



Clinical trial

Effect of transcutaneous electrical acupoint stimulation on gastrointestinal function recovery after laparoscopic radical gastrectomy – A randomized controlled trial



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ABSTRACT

Introduction: Acupuncture is widely used as perioperative analgesia and promotes postoperative physical recovery. Transcutaneous electrical acupoint stimulation (TEAS) is a acupuncture method that has many advantages. However, there has been little study on the application of TEAS in laparoscopic radical gastrectomy. This is a study exploring the effects of TEAS on gastrointestinal function recovery after laparoscopic radical gastrectomy in order to provide a stimulation model for clinical use.

Methods: A total of 120 gastric cancer patients undergoing laparoscopic radical gastrectomy were randomly assigned into the long duration TEAS (L-TEAS) group, or the placebo-control (C-TEAS) group. All patients were routinely anesthetized. For the L-TEAS group TEAS was maintained from 30 min before anesthetic induction to 30 min after the operation, and TEAS was also performed for 30 min at 8 a.m., 1 p.m. and 6 p.m. within 2 d of the operation. But in the C-TEAS group, the output wires of the stimulator were broken. The stimulation sites included bilateral Zusanli (ST 36) and Neiguan (PC 6) acupoints. Postoperatively, the patients received patient-controlled intravenous analgesia (PCIA). The consumption of analgesics as well as the scores of the visual analogue scale (VAS) and Ramsay Sedation Scale (RSS) at 4 h (T1), 8 h (T2), 16 h (T3), 24 h (T4) and 36 h (T5) were observed and recorded after the operation in the 2 groups. The duration of first bowel sounds, flatus and defecation were recorded after the operation. The incidence of postoperative nausea and vomiting (PONV) as well as patient satisfaction was recorded.

Results: Compared to the C-TEAS group, the VAS scores at 4 h (2.79 ± 0.48 vs. 3.41 ± 0.62), 8 h (2.65 ± 0.42 vs. 3.17 ± 0.49), and 24 h (1.98 ± 0.39 vs. 2.72 ± 0.73) were significantly decreased in the L-TEAS group ($P < 0.05$) after the operation. Compared to the C-TEAS group, analgesic consumption at 4 h (10.02 ± 2.26 vs. 13.38 ± 2.98), 8 h (20.55 ± 4.59 vs. 24.63 ± 3.94) and 36 h (72.64 ± 9.74 vs. 76.01 ± 10.43) was significantly decreased in the L-TEAS group ($P < 0.05$) after the operation. There was a significant difference in the incidence of PONV between the L-TEAS (12%) and C-TEAS (32.2%) groups ($P < 0.05$). No significant difference was observed with respect to RSS among the 2 groups ($P > 0.05$). The time intervals from surgery to the first bowel sounds as well as the passage of flatus and defecation were shorter in the L-TEAS group than in the C-TEAS group (19.69 ± 7.61 h vs. 26.58 ± 7.43 h, 36.58 ± 10.75 h vs. 43.56 ± 9.57 h and 71.48 ± 20.62 h vs. 77.27 ± 22.67 h, respectively) ($P < 0.05$). The rate of moderately satisfaction and above in the L-TEAS (67.3%) group was higher than for that in the C-TEAS group (42.4%), and for very satisfied, the L-TEAS (55.2%) group was higher than that in the C-TEAS group (15.3%) ($P < 0.05$).

Conclusions: Preoperative TEAS and sustained TEAS within 2 d of the operation can effectively reduce the early postoperative pain, reduce the early postoperative consumption of analgesics, the total consumption of anesthetics, and the incidence of PONV as well as shorten the duration of first bowel sounds, first flatus and first defecation after the operation, promoting the recovery of gastrointestinal function and improving the patient satisfaction rate.

