

Effectiveness of Electroacupuncture on the Recovery of Gastrointestinal Function in Patients after Abdominal Laparoscopic Surgery: A Case-Control Study

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ABSTRACT

AIM: There lacks effective means to promote the recovery of the gastrointestinal function after the surgery. This study aimed to

investigate the effectiveness of electroacupuncture on the recovery of the gastrointestinal function in patients after abdominal laparoscopic surgery.

METHODS: We designed a case-control study. Cases were patients having electroacupuncture plus the same treatment as controls; controls were those having traditional routine treatment. All patients had an abdominal laparoscopic surgery between November, 2015 and May, 2018. Based on inclusion and exclusion criteria, 60 patients were selected for each group. Outcomes included abdominal flatulence, time to the rugitus recovery, and time to the first flatus and defecation. Multinomial logistic regressions were used to estimate relative risk ratios (RRR) and 95% confidence interval (CI) for outcomes.

RESULTS: Electroacupuncture group had significantly better clinical outcomes than the controls. Average time in hours for the rugitus recovery, first flatus, and first defecation, respectively, was 29.0 ± 1.8 , 42.1 ± 2.1 , and 84.1 ± 2.3 in electroacupuncture group, and 44.7 ± 2.7 , 67.4 ± 3.1 , and 117.3 ± 2.9 in normal controls. Unadjusted RRR (95% CI) was 0.82 (0.72, 0.97) for flatulence score, 0.94 (0.92, 0.97) for time to the rugitus recovery, and 0.92 (0.90, 0.95) for the first flatus in cases using normal controls as a base outcome. Results for electroacupuncture were neither confounded nor modified.

CONCLUSIONS: Electroacupuncture helped recover gastrointestinal function faster than routine treatment after laparoscopy. Electroacupuncture should be recommended for the patients after surgery or having abdominal diseases.

Key words: Electroacupuncture; Laparoscopic surgery; Gastrointestinal function; Herb-point sticker

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INTRODUCTION

The recovery of gastrointestinal function is critically important for patients to get recovered after a surgery. Except for standardized perioperative accelerated rehabilitation surgery process and postoperative nursing process, there lacks effective means to promote the recovery of gastrointestinal function after surgery. In recent decades, studies have shown traditional Chinese medicine can promote the recovery of the gastrointestinal function for various postoperative patients^[1-4]. Traditional Chinese medicine can be used internally and externally. Dacheng decoction is the most used method for internal treatment, but its disadvantage is that the way of administration is through gastrointestinal tract, which aggravates the burden of gastrointestinal tract when the rugitus sounds are not recovered. Therefore, its clinical application is limited.

External treatment is relatively simple and intuitive, and the patient's acceptance rate is high. Auricular point pressing helps recover the gastrointestinal function in patients after gynecological laparoscopic surgery^[1]. Mirabilite combined with acupoint application promotes the recovery of gastrointestinal function after acute suppurative appendicitis surgery^[2]. From the treatment purpose, acupuncture is more direct and effective than acupoint pressing and herb-point sticker stimulating. The effect of acupuncture on the recovery of gastrointestinal function in patients after abdominal surgery is related to its regulation of gastrointestinal hormone secretion^[3]. The early application of abdominal acupuncture therapy in patients after laparoscopic surgery can significantly promote the recovery of gastrointestinal function, reduce the occurrence of surgical complications, have the characteristics of pain relief, being simple and effective, and make up for the deficiency of various traditional Chinese medicine therapies in the field of gastrointestinal function recovery after abdominal surgery^[4].

Fast rehabilitation after surgery has been demanded all the time, especially for the sake of patients, their family, and medical insurance. The widely used less invasive laparoscopy helps patients rehabilitate faster than traditional surgery methods. Due to the impact of anesthesia and laparoscopic operation per se on gastrointestinal tract, and the influence of carbon dioxide pneumoperitoneum on gastrointestinal function, many patients still have abdominal flatulence, nausea, vomiting and other gastrointestinal dysfunction symptoms after a laparoscopic surgery, and even cause intestinal obstruction gastroparesis and other complications^[5-7]. These complications delay the recovery of gastrointestinal function in patients after the laparoscopic surgery. Electroacupuncture reduces duration of postoperative ileus after laparoscopic surgery for colorectal cancer^[10]. This study was to explore the effectiveness of electroacupuncture on the recovery of gastrointestinal function in patients after abdominal laparoscopic surgery.

METHODS

Study design and patients

We designed a case-control study and set up two different controls for each case. All the study patients were those who underwent an abdominal laparoscopic surgery in the Department of General Surgery, Zhejiang Chinese Medical University Four-Province-Bordering Hospital of Traditional Chinese Medicine (Quzhou Hospital of Traditional Chinese Medicine), from November, 2015 to May, 2018.

All patients were given a consent form for treatment. Inclusion criteria were patients (1) who were given general anesthesia by

tracheal intubation during the surgery, (2) who signed the consent form, (3) who had no severe complications of other systems, and (4) who had no history of drug allergy. Exclusion criteria were those (1) who had changed to laparotomy, (2) who had intraoperative or postoperative complications, (3) who had important organ dysfunction, or (4) who refused to traditional Chinese medicine including acupuncture treatment. Based on inclusion and exclusion criteria, a total of 60 patients were selected for each case or control group. This study was approved by the Hospital Ethics Committee.

