthesia, through completion of surgery	VAS (1 d), Analgesia-Related Adverse Effects (1 d)
Li 2019 [30]	68.64 ± 5.74	69.12 ± 5.88	NR		25	25	TEAS, analgesia drugs, routine rehabilitation	Analgesia drugs, routine rehabilitation	SP9, GB34/100 HZ/30 min, once daily, 30 min before routine rehabilitation	KSS (7, 14 d), ROM of knee (3, 7, 14 d)
Wang 2019 [31]	64.60 ± 4.51	64.11 ± 4.92	13/7	12/8	20	20	TEAS, analgesia pump	Analgesia pump	LI4, PC6, ST36, GB31, BL57, SP6/2~100 HZ/15 min before anesthesia, and 30 min, once daily, 1 day after surgery	VAS (1, 2, 3, 4 d), Analgesia-Related Adverse Effects (5 d), IL-6 (1, 3, 5 d), CRP (1, 3, 5 d)
Tong 2020 [32]	68.7 ± 4.9	69.2 ± 7.6	5/15	1/19	20	20	TEAS, analgesia drugs	Analgesia drugs	LI4, PC6/2~100 HZ/30 min before anesthesia, through completion of surgery	VAS (1, 2, 6, 12, 24, 48 h), Analgesia-Related Adverse Effects (2 d)
Kim et al. 2021 [33]	63.53 ± 4.29	62.07 ± 3.88	6/9	8/7	15	15	TEAS	TENS	BL36, BL37, ST32, ST34, SP10/2~150 HZ/30 min, 5 times per week, 1 day after surgery	VAS (14 d), CRP (1 d)
Wang(a) 2021 [34]	69.7 ± 4.31	70.87 ± 5.56	13/21	9/23	34	32	TEAS	Sham TEAS	GB20, LI4, PC6/2~100 HZ/30 min before anesthesia, through completion of surgery	VAS (6, 12, 24, 48 h), Analgesia-Related Adverse Effects (2 d), IL-6 (6 h after surgery, 1 d)
Wang(b) 2021 [35]	65.94 ± 3.87	65.16 ± 2.68	11/20	6/25	31	31	TEAS, analgesia drugs	Analgesia drugs	LI4, PC6, SP6, GB39, ST36/2~100 HZ/30 min, 1 day before surgery	VAS (1, 2, 3, 5, 7 d)
Li 2021 [36]	66.95 ± 3.46	66 ± 3.76	5/15	6/14	20	20	TEAS, analgesia pump, femoral nerve blocked	Analgesia pump, femoral nerve blocked	SP9, GB34, ST36, SP6, ST34, GB39, BL60/2~100 HZ/30 min, once daily, 2 days after surgery	VAS (2, 3, 5, 7 d), HSS (2, 3, 5, 7 d), Analgesia-Related Adverse Effects (7 d)
Hu et al. 2021 [37]	70~88		52/48		50	50	TEAS	Blank	SP12, ST31, ST36, SP6, SP10/2~100 HZ/30 min, 1 day before surgery and 30 min before anesthesia	VAS (1, 6, 24, 48 h), Analgesia-Related Adverse Effects (1 d), IL-6 (Immediately after surgery), CRP (Immediately after surgery)

Cui 2021 [38]	62.9 ± 5.05	64.20 ± 5.99	1/19	4/16	20	20	TEAS, analgesia pump, routine rehabilitation	Analgesia pump, routine rehabilitation	SP9, GB34, ST34, ST36, BL60, GB39, SP6/2~100 HZ/30 min, once daily, 30 min before routine rehabilitation	VAS (2, 3, 5, 7 d), HSS (2, 3, 5, 7 d), ROM of knee (2, 3, 5, 7 d), Analgesia-Related Adverse Effects (7 d)
Xie 2021 [39]	67.71 ± 5.41	65.22 ± 6.04	2/39	8/33	41	41	TEAS, routine rehabilitation	Sham TEAS, routine rehabilitation	SP10, ST34, BL37, BL40/1~20 HZ/30 min, twice daily, 3 days after surgery	VAS (1, 2, 3, 7, 14 d), KSS (14, 30 d), ROM of knee (7, 14 d)
Zhang 2021 [40]	69.78 ± 4.63	70.89 ± 4.68	9/23	13/22	32	35	TEAS, analgesia drugs, routine rehabilitation	Analgesia drugs, routine rehabilitation	SP9, SP10, ST34, ST36/2~100 HZ/1 day before surgery	VAS (12, 24, 48 h), HSS (7, 14 d), ROM of knee (12, 24, 48 h)
Wang et al. 2022 [41]	60~84		NR		24	24	TEAS	Blank	LI4, PC6/2~100 HZ/30 min before anesthesia, through completion of surgery	VAS (1, 6, 24 h), Analgesia-Related Adverse Effects (1 d), IL-6 (1 d)
Bai et al. 2023 [42]	65.61 ± 5.73	65.07 ± 5.98	28/43	30/39	71	69	TEAS, analgesia drugs	Analgesia drugs	SP9, GB34, SP10, ST36, ST34, BL40/2~100 HZ/30 min, twice daily, 1 day after surgery	VAS (1, 3, 7 d), HSS (7, 14 d), Analgesia-Related Adverse Effects (7 d)