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1. Introduction

Gastric cancer is an important health burden. This type of cancer is the third most common cause of cancer death and the fifth most common malignant tumor worldwide [1]. Surgical resections of gastric tumors and regional lymphadenectomy are widely used surgical methods for the treatment of gastric cancer. Whether for the treatment of early gastric cancer (EGC) or advanced gastric cancer (AGC), laparoscopic radical gastrectomy is always a safe and effective treatment [2]. However, after radical gastrectomy, patients may experience severe pain [3]. To relieve postoperative pain, patient-controlled intravenous analgesia (PCIA) is widely used in patients. Adverse reactions such as nausea, vomiting, respiratory depression and constipation are often associated with opioids used for PCIA, which are not conducive to postoperative recovery, but reducing the use of opioids can reduce the incidence of these adverse reactions [4]. After radical gastrectomy, doctors also pay attention to patients' gastrointestinal function recovery because functional recovery is a very important part of enhanced recovery after surgery (ERAS). ERAS recommends the use of multiple methods of anesthesia management and postoperative analgesia to relieve perioperative adverse reactions such as stress and pain and to promote postoperative recovery. Anesthesiologists play an important role in ERAS by choosing premedication, anesthetics and techniques, using prophylactic drugs to reduce side effects, and administering adjunctive drugs during and after surgery to maintain the systemic functions of the major organ [5].

In modern anesthesiology, an increasing number of new methods have been applied for perioperative anesthesia. Traditional Chinese medicine (TCM) has its own independent theoretical system and diagnostic methods, it has been the subject of a large number of historical studies, and it has been widely applied in modern Western Medicine. Acupuncture, as an important part of TCM, not only reduces the consumption of anesthetics and analgesics but also protects organs during the perioperative period and prevents anesthesia-related complications, such as postoperative nausea and vomiting (PONV) [6–8]. Transcutaneous electrical acupoint stimulation (TEAS) is a new acupoint therapy that is noninvasive, easy to operate, and has high patient acceptance as well as other advantages. Recently, many studies have been conducted on the effects of acupuncture on the digestive system. However, to date, there has been little study on application of TEAS in laparoscopic radical gastrectomy. Therefore, the aim of this study was to study the effects of TEAS at Zusanli (ST36) and Neiguan (PC6) acupoints on analgesia and gastrointestinal function recovery after laparoscopic radical gastrectomy.

2. Methods

2.1. Patients

The study was performed in 120 patients in our hospital, from February 2017 to June 2018, with TNM Ib ~ IIIa gastric cancer confirmed by gastroscopy or multislice spiral CT (MSCT), undergoing laparoscopic radical gastrectomy. The patients had an American Society of Anesthesiologists (ASA) physical status classification of grade I or II. The exclusion criteria included the presence of a painful condition (e.g., inflammatory rheumatic disease, lumbar muscle degeneration), major organ system disease, or history of any gastrointestinal surgeries; patients using analgesic or psychotropic drugs; and patients with central nervous system disease, local skin infection, or upper or lower limb nerve injury. Written consent was obtained from each subject before the start of the study.

The study was undertaken in accordance with the Declaration of Helsinki. Our study had been approved by the Ethical Committee of Human Research of Tangshan People's Hospital & Tangshan Cancer Hospital (RMYY-YWLL-2017-0120). No patient had knowledge of TEAS prior to this study.

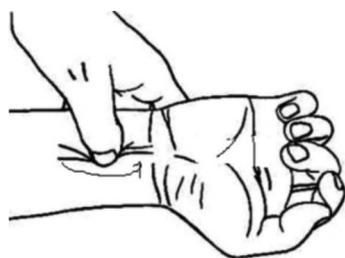
The sample size was calculated based on the primary outcome from a pilot study and this came from a similar study of TEAS in our hospital [26]. A randomized controlled trial with a pre- and posttest design was conducted in accordance with the STRICTA recommendations [9]. The researchers screened the patients the day before the operations. Each enrolled patient was randomized according to a computer-generated random numbers table. Patients were divided into 2 groups: the long duration TEAS (L-TEAS) group and the control (C-TEAS) group, and the allocation ratio was 1:1 for the 2 groups. We chose these durations because they are representative and widely used in clinical practice. All patients were unaware of the group allocations. A single investigator was responsible for applying the type of intervention. Another investigator collected the data and was blind to the group allocation. Those who managed the data and statistical analysis were also blinded to the grouping of patients.