Expression of specific organs and or other names in Chinese medicine

All specific organs and or other related names in Chinese medicine are expressed using capital letter for the first letter for each name in this study. For examples, Liver and Stomach are specific organs used in Chinese medicine which are different organs from modern medicine, and points Shangwan and Zhongwan mean specific point for acupuncture and herb sticker treatment. Organ names used in the variable of surgery location are organs in modern medicine which are expressed using small letter for the first letter for each name in this study. For examples, liver and stomach are names used in modern medicine.

Definition of Cases and Controls Based on Their Treatments

Normal controls were defined as patients who had traditional routine treatment after a laparoscopic surgery. Traditional routine treatment included postoperative fasting, selective indwelling gastric tube, antibiotics infusion if there were any symptoms or signs of infections, and nutrition support if necessary. After the first flatus, the gastric tube was removed and then the fluid food was given to patients. The clinical outcomes were observed for 5-7 days after the laparoscopic surgery.

Herb controls were defined as those who had Chinese herb-point stickers with Dachengqi powder paste on it and the same routine treatment as normal controls. The application of the herb sticker started in 2-4 hours after the laparoscopic surgery. According to each patient's specific symptoms and signs, the herb stickers were put on 4-8 points selected from points Guanyuan, Qihai, Zhongwan, Shangwan, Zusanli, Hegu, Neiguan and Tianshu. A thumb was used to massage these points sequentially once every 6 hours for 10 minutes for 4 times a day with a massaging degree for patients to feel sore, numb, puffed and or aching. The clinical outcomes were observed for 5-7 days after the laparoscopic surgery.

Cases (electroacupuncture) were defined as patients who had electroacupuncture and the same routine treatment as normal controls. Electroacupuncture was given in 2-4 hours after operation. Main acupoints included points Neiguan, Shangwan, Zhongwan, Tianshu, Qihai, and Zusanli (some of acupoints could not be given electroacupuncture if there was any surgical incision near/ in acupoints). For patients who had Liver depression and Qi stagnation, acupoints Hegu and Taichong were added to be given electroacupuncture; for those who had Qi deficiency, acupoint Tanzhong was added to be given electroacupuncture; for those who had Blood deficiency, acupoint Sanyinjiao was added to be given electroacupuncture; for those who had Yin deficiency, acupoint Taixi was added to be given electroacupuncture; for those who had Yang deficiency, acupoint Guanyuan was added to be given electroacupuncture. The patient was placed in supine position after routine disinfection of acupoints, 0.25 mm × 50 mm disposable filiform needle (produced by Jiangsu Wujiang Jiachen Acupuncture Instrument Limited Company) was used for acupuncture. When

the operator felt heavy and astringent under the needle, and the patient felt sore, numb, puffed and or aching, the needle was stopped there, and then a low-frequency electronic pulse therapy instrument (produced by Shanghai Medical Electronic Instrument Factory, Model G9805-C) was connected, which frequency was set up at 1 Hz and which stimulating time was based on the patient's tolerance. Keep the needle in points for 30 minutes, once a day, 7 times as a treatment course.

Clinical Outcomes

Postoperative abdominal flatulence was examined every 6 hours from 12 hours after the laparoscopic surgery until the first flatus. Abdominal flatulence was measured by a score from 0 to 10, 0 for no abdominal flatulence and 10 for the highest abdominal flatulence. According to the subjective feeling by patients, abdominal flatulence degree was defined score 0 as no abdominal flatulence, scores 1-4 as mild flatulence, scores 5-7 as moderate flatulence, and 8-10 as severe flatulence.

Time to the rugitus recovery was used as a measure for the recovery of gastrointestinal function after the laparoscopic surgery. Rugitus was monitored every 4 hours after operation, and each auscultation lasted for more than 3 minutes. If rugitus frequency reached 3-4 times per minute, the gastrointestinal function was considered being recovered, and time to the rugitus recovery was measured in hours.

Time to the first flatus was used as another measure for the recovery of gastrointestinal function after the laparoscopic surgery. It was recorded in hours for all patients in the three groups. Time to the first flatus was based on the description of patients or their family members.

Time to the first defecation was used as another measure for the recovery of gastrointestinal function after the laparoscopic surgery. It was measured in hours and was based on the words told by patients or their family members.

Statistical Analysis

STATA/SE 15.1 statistical software was used for data analysis. All continuous variables were expressed by mean \pm standard deviation ($M \pm SD$) and their differences between the three groups were tested by multivariate F test. All categorical variables were expressed by number and percentage (n and %) and their differences between the three groups were tested by Chi-squared test. $P < 0.05$ was considered statistically significant.