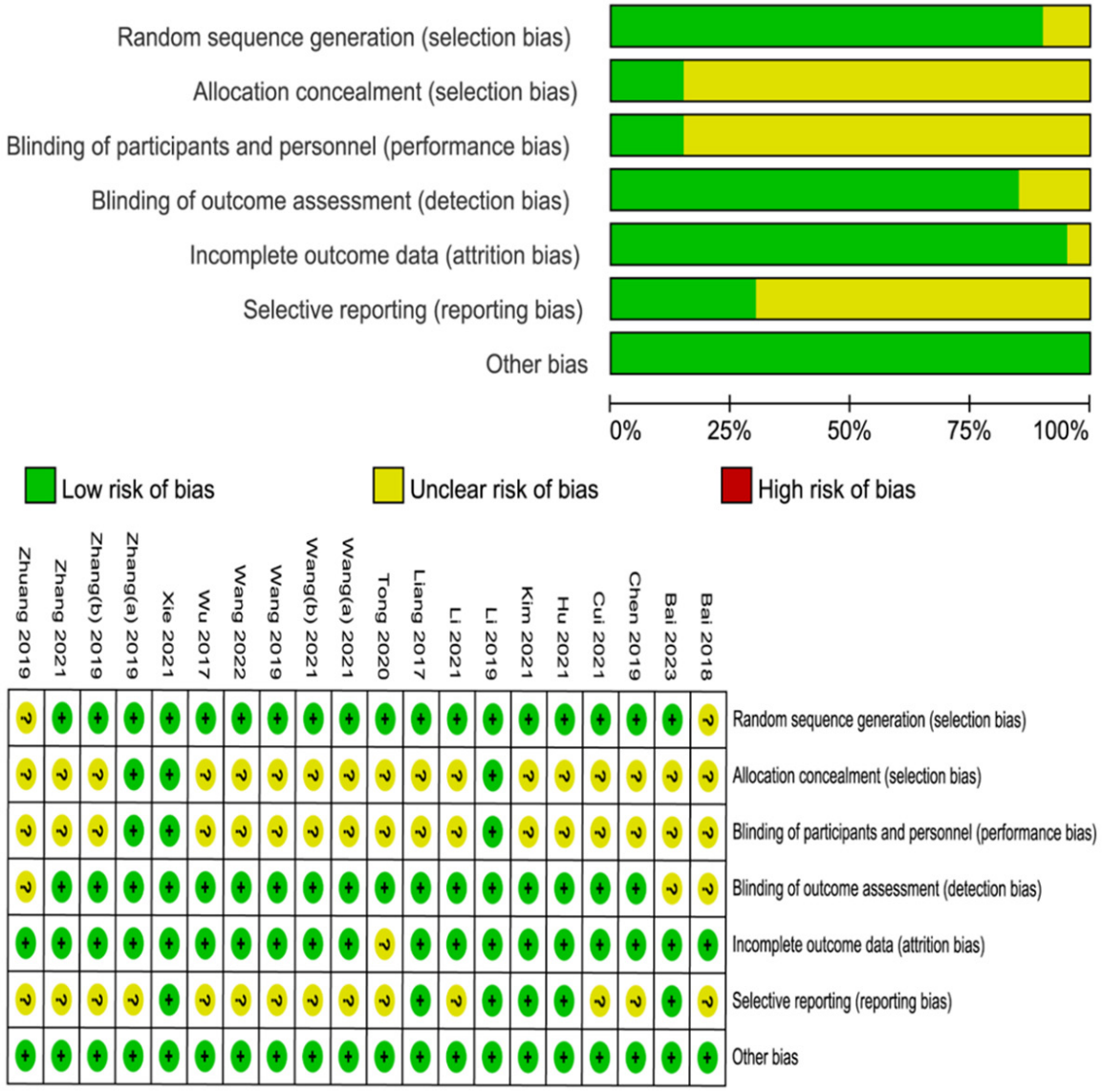

Figure 2. Risk of bias graph.

[25, 27] mentioned randomization with without specific methods. Three studies [26, 30, 39] described the correct method of complete allocation concealment, and the remaining trials were unclear for allocation concealment. Three studies [26, 30, 39] reported detailed participant blinding methods, and most included studies performed well on detection bias. All studies had a low risk of incomplete outcome data. It was difficult to assess selective reporting in this study because most research protocols were unavailable. The risk of bias assessments for the selected studies are summarized in **Figure 2**.

Meta-analysis

Post-operative pain: Meta-analysis results and evidence quality for the effect of TEAS on rehabilitation after TKA are shown in **Table 2**. A total of eighteen studies reported postoperative VAS, with 583 cases in the experimental group (EG) and 576 cases in the control group (CG) overall. An overall meta-analysis indicated that the EG had considerably improved VAS [MD = -0.60 (95% CI: -0.74, -0.47), $P < 0.00001$, $I^2 = 84\%$] when compared to the CG, with substantial heterogeneity, using a random-effects model. To identify sources of high heterogeneity,

Table 2. Main findings of meta-analysis of TEAS on rehabilitation after TKA

Variable	No. of Studies	No. of Participants	Effect Estimate (95% CI)	I^2 Heterogeneity, %	GRADE
Post-operative Pain					
6 h	5	336	-0.86 (-1.35 to -0.37)	91	Very Low
12 h	4	213	-0.86 (-1.37 to -0.36)	78	Low
24 h	13	895	-0.39 (-0.60 to -0.17)	79	Low
48 h	11	667	-0.47 (-0.77 to -0.17)	85	Very Low
72 h	8	514	-0.95 (-1.36 to -0.54)	81	Low
7 d	7	474	-0.56 (-0.86 to -0.26)	72	Low
14 d	2	112	-0.50 (-0.76 to -0.24)	0	Moderate
Function					
HSS	6	507	3.96 (1.60 to 6.32)	91	Low
KSS	3	212	7.33 (1.22 to 13.45)	86	Very Low
Rom of knee	6	329	5.61 (4.08 to 7.14)	61	Low
Analgesia-related adverse effects	12	744	0.30 (0.20 to 0.45)	0	Moderate
CRP	3	170	-0.92 (-1.57 to -0.27)	71	Low
IL-6	4	354	-1.29 (-2.07 to -0.51)	87	Low

we performed subgroup analyses according to the time of postoperative outcome testing. The subgroup analysis was performed to evaluate effect of TEAS on the VAS at 6, 12, 24, 48, 72 hours, 7 and 14 days after TKA operation. In comparison to the CG, **Figure 3** showed that the EG had a significant reduction in pain at post-operative 6 h [MD = -0.86 (95% CI: -1.35, -0.37), $P = 0.0006$, $I^2 = 91\%$], 12 h [MD = -0.86 (95% CI: -1.37, -0.36), $P = 0.0008$, $I^2 = 78\%$], 24 h [MD = -0.39 (95% CI: -0.60, -0.17), $P = 0.0004$, $I^2 = 79\%$], 48 h [MD = -0.47 (95% CI: -0.77, -0.17), $P = 0.002$, $I^2 = 85\%$], 72 h [MD = -0.95 (95% CI: -1.36, -0.54), $P < 0.00001$, $I^2 = 81\%$], 7 days [MD = -0.56 (95% CI: -0.86, -0.26), $P = 0.0002$, $I^2 = 72\%$], and 14 days [MD = -0.50 (95% CI: -0.76, -0.24), $P = 0.0002$, $I^2 = 0\%$].

Functional score: Eight studies reported knee function using different instruments including Hospital for Special Surgery Knee Score (HSS) and knee society score (KSS), with 359 participants in the EG and 360 participants in the the CG overall. Six studies reported post-treatment HSS scores with 253 patients in the EG and 254 patients in the CG. HSS scores were statistically higher in the EG than in the CG [MD = 3.96 (95% CI: 1.60, 6.32), $P = 0.001$, $I^2 = 91\%$]. Three studies reported post-treatment KSS scores with 106 patients in the EG and 106 patients in the CG. The result indicated that the KSS score of EG improved more than that of CG [MD = 7.33 (95% CI: 1.22, 13.45), $P = 0.02$, $I^2 = 86\%$]. Meta-analysis and forest plots are shown in **Figure 4**.

ROM of knee: A total of six studies, with 166 participants in the control groups and 163 in the experimental groups, reported the efficacy of TEAS for ROM of knee after TKA. The analysis result revealed a significant difference in ROM of knee between EG and CG [MD = 5.61 (95% CI: 4.08, 7.14), $P < 0.00001$, $I^2 = 61\%$], with substantial heterogeneity, using a random-effects model (**Figure 5**).

Nausea/vomiting (analgesia-related adverse effect): Twelve studies reported the occurrence of analgesia-related adverse effects with 374 participants in the EG and 370 participants in the CG. Meta-analysis results showed a substantial difference between the EG and the CG [OR = 0.30 (95% CI: 0.20, 0.45), $P < 0.00001$, $I^2 = 0\%$], with no heterogeneity, using a fixed-effects model (**Figure 6**).