2.2. Anesthetic techniques

All patients fasted, food for 6 h and liquid for 4 h. After entering the operating room, an intravenous catheter was inserted into a forearm vein by a circuit nurse, and standard monitoring was applied, which included ECG monitoring as well as the monitoring of oxygen saturation (SpO₂), noninvasive blood pressure (NIBP) with a 3-minute interval, end-tidal Co₂ (Etco₂), nasopharyngeal temperature and the bispectral index (BIS). Anesthetic induction was implemented by experienced anesthesiologists. Anesthesia was induced with 2.0 mg/kg propofol, 0.5 µg/kg sufentanil and 0.15 mg/kg cis-atracurium. During the operation, the same closed-loop automated system of propofol and remifentanyl was applied to patients, and the infusion of cis-atracurium was sustained to maintain muscle relaxation. All vital signs and parameters were maintained within the normal ranges. At the end of the operation, patients received 100 ml electronic patient-controlled intravenous analgesia (PCIA) devices with 100 µg sufentanil, 200 µg dexmedetomidine, 100 mg flurbiprofen axetil, and 0.5 mg palonosetron (bolus dose 0.5 ml, lock-out time 15 min, basal infusion 2 ml/h). Before the end of the operation, the patients were given 0.25 mg palonosetron (the duration of the injection was over 30 s). After surgery, the patients were transferred while intubated to the surgical ICU, where they were further monitored. Each patient was extubated in the surgical ICU if they met the clinical criteria, and then they were discharged the next morning. Postoperatively, patients were discouraged from receiving any analgesic treatments, except for PCIA, throughout the trial.

2.3. Transcutaneous electrical acupoint stimulation (TEAS)

The HANS LH-202 TEAS equipment was used in our study. The bilateral Zusanli (ST36) and Neiguan (PC6) acupoints were marked with the traditional anatomical position and cleaned with alcohol swabs (Fig. 1). Electrode tabs were placed on bilateral Zusanli (ST36) and Neiguan (PC6) acupoints, and the stimulator and tabs were connected with output wires. For patients in the 2 groups, TEAS was maintained from 30 min before anesthetic induction in the holding area to 30 min after the operation in the surgical ICU, and TEAS was performed for 30 min at 8 a.m., 1 p.m. and 6 p.m. within 2 d of the operation. The stimulation started at the next time point after the operation. The frequency was set to 2/100 Hz with a dense-disperse wave. For patients in the long duration TEAS (L-TEAS) group, the intensity of the TEAS ranged from 5 to 30 mA and made patients feel de qi sensations (feelings of numbness, warmth, heaviness, or distention around the area). For patients in the control group (C-TEAS), the output wires of the stimulator were broken and the intensity was set to 20 mA. The patients in the C-TEAS group were told that TEAS is a kind of acupuncture method without the feeling. Both the operating room and the surgical ICU have research nurses who are responsible for TEAS before and after the operation and after the transfer to the ICU. All research nurses had been trained in TEAS for one year and they were qualified



Neiguan(PC6) localized with the forearm extended and the palm faced upwards, 2 cun above Daling(PC7), in the center of the palmar aspect of the forearm, between the tendons of the long palmar muscle and the radial flexor muscle of the wrist.



Zusanli(ST36) localized in the erect sitting position, with the foot dropped down, 3 cun below Dubi(ST35), about 0.5 cun from the anterior crest of the tibia, between the tendon and bone (the anterior tibial muscle and anterior crest of the tibia).

Fig. 1. Traditional anatomical localizations of Neiguan (PC6) and Zusanli (ST36) acupoints.

members of the research team.

2.4. Measurements

The intraoperative checkups included assessments of the operation time, operative method and anastomotic mode. The consumption of analgesics as well as the scores of the visual analogue scale (VAS, scale of 0–10, 0 = no pain, 10 = extreme pain) at 4 h (T1), 8 h (T2), 16 h (T3), 24 h (T4) and 36 h (T5) were observed and recorded in the 2 groups after the operation. The Ramsay Sedation Scale (RSS, 1, anxious patient; 2, cooperative, oriented and tranquil; 3, responding to command only; 4, brisk response to light glabellar tap or loud auditory stimulus; 5, sluggish response to stimuli; 6, no response to stimuli) were observed and recorded at the same time points. Analgesic consumption was extracted from the PCIA device records after withdrawing the pain service. PONV were also recorded. This procedure was blindly performed by a well-trained anesthetic nurse. The return of gastrointestinal function was assessed using 3 parameters: time to first bowel sounds, flatus and defecation. Bowel sounds were blindly noted every hour postoperatively by a surgical ICU nurse. The four abdominal quadrants were auscultated for more than four minutes, and the number of bowel sounds was recorded. Before surgery, the patients were informed of the importance of notifying the anesthetic nurse of the first flatus and defecation. The patients were instructed to self-record the first postoperative flatus and defecation. A blinded anesthesiologist recorded the satisfaction of the patient for the anesthetic technique according to four degrees with questionnaires (1, very satisfied; 2, satisfied; 3, moderately satisfied; 4, not satisfied) at 36 h postoperatively.

2.5. Data analysis

Data are expressed as the number, percentage, or mean \pm standard deviation. Differences between the 2 groups were analyzed by Student's *t*-test Pearson's chi-square test or Fisher's exact test was used to analyze the incidence of PONV and patient satisfaction between the 2 groups. A *P* value of less than 0.05 was considered significant. All analyses were performed with the Statistical Package for SPSS 24.0 (SPSS Inc., Chicago, IL, USA).

3. Results

3.1. Patients

Of 139 screened patients, 120 patients met the inclusion criteria and were randomly allocated to one of the 2 study groups using random number tables. A total of 117 patients completed the trial (Fig. 2). No differences in the operation duration, TNM stage, operative method or anastomotic mode were observed among the groups. Baseline characteristics were not significantly different among the groups (Table 1).

3.2. VAS scores within 36 h postoperatively

Compared to the C-TEAS group, the VAS scores at 4 h (2.79 ± 0.48 vs. 3.41 ± 0.62), 8 h (2.65 ± 0.42 vs. 3.17 ± 0.49), and 24 h (1.98 ± 0.39 vs. 2.72 ± 0.73) were significantly reduced in the L-TEAS group ($P < 0.05$) after the operation. (Fig. 3)

3.3. Analgesic consumption within 36 h postoperatively

Compared to the C-TEAS group, analgesic consumption at 4 h (10.02 ± 2.26 vs. 13.38 ± 2.98), 8 h (20.55 ± 4.59 vs. 24.63 ± 3.94), and 36 h (72.64 ± 9.74 vs. 76.01 ± 10.43) was significantly reduced in the L-TEAS group ($P < 0.05$) after the operation. (Fig. 4)

3.4. RSS and incidence of PONV

There was a significant difference in the incidence of PONV between the L-TEAS (12%) and C-TEAS (32.2%) groups ($P < 0.05$). (Fig. 5) No significant difference was observed with respect to RSS among the three groups ($P > 0.05$) (Table 2).

3.5. Effects of TEAS on gastrointestinal function recovery

In the L-TEAS group, the time intervals from surgery to the first bowel sounds, passage of flatus and defecation were shorter than those in the C-TEAS group (19.69 ± 7.61 h vs. 26.58 ± 7.43 h, 36.58 ± 10.75 h vs. 43.56 ± 9.57 h and 71.48 ± 20.62 h vs. 77.27 ± 22.67 h, respectively) ($P < 0.05$) (Table 3).