Relevant serum indexes including IL-6, CRP: A total of five trials reported TEAS intervention for efficacy of inflammation indicators including Interleukin-6 (IL-6) and C-reactive protein (CRP) after TKA operation. A pooled meta-analysis of four studies with 254 participants showed that there was a meaningful variation in the degree of IL-6 improvement IL-6 between the EG and the CG [SMD = -0.92 (95% CI: -1.57, -0.27), $P =$

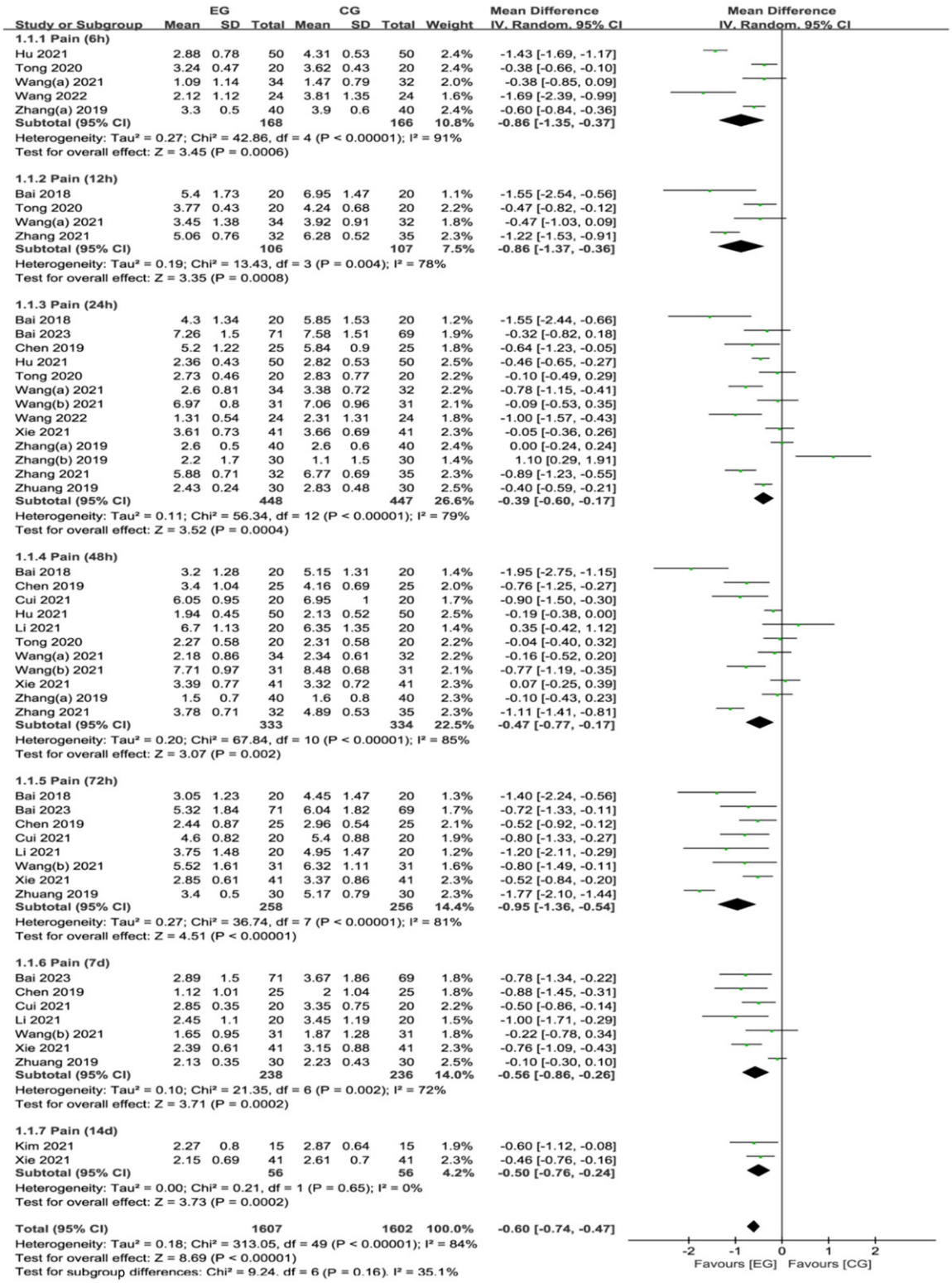

Figure 3. Meta-analysis and forest plot and for postoperative pain at different periods.

0.001, I^2 = 71%], with high heterogeneity, using a random-effects model (**Figure 7**). Regarding CRP, a meta-analysis including 3 studies showed lower postoperative CPR in the EG than in

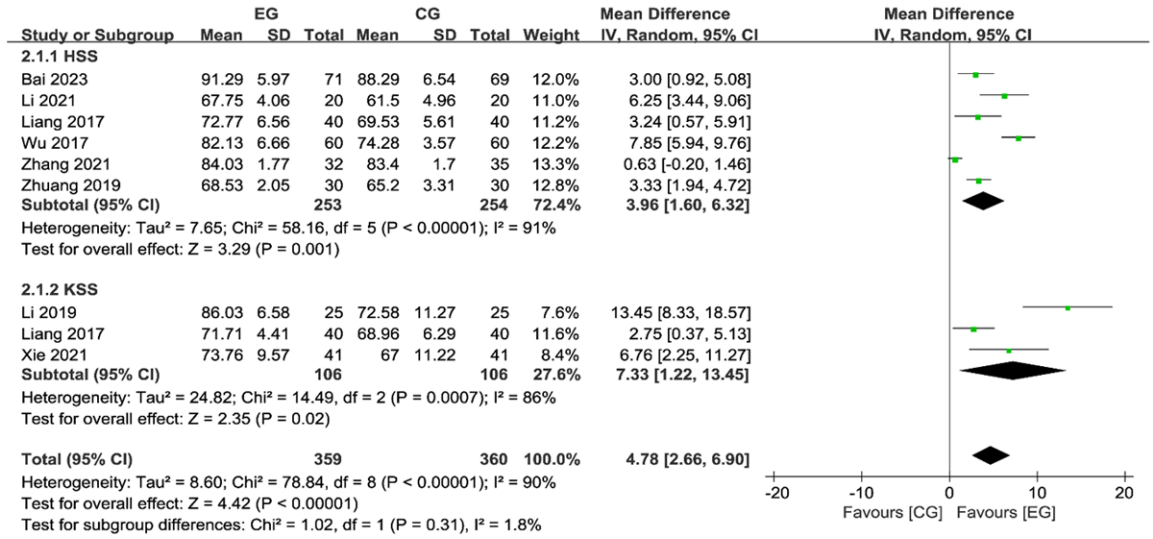

Figure 4. Meta-analysis and forest plot for function.

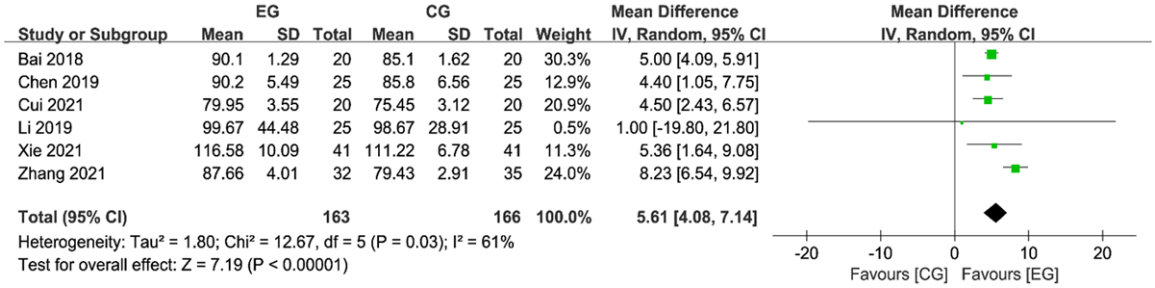

Figure 5. Meta-analysis and forest plot for range of motion (ROM) of knee.

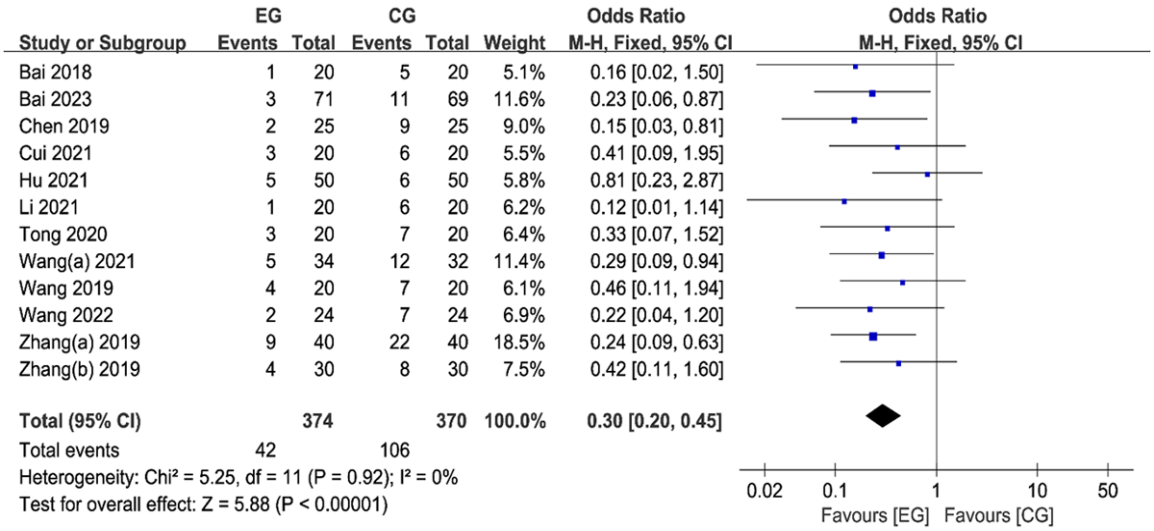

Figure 6. Meta-analysis and forest plot for analgesia-related adverse effects.

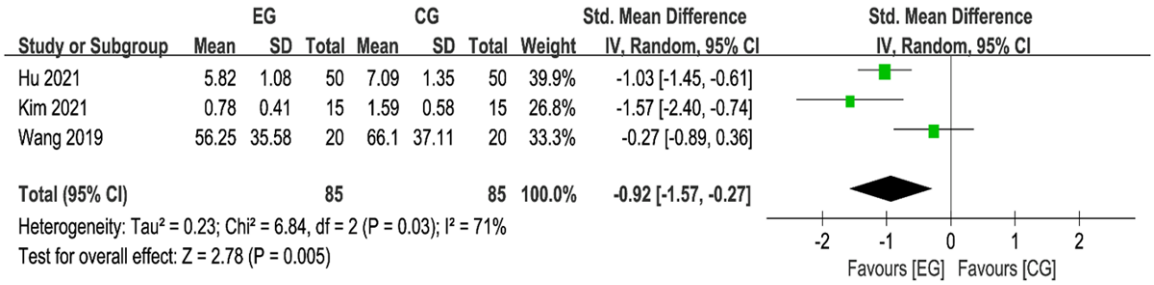

Figure 7. Meta-analysis and forest plot and for Interleukin-6.

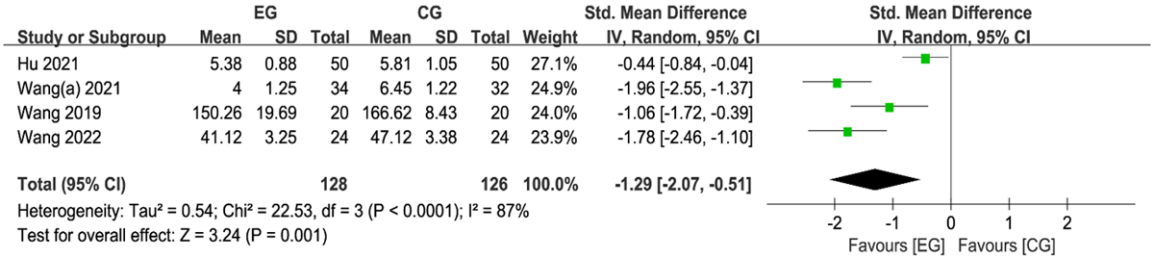

Figure 8. Meta-analysis and forest plot and for C-reactive protein.

the CG [SMD = -1.29 (95% CI: -2.07, -0.51), P = 0.005, I^2 = 87%], with significant heterogeneity, using a random-effects model (**Figure 8**).

Sensitivity analysis

Sensitivity analyses of the primary outcomes were performed by removing trials "one-at-a-time" to identify the source(s) of heterogeneity, which revealed that there were overall stable heterogeneities and results (Supplementary Table 2).

Publication bias

The funnel plot for the VAS and functional score was symmetric as presented in Supplementary Figure 1. Begg and Eggers' tests indicated that there was no significant publication bias in the included studies (Supplementary Table 3).

Evidence quality assessment

Evidence quality was assessed using the Grading of Recommendations, Assessment, Development, and Evaluation (i.e., "GRADE") system. A brief summary of the results is presented in Supplementary Figure 2.

Discussion

Total knee arthroplasty (TKA) is indicated for patients with advanced osteoarthritis of the knee that has not responded to conservative treatment and significantly limits daily activity [43]. Accelerating recovery after TKA has been a long-standing concern. TEAS has become an essential interventional modality in the perioperative period, offering various benefits to promote postoperative recovery, including pain reduction, gastrointestinal modulation, anti-inflammatory effects, and stress reduction [44, 45]. We found that most of the included studies had a follow-up time of less than one month, thus the efficacy of TEAS for long-term rehabilitation after TKA is still not clear, and the follow-up time needs to be further increased in future clinical trials. Current clinical trials of TEAS for postoperative rehabilitation after TKA vary in acupuncture points, duration of intervention, and settimngs of electrical stimulation, a situation that limits their expansion in clinical practice and requires further standardization of these treatment protocols. A previous meta-analysis showed that acupuncture achieved significant improvement in relieving early pain and reducing nausea/vomiting after TKA. However, the improvement in knee ROM was not significant [46]. Compared to the previous meta-analysis, it was found that TEAS was more effective than acupuncture in improving knee ROM after TKA. Meta-analysis by Zhu [47] showed that TENS supplementation intervention was found to significantly reduce pain and

morphine requirement over a 24-hour period and promote functional recovery in patients who had undergone TKA. This study demonstrated that TEAS, a therapy that combines the benefits of acupuncture and TENS, not only improved analgesia but also enhanced knee motor function and anti-inflammatory effects, and reduced the incidence of analgesia-related adverse effects.