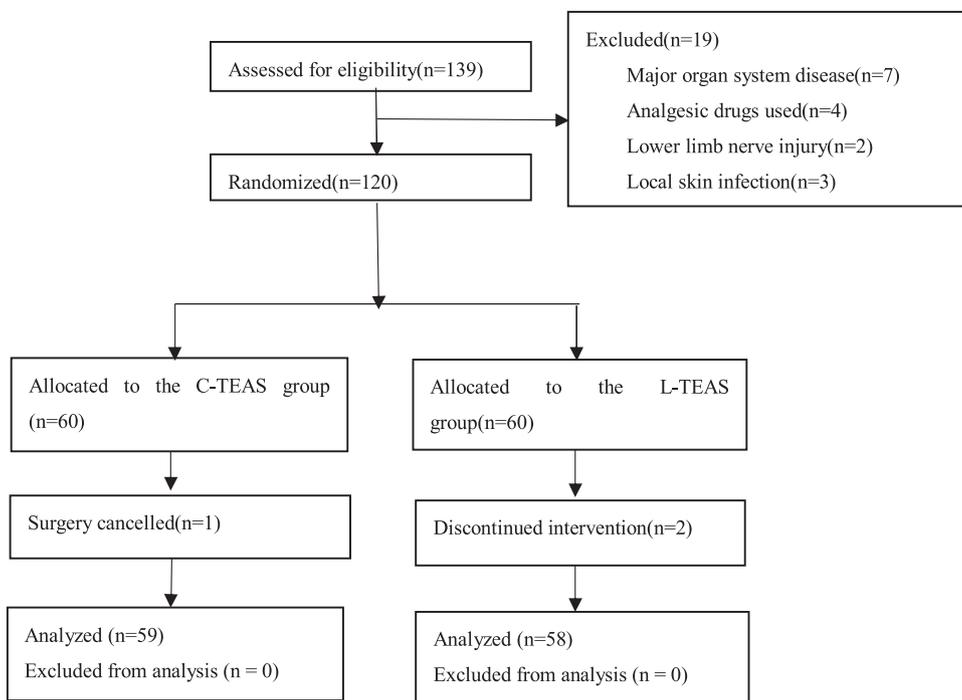


Fig. 2. Consolidated Standards of Reporting Trials (CONSORT) flow diagram depicting the progress of subjects throughout the trial. TEAS: transcutaneous electric acupoint stimulation.

NOTE: T1, T2, T3, T4 and T5 represent 4, 8, 16, 24 and 36 h after operation respectively.

Table 1
Characteristics of patients.

Characteristics	C-TEAS(n = 59)	L-TEAS(n = 58)
Age (mean ± SD, year)	56.67 ± 6.23	57.59 ± 7.32
Sex		
Male	29	31
Female	30	27
BMI(mean ± SD, kg/m ²)	21.84 ± 2.78	22.71 ± 2.54
ASA physical status		
I	20	23
II	39	35
Operation time (mean ± SD, min)	179.78 ± 35.67	177.35 ± 41.35
TNM stage		
Ib ~ IIa	25	26
IIb ~ IIIa	34	32
Operative method		
Proximal gastrectomy	16	18
Distal gastrectomy	20	18
Total gastrectomy	23	22
Anastomotic mode		
BI	15	16
BII	21	20
Roux-en-Y	23	22

3.6. Patient satisfaction

The rate of moderately satisfied and above in the L-TEAS (67.3%) group was higher than that in the C-TEAS group (42.4%), among them very satisfied in the L-TEAS (55.2%) group was higher than that in the C-TEAS group (15.3%) (P < 0.05) (Table 4).

4. Discussion

The ERAS pathway has been demonstrated to reduce the use of drugs, incidence of adverse reactions and length of stay [10,11].The application of ERAS in anesthesia is to reduce the influence of anesthesia on the body, make the patient awaken faster from anesthesia and accelerate the recovery of various patient functions [12]. The

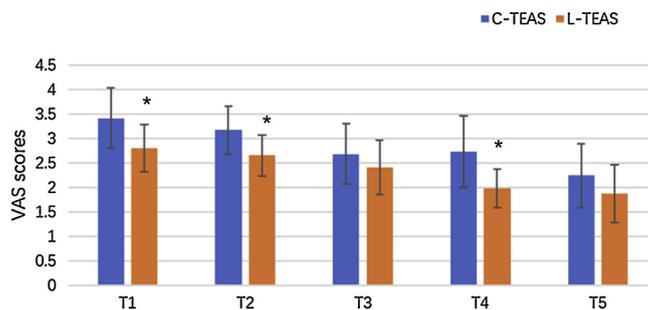


Fig. 3. Comparison of the VAS scores within 36 h postoperatively between the 2 groups. The data are shown as the mean ± SD; *P < 0.05 vs. the C-TEAS group.

NOTE: T1, T2, T3, T4 and T5 represent 4, 8, 16, 24 and 36 h after operation respectively.

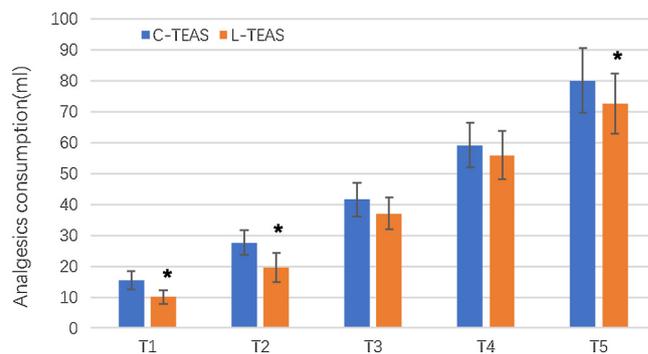


Fig. 4. Comparison of analgesic consumption within 36 h postoperatively between the 2 groups. The data are shown as the mean ± SD; *P < 0.05 vs. the C-TEAS group.

application of acupuncture in gastrointestinal surgery can improve the effects of ERAS. According to the theory of TCM, gastrointestinal

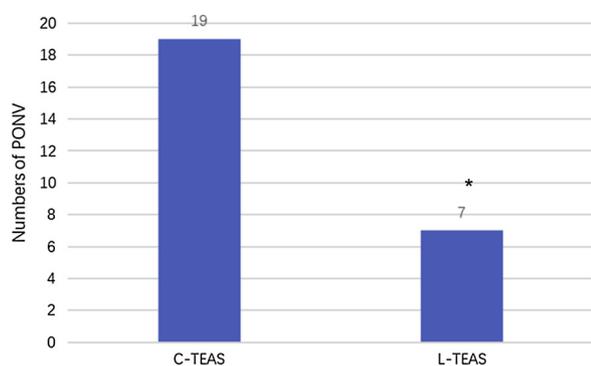


Fig. 5. Comparison of the numbers of PONV between the 2 groups. The data are shown as the mean \pm SD; *P < 0.05 vs. the C-TEAS group.

surgery disrupts the balance of both qi and blood and disturbs the normal physiology of the human body. The main function of acupuncture is to balance qi and blood in the body by stimulating acupoints, such as regulating gastrointestinal function and these are fully in line with the requirements of ERAS [13,14]. For example, PC6 is a point related to gastrointestinal function and can regulate the balance of qi and blood, thus preventing nausea and vomiting.

There are different categories of acupuncture, and TEAS is a kind of transcutaneous electrical nerve stimulation (TENS) that uses electrical impulses delivered to acupoints via electrodes attached to the skin. TEAS is a simple, painless, reliable and effective method that may replace traditional acupuncture and electroacupuncture (EA). TEAS can be widely used in clinical studies because it is precisely controllable. In previous studies, TEAS has been used during perioperative periods with different stimulation methods. There are also many different acupoints and frequencies of TEAS. Therefore, we retrieved the relevant literature and found that extensive research has shown that EA at the Neiguan (PC6) and Zusanli (ST36) acupoints enhance the regularity of gastric myoelectrical activity and modulate digestive functions [15,16]. Huang S et al, in a randomized, placebo-controlled, double-blinded study, examined the efficacy of TAES using video-assisted thoracic surgical (VATS) lobectomy and concluded that 2/100 Hz TEAS was a safe and effective parameter to reduce the use of anesthetics, reduce postoperative pain scores, and shorten the duration in the post anesthesia care unit (PACU) [17]. We considered both previous studies and consulted with the Chinese medicine experts in our hospital to design our studies; thus, the frequency was set to 2/100 Hz with a dense-disperse wave, and acupoints were set as Neiguan (PC6) and Zusanli (ST36) for perioperative TEAS.