Postoperative pain management

Postoperative pain management is essential for rehabilitation and to enhance recovery in patients undergoing TKA [48]. In terms of functional status and quality of life, TKA provides substantial improvement for patients. However, there is evidence that approximately 8% to 34% of postoperative pain will develop into chronic pain [49]. With 3.48 million TKA surgeries projected to be performed annually in the United States by 2030, up to 500,000 patients per year could develop chronic postoperative pain [50]. In this review, we investigated the influence of TEAS on short-term postoperative pain relief and relevant serum inflammatory indexes. Our results revealed that patients treated with TEAS (experimental group EG) demonstrated substantial improvement in pain compared with control group CG at 6, 12, 24, 48, and 72 h and 7 and 14 days after TKA. In addition, we found that TEAS reduced IL-6 and CRP levels at an early stage after TKA surgery. Amelioration of early pain may be associated with the efficacy of TEAS in reducing the local inflammatory response in the knee joint. Nevertheless, the efficacy of TEAS for long-term pain control after knee replacement remains unclear.

With a history exceeding 3000 years, acupuncture has been used extensively in Chinese health care. TEAS is a non-invasive type of electrical acupuncture stimulation developed from the technology of acupuncture, which is widely accepted and used for postoperative pain worldwide [51]. However, the mechanisms underlying the analgesic effects of TEAS have not been clearly elucidated. Some research has shown that TEAS can exert an interventional effect on pain sensation through multiple mechanisms: (1) TEAS may have analgesic effects through enhancement of the release of endogenous opioid peptides and inhibiting the production of endogenous pain mediators [52]; (2) TEAS relieves postoperative immune damage and decreases levels of the tumor necrosis factor-α (TNF-α) and cytokines interleukin-1β (IL-1β) in the peripheral circulation [53]; (3) TEAS prevents early neuropathic pain sensitization at the peripheral level [54].

Function

Functional scores and ROM of the knee joint reflect the recovery of knee function after TKA surgery. The HSS and KSS values are reliable for assessing knee dysfunction, including pain, joint function, and muscle strength, and are widely used to evaluate the outcome of TKA [55, 56]. Eight studies in this meta-analysis evaluated functional scores, and the subgroup analysis of rating scale type indicated that TEAS had a substantial benefit in rehabilitation compared to a CG, whether measured by the HSS score or the KSS score. Range of motion reflects the degree of joint stiffness and plays an essential role in helping to restore knee function. Knee ROM was reported in six studies, and the analysis result showed that TEAS significantly improved the rehabilitation of knee ROM compared to the CG.

Analgesia-related adverse effects

Painkillers are widely used after surgery, mostly to minimize physical and psychological discomfort and speed recovery, but the side effects of painkillers often impair patient recovery [57]. Analgesics have numerous side effects ranging from bothersome to life-threatening, including nausea, vomiting, constipation, pruritus, drowsiness, and respiratory depression [58]. The prevalence and severity of adverse effects associated with analgesia are such that they cannot go unnoticed [59]. Of these, nausea and vomiting are the most frequent. TEAS greatly reduced the incidence of nausea/vomiting after TKA surgery compared to the control group in this study. In addition, the choice of acupuncture points is an essential element of TEAS treatment. In terms of the selection of acupoints for TEAS treatment, PC6 (Neiguan) and LI4 (Hegu) were the most frequently selected acupuncture points in the included studies. Studies to date indicate that stimulation of LI4 (Hegu) and PC6 (Neiguan) may decrease the incidence of nausea and vomiting [60]. SP9 (n = 9), SP10 (n = 9), LI4 (n = 8), and PC6 (n = 8)

were the four most commonly used acupoints in the included studies. We believe that SP9, SP10, LI4, and PC6 are the best combinations of acupuncture points according to the review.

Some limitations of the present study should be addressed. First, the results of long-term follow-up are not known because the observation time point in the included trials was mostly < 28 days postoperative. Second, the acupuncture points, intervention time, and electrical stimulation parameters were inconsistent, which could have led to a high degree of heterogeneity and affected the results. Third, some of the studies had a small sample size and were of low quality, which had a negative impact on the strength of the evidence supporting the research findings. Therefore, to draw firmer conclusions, high-quality, large-sample, multicenter RCTs are needed in the future.

In conclusion, we systematically evaluated the effects of TEAS on postoperative rehabilitation in TKA patients. Our results suggest that the performance of TEAS in TKA patients was associated with early postoperative pain reduction, improved knee function, and reduced adverse effects of analgesics. While stronger evidence is required to determine the best method to apply TEAS approach in clinical practice, our findings support the use of TEAS therapy during the clinical practice for early TKA postoperative rehabilitation.

Acknowledgements

This research was funded by China Postdoctoral Science Foundation (2023M731070), Hunan Provincial Science and Technology Department (2023JJ60118), Hunan University of Traditional Chinese Medicine Graduate Student Innovation Projects (2023CX18), and Hunan Academy of Chinese Medicine (202129).

Disclosure of conflict of interest

None.

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Supplementary Table 1. The search strategy in this review