Postoperative pain is the first feeling after postoperative recovery, especially in the initial 12 h [18]. Pain management can effectively improve postoperative recovery. Effective analgesia not only alleviates an individual's stress response but also promotes early postoperative activity and oral intake [19]. Prior studies have noted the many positive functions of EA or TENS. CC Xue et al. found that EA reduces the need for opioids in patients with chronic pain and suggested the application of acupuncture in the treatment of chronic pain [20]. J Li et al.'s meta-analysis confirmed that TENS was an efficient and safe method for pain control after total knee arthroplasty and that it reduced analgesic consumption and reduced the incidence of adverse reactions after total knee arthroplasty [21]. This result is consistent with M Emmiler et al.'s

Table 2
Comparison of RSS within 36 h postoperatively between 2 groups.

Group	T1	T2	T3	T4	T5
C-TEAS	3.12 \pm 0.89	2.82 \pm 0.71	2.43 \pm 0.64	2.32 \pm 0.45	2.25 \pm 0.42
L-TEAS	2.85 \pm 0.63	2.59 \pm 0.65	2.45 \pm 0.54	2.25 \pm 0.49	2.12 \pm 0.35

Note: T1, T2, T3, T4 and T5 represent 4, 8, 16, 24 and 36 h after operation respectively.

Table 3
Comparison of postoperative gastrointestinal function recovery between 2 groups.

Group	First bowel sounds(hour)	First flatus(hour)	First defecation(hour)
C-TEAS	26.58 \pm 7.43	43.56 \pm 9.57	77.27 \pm 22.67
L-TEAS	19.69 \pm 7.61	36.58 \pm 10.75	71.48 \pm 20.62
t	2.57	2.19	2.12
P value	0.01*	0.03*	0.04*

Note: The data are shown as the mean \pm SD; *P < 0.05 vs. the C-TEAS group.

Table 4
Comparison of satisfaction between 2 groups.

Group	Very satisfied (n/%)	Satisfied(n/%)	Moderately satisfied (n/%)	Not satisfied (n/%)
C-TEAS	9/15.3	32/54.2	16/27.1	2/3
L-TEAS	32/55.2	19/33.8	7/12.1	0/0
χ^2	20.47	5.49	4.19	2.00
P value	0.00*	0.02*	0.04*	0.16

Note: The data are shown as the number of cases/percentage; *P < 0.05 vs. the C-TEAS group.

findings in the application of TENS during cardiac surgical procedures; M Emmiler et al. found that the VAS score of the TNES group decreased significantly on the first day after operation and limited metamizol sodium and pethidine HCL intake [22]. PONV is one of the most unpleasant experiences after surgery, and its incidence is as high as 70% [14]. Opioid analgesics and inhalation anesthetics are both important causes of PONV [23]. Furthermore, laparoscopic procedures are probably independent predictors of PONV agents [24]. Many studies have shown that TEAS can effectively prevent PONV. Research by AA Kabalak et al. found that TEAS on the Neiguan (PC6) and Shangwan (LI01) acupoints (20 Hz, 5 min) used during tonsillectomy in children had the same effect as ondansetron (0.15 mg. kg (-1)), and the incidence of side effects in the ondansetron group was higher than that in the TEAS group. In addition, PC6 can effectively prevent postoperative nausea and vomiting in adults for up to 12 h. Thus, TEAS is a very safe antiemetic method [25].

If the VAS scored less than 3 points this meant mild pain, however when the VAS scored more than 3 points, patients may sometimes need analgesia [26]. In our study, compared to the C-TEAS group, the VAS scores at 4 h (2.79 \pm 0.48 vs. 3.41 \pm 0.62), 8 h (2.65 \pm 0.42 vs. 3.17 \pm 0.49), and 24 h (1.98 \pm 0.39 vs. 2.72 \pm 0.73) were significantly reduced in the L-TEAS group (P < 0.05) after the operation. In addition, compared to the C-TEAS group, analgesic consumption at 4 h (10.02 \pm 2.26 vs. 13.38 \pm 2.98), 8 h (20.55 \pm 4.59 vs. 24.63 \pm 3.94), and 36 h (72.64 \pm 9.74 vs. 76.01 \pm 10.43) was significantly reduced in the L-TEAS group (P < 0.05) after the operation. Because patients use analgesic pumps when they feel pain, this may affect some changes in the VAS scores. Although in this study the real difference in the VAS all less than 1 unit, L-TEAS group can reduce the early VAS scores to less than 3 and reduce the consumption of analgesics, we consider TEAS have clinical significance in analgesia. The times to first bowel sounds, flatus and defecation have been used as evaluation indexes for gastrointestinal function recovery in many studies [3,27]. Some studies indicate that the first bowel sounds are