A. Search strategy for PubMed (84)	
Search	Terms
#1	((((((((((((((((((((((((((((((Arthroplasties, Replacement, Knee) OR (Arthroplasty, Knee Replacement)) OR (Knee Replacement Arthroplasties)) OR (Knee Replacement Arthroplasty)) OR (Replacement Arthroplasties, Knee)) OR (Knee Arthroplasty, Total)) OR (Arthroplasty, Total Knee)) OR (Total Knee Arthroplasty)) OR (Replacement, Total Knee)) OR (Total Knee Replacement)) OR (Knee Replacement, Total)) OR (Knee Arthroplasty)) OR (Arthroplasty, Knee)) OR (Arthroplasties, Knee Replacement)) OR (Replacement Arthroplasty, Knee)) OR (Arthroplasty, Replacement, Partial Knee)) OR (Unicompartmental Knee Arthroplasty)) OR (Arthroplasty, Unicompartmental Knee)) OR (Knee Arthroplasty, Unicompartmental)) OR (Unicondylar Knee Arthroplasty)) OR (Arthroplasty, Unicondylar Knee)) OR (Knee Arthroplasty, Unicondylar)) OR (Partial Knee Arthroplasty)) OR (Arthroplasty, Partial Knee)) OR (Knee Arthroplasty, Partial)) OR (Unicondylar Knee Replacement)) OR (Knee Replacement, Unicondylar)) OR (Partial Knee Replacement)) OR (Knee Replacement, Partial)) OR (Unicompartmental Knee Replacement)) OR (Knee Replacement, Unicompartmental)) OR ("Arthroplasty, Replacement, Knee"[Mesh]))
#2	((((((((((((((transcutaneous electrical acupoint stimulation) OR (transcutaneous acupoint electrical stimulation)) OR (TEAS)) OR (TAES)) OR (acustimulation)) OR (Transcutaneous electrical nerve stimulation on acupoints)) OR (Acupuncture-like Transcutaneous Electrical Nerve Stimulation)) OR (Electrical Stimulation)) OR (Electrical Stimulations)) OR (Stimulation, Electrical)) OR (Stimulations, Electrical)) OR (Stimulation, Electric)) OR (Electric Stimulations)) OR (Stimulations, Electric)) OR ("Electric Stimulation"[Mesh])
#3	((randomized controlled trial[Publication Type]) OR (randomized[Title/Abstract])) OR (placebo[Title/Abstract])
#4	#1 AND #2 AND #3
B. Search strategy for Embase (83)	
Search	Terms
#1	'Knee arthroplasty'/exp
#2	'arthroplasty, replacement, knee' OR 'arthroplasties, replacement, knee' OR 'arthroplasty, knee replacement' OR 'knee replacement arthroplasties' OR 'knee replacement arthroplasty' OR 'replacement arthroplasties, knee' OR 'knee arthroplasty, total' OR 'arthroplasty, total knee' OR 'total knee arthroplasty' OR 'replacement, total knee' OR 'total knee replacement' OR 'knee replacement, total' OR 'knee arthroplasty' OR 'arthroplasty, knee' OR 'arthroplasties, knee replacement' OR 'replacement arthroplasty, knee' OR 'arthroplasty, replacement, partial knee' OR 'unicompartmental knee arthroplasty'
#3	'arthroplasty, unicompartmental knee' OR 'knee arthroplasty, unicompartmental' OR 'unicondylar knee arthroplasty' OR 'arthroplasty, unicondylar knee' OR 'knee arthroplasty, unicondylar' OR 'partial knee arthroplasty' OR 'arthroplasty, partial knee' OR 'knee arthroplasty, partial' OR 'unicondylar knee replacement' OR 'knee replacement, unicondylar' OR 'partial knee replacement' OR 'knee replacement, partial' OR 'unicompartmental knee replacement' OR 'knee replacement, unicompartmental'
#4	#1 OR #2 OR #3
#5	'electrostimulation'/exp
#6	'transcutaneous electrical acupoint stimulation' OR 'transcutaneous acupoint electrical stimulation' OR teas OR taes OR acustimulation OR 'transcutaneous electrical nerve stimulation' OR acupoints
#7	#5 OR #6
#8	'clinical trial'/exp OR 'clinical trial' OR (('clinical' OR 'clinical'/exp OR clinical) AND ('trial' OR 'trial'/exp OR trial)) OR (randomized AND controlled AND ('trial'/exp OR trial)) OR trials
#8	#4 AND #7 AND #8
C. Search strategy for CENTRAL (41)	
Search	Terms
#1	(transcutaneous electrical acupoint stimulation):ti,ab,kw
#2	(transcutaneous acupoint electrical stimulation):ti,ab,kw
#3	(TEAS):ti,ab,kw
#4	(TAES):ti,ab,kw
#5	(acustimulation):ti,ab,kw

#6	(Transcutaneous electrical nerve stimulation on acupoints):ti,ab,kw
#7	MeSH descriptor: [Electric Stimulation] explode all trees
#8	#1 OR #2 OR #3 OR #4 OR #5 OR #6 OR #7
#9	MeSH descriptor: [Arthroplasty, Replacement, Knee] explode all trees
#10	((Arthroplasty, Replacement, Knee) OR (Arthroplasties, Replacement, Knee) OR (Arthroplasty, Knee Replacement) OR (Knee Replacement Arthroplasties) OR (Knee Replacement Arthroplasty) OR (Replacement Arthroplasties, Knee) OR (Knee Arthroplasty, Total) OR (Arthroplasty, Total Knee) OR (Total Knee Arthroplasty) OR (Replacement, Total Knee) OR (Total Knee Replacement) OR (Knee Replacement, Total) OR (Knee Arthroplasty) OR (Arthroplasty, Knee) OR (Arthroplasties, Knee Replacement) OR (Replacement Arthroplasty, Knee) OR (Arthroplasty, Replacement, Partial Knee) OR (Unicompartmental Knee Arthroplasty) OR (Arthroplasty, Unicompartmental Knee) OR (Knee Arthroplasty, Unicompartmental) OR (Unicondylar Knee Arthroplasty) OR (Arthroplasty, Unicondylar Knee) OR (Knee Arthroplasty, Unicondylar) OR (Partial Knee Arthroplasty) OR (Arthroplasty, Partial Knee) OR (Knee Arthroplasty, Partial) OR (Unicondylar Knee Replacement) OR (Knee Replacement, Unicondylar) OR (Partial Knee Replacement) OR (Knee Replacement, Partial) OR (Unicompartmental Knee Replacement) OR (Knee Replacement, Unicompartmental)):ti,ab,kw
#11	#9 OR #10
#12	#8 AND #11

D. Search strategy for CNKI (74)
(SU% = transcutaneous acupoint electrical stimulation + acupoint electrical stimulation + electrical stimulation) AND (SU % = knee replacement + joint replacement + total knee replacement)

E. Search strategy for WanFang (77)
Topic: ('transcutaneous electrical acupoint stimulation' OR 'acupoint electrical stimulation' OR 'electrical stimulation') and Topic: ('knee replacement' OR 'joint replacement' OR 'total knee replacement')

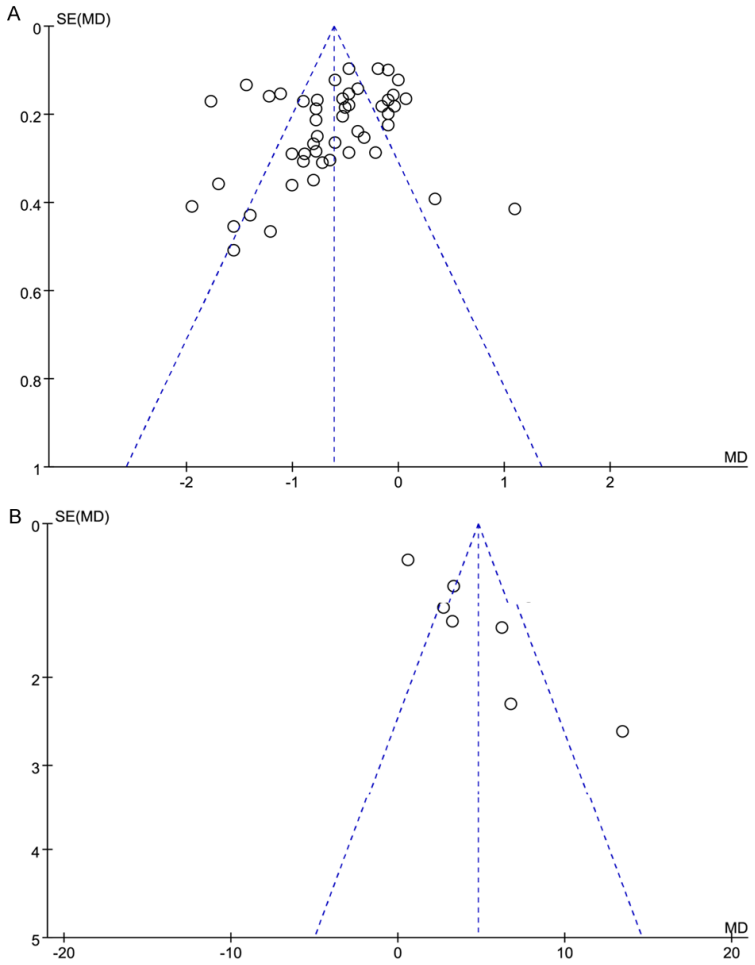
F. Search strategy for VIP (79)
(U = transcutaneous acupoint electrical stimulation OR acupoint electrical stimulation OR electrical stimulation) AND (U = knee replacement OR joint replacement OR total knee replacement)

G. Search strategy for CBM (88)
('Knee replacement' [all fields: intelligent] OR 'joint replacement' [all fields: intelligent] OR 'total knee replacement' [all fields: intelligent]) AND ('transcutaneous electrical acupoint stimulation' [all fields: intelligent] OR 'acupoint electrical stimulation' [all fields: intelligent] OR 'electrical stimulation' [all fields: intelligent])

Supplementary Table 2. Sensitivity analysis for VAS, functional scores

Outcomes	References	Effect size	95% CI	P	I^2
VAS	Hu 2021	-0.58	-0.71, -0.45	< 0.00001	82%
	Tong 2020	-0.61	-0.75, -0.47	< 0.00001	85%
	Wang(a) 2021	-0.61	-0.75, -0.47	< 0.00001	85%
	Wang 2022	-0.59	-0.72, -0.45	< 0.00001	84%
	Zhang(a) 2019	-0.60	-0.75, -0.46	< 0.00001	85%
	Bai 2018	-0.59	-0.73, -0.46	< 0.00001	84%
	Tong 2020	-0.61	-0.75, -0.47	< 0.00001	85%
	Wang(a) 2021	-0.61	-0.74, -0.47	< 0.00001	85%
	Zhang 2021	-0.59	-0.72, -0.45	< 0.00001	84%
	Bai 2018	-0.59	-0.73, -0.46	< 0.00001	84%
	Bai 2023	-0.60	-0.74, -0.46	< 0.00001	85%
	Chen 2019	-0.60	-0.74, -0.46	< 0.00001	85%
	Hu 2021	-0.61	-0.75, -0.48	< 0.00001	84%
	Tong 2020	-0.62	-0.75, -0.48	< 0.00001	84%
	Wang(a) 2021	-0.61	-0.75, -0.48	< 0.00001	84%
	Wang(b) 2021	-0.61	-0.75, -0.47	< 0.00001	85%
	Wang 2022	-0.60	-0.73, -0.46	< 0.00001	85%
	Xie 2021	-0.60	-0.74, -0.46	< 0.00001	85%
	Zhang(a) 2019	-0.62	-0.75, -0.48	< 0.00001	84%
	Zhang(b) 2019	-0.63	-0.76, -0.49	< 0.00001	84%
	Zhang 2021	-0.59	-0.73, -0.45	< 0.00001	84%
	Zhuang 2019	-0.62	-0.75, -0.48	< 0.00001	84%
	Bai 2018	-0.58	-0.72, -0.45	< 0.00001	84%
	Chen 2019	-0.61	-0.74, -0.47	< 0.00001	85%
	Cui 2021	-0.61	-0.75, -0.47	< 0.00001	85%
	Hu 2021	-0.61	-0.75, -0.47	< 0.00001	85%
	Li 2021	-0.60	-0.73, -0.46	< 0.00001	85%
	Tong 2020	-0.61	-0.75, -0.48	< 0.00001	84%
	Wang(a) 2021	-0.60	-0.74, -0.46	< 0.00001	85%
	Wang(b) 2021	-0.60	-0.74, -0.46	< 0.00001	85%
	Xie 2021	-0.61	-0.75, -0.47	< 0.00001	85%
	Zhang(a) 2019	-0.62	-0.75, -0.48	< 0.00001	84%
	Zhang 2021	-0.60	-0.74, -0.46	< 0.00001	84%
	Bai 2018	-0.59	-0.73, -0.46	< 0.00001	84%
	Bai 2023	-0.60	-0.74, -0.46	< 0.00001	85%
	Chen 2019	-0.60	-0.74, -0.46	< 0.00001	85%
	Cui 2021	-0.60	-0.74, -0.46	< 0.00001	85%
	Li 2021	-0.60	-0.73, -0.46	< 0.00001	85%
	Wang(b) 2021	-0.60	-0.74, -0.46	< 0.00001	85%
	Xie 2021	-0.61	-0.75, -0.47	< 0.00001	85%
	Zhuang 2019	-0.57	-0.70, -0.44	< 0.00001	81%
	Bai 2023	-0.61	-0.75, -0.47	< 0.00001	85%
	Chen 2019	-0.60	-0.74, -0.46	< 0.00001	85%
	Cui 2021	-0.60	-0.74, -0.46	< 0.00001	85%
	Li 2021	-0.62	-0.75, -0.48	< 0.00001	84%
	Wang(b) 2021	-0.61	-0.75, -0.48	< 0.00001	84%
	Xie 2021	-0.62	-0.76, -0.48	< 0.00001	84%
	Zhuang 2019	-0.61	-0.75, -0.47	< 0.00001	85%
	Kim 2021	-0.60	-0.74, -0.47	< 0.00001	85%
	Xie 2021	-0.62	-0.75, -0.48	< 0.00001	84%

Function	Bai 2023	5.08	2.67, 7.49	< 0.0001	91%
	Li 2019	4.04	2.05, 6.03	< 0.0001	89%
	Li 2021	4.60	2.36, 6.84	< 0.0001	90%
	Liang 2017	5.01	2.67, 7.35	< 0.0001	91%
	Liang 2017	5.09	2.72, 7.46	< 0.0001	91%
	Wu 2017	4.20	2.26, 6.14	< 0.0001	85%
	Xie 2021	4.60	2.39, 6.81	< 0.0001	91%
	Zhang 2021	5.30	3.39, 7.21	< 0.00001	79%
	Zhuang 2019	5.09	2.50, 7.69	= 0.0001	91%



Supplementary Figure 1. Funnel plot analysis. A. Funnel plot analysis of VAS. B. Funnel plot analysis of functional score.

Supplementary Table 3. Assessment of publication bias

Outcomes	N	Begg's test	Egger's test
Postoperative pain (6 h)	5	0.806	0.816
Postoperative pain (12 h)	4	1	0.961
Postoperative pain (24 h)	13	0.760	0.815
Postoperative pain (48 h)	11	0.276	0.291
Postoperative pain (72 h)	8	0.174	0.989
Postoperative pain (7 d)	7	0.548	0.053
Postoperative pain (14 d)	2	1	NA
Function (HSS)	6	0.452	0.074
Function (KSS)	3	0.296	0.241
ROM	6	0.452	0.998
Analgesia-Related Adverse Effects	12	0.244	0.3
CRP	3	1	0.943
IL-6	4	0.734	0.180

N: number of studies; NA: not available.