associated with the early recovery of stomach motility, and the first flatus is associated with the early recovery of bowel motility [28]. In Zhang Z et al.'s study, they found in EA group, the time of the first bowel sounds were 6 h earlier than that in sham- EA group [29]. Zhou D et al. found that TEAS advance the passage of first flatus by 7 h in women undergoing cesarean section and reduce postoperative hospital length, and improved daily living activities after surgery [30]. We found that, in the L-TEAS group, the time intervals from surgery to the first bowel sounds, passage of flatus and defecation were shorter than those in the C-TEAS group (19.69 ± 7.61 h vs. 26.58 ± 7.43 h, 36.58 ± 10.75 h vs. 43.56 ± 9.57 h and 71.48 ± 20.62 h vs. 77.27 ± 22.67 h, respectively). In this study, the application of the TEAS reduced the passage of the first bowel sounds and flatus by 7 h, and we consider that it have clinical significance for the recovery of patients after operation. TEAS can also reduce the incidence of postoperative adverse reactions. Most of the PONV occurred within 24 h after the operation. In our study, there was a significant difference in the incidence of PONV between the L-TEAS (12%) and C-TEAS (32.2%) groups. In addition, the rate of moderately satisfied and above in the L-TEAS (67.3%) group was higher than that in the C-TEAS group (42.4%), among them very satisfied in the L-TEAS (55.2%) group was higher than that in the C-TEAS group (15.3%). Therefore, TEAS was maintained from 30 min before anesthetic induction to 30 min after the operation, and TEAS performed three times per day within 2 d of the operation achieved a better effect on the patients.

The mechanism of the analgesic effects of electroacupuncture is not very clear. Several possible explanations include the modulation of motor reflexes and sympathetic tone, the release of adenosine and NO and the modulation of descending pain inhibition [31,32]. In studies of TEAS on gastrointestinal function, LEE C found that Zusanli (St36) stimulation in rats resulted in histochemical changes in serotonin, insulin, gastrin, calcitonin gene-related peptide (CGRP) and pancreatic polypeptide (PP). These results show that electrical stimulation at St36 can affect the secretion of gastrointestinal cells (CGRP, serotonin, insulin, gastrin and PP), thus regulating gastrointestinal function [33]. Similarly, X Lin et al. revealed that electrical stimulation can increase the myoelectrical activity and enhance the digestion of the stomach [34]. These reasons may lead to the ability of TEAS to promote the recovery of gastrointestinal function and prevent PONV.

5. Limitations

The weaknesses of this study are described as follows. First, we did not ask patients which group they thought they were in. Second, we only conducted our study on laparoscopic radical gastrectomy patients, and the type surgeries received by each patient differed. Third, EA at the ST36 and PC6 acupoints enhance the regularity of gastric myoelectrical activity and modulate digestive functions so this study employed the two acupoints, but other acupoints may be even more effective and this needs further study. Fourth, the duration of TEAS we chose was time-consuming in terms of it delivery; more knowledge is required to determine whether shorter treatment times can achieve the same effect.

6. Conclusion

The application of TEAS in laparoscopic radical gastrectomy can reduce the early postoperative pain, reduce the early postoperative consumption of analgesics, the total consumption of anesthetics, and the incidence of PONV as well as shorten the duration of first bowel sounds, flatus and defecation after the operation, effectively promoting the recovery of gastrointestinal function and improving patient satisfaction.

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Conflicts of interest

The authors declare that there are no conflicts of interest.

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