TEAS for rehabilitation after TKA

Patient or population: patients with rehabilitation after TKA
Settings:
Intervention: TEAS

Outcomes	Illustrative comparative risks* (95% CI) Assumed risk Control	Corresponding risk TEAS	Relative effect (95% CI)	No of Participants (studies)	Quality of the evidence (GRADE)	Comments
VAS - Pain (6h)		The mean vas - pain (6h) in the intervention groups was **0.86 lower** (1.35 to 0.37 lower)		334 (5 studies)	⊕⊖⊖⊖ **very low**[1]	
VAS - Pain (12h)		The mean vas - pain (12h) in the intervention groups was **0.86 lower** (1.37 to 0.36 lower)		213 (4 studies)	⊕⊕⊖⊖ **low**[1]	
VAS - Pain (24h)		The mean vas - pain (24h) in the intervention groups was **0.39 lower** (0.6 to 0.17 lower)		895 (13 studies)	⊕⊕⊖⊖ **low**[1]	
VAS - Pain (48h)		The mean vas - pain (48h) in the intervention groups was **0.47 lower** (0.77 to 0.17 lower)		667 (11 studies)	⊕⊖⊖⊖ **very low**[1]	
VAS - Pain (72h)		The mean vas - pain (72h) in the intervention groups was **0.95 lower** (1.36 to 0.54 lower)		514 (8 studies)	⊕⊕⊖⊖ **low**[1]	
VAS - Pain (7d)		The mean vas - pain (7d) in the intervention groups was **0.56 lower** (0.86 to 0.26 lower)		474 (7 studies)	⊕⊕⊖⊖ **low**[1]	
VAS - Pain (14d)		The mean vas - pain (14d) in the intervention groups was **0.5 lower** (0.76 to 0.24 lower)		112 (2 studies)	⊕⊕⊕⊖ **moderate**[1]	

*The basis for the **assumed risk** (e.g. the median control group risk across studies) is provided in footnotes. The **corresponding risk** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).

CI: Confidence interval;

GRADE Working Group grades of evidence
High quality: Further research is very unlikely to change our confidence in the estimate of effect.
Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.
Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.
Very low quality: We are very uncertain about the estimate.

[1] No explanation was provided

TEAS for rehabilitation after TKA

Patient or population: patients with rehabilitation after TKA
Settings:
Intervention: TEAS

Outcomes	Illustrative comparative risks* (95% CI) Assumed risk Control	Corresponding risk TEAS	Relative effect (95% CI)	No of Participants (studies)	Quality of the evidence (GRADE)	Comments
HSS		The mean hss in the intervention groups was **3.96 higher** (1.6 to 6.32 higher)		507 (6 studies)	⊖⊖⊖⊖ **low**[1]	
KSS		The mean kss in the intervention groups was **7.33 higher** (1.22 to 13.45 higher)		212 (3 studies)	⊖⊖⊖⊖ **very low**[1]	

*The basis for the **assumed risk** (e.g. the median control group risk across studies) is provided in footnotes. The **corresponding risk** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).

CI: Confidence interval;

GRADE Working Group grades of evidence
High quality: Further research is very unlikely to change our confidence in the estimate of effect.
Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.
Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.
Very low quality: We are very uncertain about the estimate.

[1] No explanation was provided

TEAS for rehabilitation after TKA

Patient or population: patients with rehabilitation after TKA
Settings:
Intervention: TEAS

Outcomes	Illustrative comparative risks* (95% CI) Assumed risk Control	Corresponding risk TEAS	Relative effect (95% CI)	No of Participants (studies)	Quality of the evidence (GRADE)	Comments
Rom		The mean rom in the intervention groups was **5.61 higher** (4.08 to 7.14 higher)		329 (6 studies)	⊖⊖⊖⊖ **low**[1]	

*The basis for the **assumed risk** (e.g. the median control group risk across studies) is provided in footnotes. The **corresponding risk** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).

CI: Confidence interval;

GRADE Working Group grades of evidence
High quality: Further research is very unlikely to change our confidence in the estimate of effect.
Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.
Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.
Very low quality: We are very uncertain about the estimate.

[1] No explanation was provided

TEAS for rehabilitation after TKA

Patient or population: patients with rehabilitation after TKA
Settings:
Intervention: TEAS

Outcomes	Illustrative comparative risks* (95% CI) Assumed risk Control	Corresponding risk TEAS	Relative effect (95% CI)	No of Participants (studies)	Quality of the evidence (GRADE)	Comments
Nausea/Vomiting	Study population		OR 0.3 (0.2 to 0.45)	744 (12 studies)	⊕⊕⊕⊖ moderate[1]	
	286 per 1000	108 per 1000 (74 to 153)				
	Moderate					
	300 per 1000	114 per 1000 (79 to 162)				

*The basis for the **assumed risk** (e.g. the median control group risk across studies) is provided in footnotes. The **corresponding risk** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).

CI: Confidence interval; **OR:** Odds ratio;

GRADE Working Group grades of evidence
High quality: Further research is very unlikely to change our confidence in the estimate of effect.
Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.
Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.
Very low quality: We are very uncertain about the estimate.

[1] No explanation was provided

CRP for rehabilitation after TKA

Patient or population: patients with rehabilitation after TKA
Settings:
Intervention: CRP

Outcomes	Illustrative comparative risks* (95% CI) Assumed risk Control	Corresponding risk CRP	Relative effect (95% CI)	No of Participants (studies)	Quality of the evidence (GRADE)	Comments
CRP		The mean crp in the intervention groups was **0.92 standard deviations lower** (1.57 to 0.27 lower)		170 (3 studies)	⊕⊕⊖⊖ low[1]	SMD -0.92 (-1.57 to -0.27)

*The basis for the **assumed risk** (e.g. the median control group risk across studies) is provided in footnotes. The **corresponding risk** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).

CI: Confidence interval;

GRADE Working Group grades of evidence
High quality: Further research is very unlikely to change our confidence in the estimate of effect.
Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.
Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.
Very low quality: We are very uncertain about the estimate.

[1] No explanation was provided

TEAS for rehabilitation after TKA

Patient or population: patients with rehabilitation after TKA
Settings:
Intervention: TEAS

Outcomes	Illustrative comparative risks* (95% CI) Assumed risk Control	Corresponding risk TEAS	Relative effect (95% CI)	No of Participants (studies)	Quality of the evidence (GRADE)	Comments
IL-6		The mean il-6 in the intervention groups was **1.29 standard deviations lower** (2.07 to 0.51 lower)		254 (4 studies)	⊕⊕⊖⊖ low[1]	SMD -1.29 (-2.07 to -0.51)

*The basis for the **assumed risk** (e.g. the median control group risk across studies) is provided in footnotes. The **corresponding risk** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).

CI: Confidence interval;

GRADE Working Group grades of evidence
High quality: Further research is very unlikely to change our confidence in the estimate of effect.
Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.
Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.
Very low quality: We are very uncertain about the estimate.

[1] No explanation was provided

Supplementary Figure 2. Evidence quality assessment.