Multinomial logistic regression was used to estimate the relative risk ratio (RRR) with a 95% confidence interval (CI) for the clinical outcomes comparing the case group or the herb control group with the normal control group as a base outcome with or without adjusting for other risk factors. Variables of abdominal flatulence degree, occupation, and the disease location were used as a dummy variable. Abdominal flatulence degree was defined as 0 = none as a reference, 1 = light, 2 = moderate, and 3 = severe. Variables of abdominal flatulence score, time in hours for the rugitus recovery, the first flatus, and the first defecation were used as a continuous variable in multinomial logistic regressions. Other adjusted factors included age in years which was defined as a continuous variable, gender (0 = woman and 1 = man), and occupation (0 = worker (working in the manufactory, labor worker, etc.), 1 = officer (working in the office including teacher, doctor, nurse, and student), and farmer (working in the farm), cigarette smoking status (0 = no and 1 = yes), alcohol drinking status (0 = no and 1 = yes), and surgery location (0 = gall bladder, 1 = liver/pancreas, 2 = stomach/intestine, and 3 = others including spleen and belly).

RESULTS

Table 1 shows basic characteristics in the case and two control groups. There were no significant differences in gender, age, occupation, cigarette smoking status, alcohol drinking status, surgery location between the three groups ($p > 0.05$), which indicated basic characteristics were comparable. The clinical outcomes of abdominal flatulence degree, abdominal flatulence score, time to the rugitus recovery, time to the first flatus, and time to the first defecation in both electroacupuncture and herb-point sticker group were significantly better ($p < 0.01$) than those in normal control group as a reference group (Table 1). Average abdominal flatulence score, time in hours to the rugitus recovery, to the first flatus, and to the first defecation were 3.1 ± 0.4 , 29.0 ± 1.8 , 42.1 ± 2.1 , and 84.1 ± 2.3 in electroacupuncture group, 3.7 ± 0.4 , 44.7 ± 2.7 , 67.4 ± 3.1 , and 117.3 ± 2.9 in herb control group, and 5.1 ± 0.4 , 34.5 ± 2.0 , 57.2 ± 1.9 , and 90.7 ± 1.9 in normal control group, respectively (Table 1).

Unadjusted RRR (95% CI) was 0.82 (0.72, 0.97) and 0.87 (0.77, 0.97) for flatulence score, 0.94 (0.92, 0.97) and 0.97 (0.95, 0.99) for time to the rugitus recovery, 0.92 (0.90, 0.95) and 0.98 (0.96, 0.99) for time to the first flatus, and 0.90 (0.87, 0.93) and 0.93 (0.90, 0.95) for time to the first defecation in electroacupuncture and herb control group, respectively, using normal control group as a base outcome (Table 2). After adjusting for age, gender, occupation, disease location, smoking and alcohol drinking status, RRRs kept the same significant (tables for these results are not provided here since RRRs are very similar).

Stratified by gender (Table 3), electroacupuncture group consistently had the same significant RRRs in both women and men. Herb control group kept the same significant RRRs in men but not in women. All clinical outcomes except time to the first defecation in woman herb-point sticker users did not show any significant RRRs.

Stratified by cigarette smoking status (Table 4), electroacupuncture group consistently had the same significant RRRs in both smokers and non-smokers. Herb control group kept the same significant RRRs in smokers but not in non-smokers. All the clinical outcomes except time to the first defecation in non-smoking herb-point sticker users did not show any significant RRRs.

Stratified by alcohol drinking status (Table 5), electroacupuncture group consistently had the same significant RRRs in both alcohol users and non-users. Herb-point sticker group kept the same significant RRRs in alcohol users but not in non-alcohol users. All the clinical outcomes except time to the first defecation in non-alcohol herb-point sticker users did not show any significant RRRs.

DISCUSSION

This case-control study found patients who had electroacupuncture overall had significantly better clinical outcomes, less abdominal flatulence, faster rugitus recovery, and shorter time to the first flatus and the first defecation after the laparoscopy, than the two control groups; herb controls also had significantly better clinical outcomes than the normal controls. When examining confounding and effect modification, results for electroacupuncture were neither confounded by age, gender, occupation, disease location, disease type, smoking and alcohol drinking status nor effect-modified by any factor of gender, smoking or drinking status. Results for herb-point sticker users were modified by gender, smoking, or alcohol drinking status and they were not confounded by any factor investigated in this study. These findings suggest that electroacupuncture should be recommended for the patients after surgery or having abdominal diseases.

Table 1 Basic characteristics among three groups in a case-control study of the effectiveness of electroacupuncture on the recovery of the gastrointestinal function after abdominal laparoscopic surgery from November, 2015 to May, 2018.

Characteristic		Case	Normal control	Herb control	P value
Gender	Woman	25 (41.7%)	26 (43.3%)	24 (40.0%)	0.93
	Man	35 (58.3%)	34 (56.7%)	36 (60.0%)	
Age mean ± SD (years)		54.0 ± 16.0	54.3 ± 14.2	54.5 ± 11.7	0.98
Occupation, n (%)	Worker	26 (43.3%)	23 (38.3%)	26 (43.3%)	0.69
	Office	23 (38.3%)	29 (48.3%)	22 (36.7%)	
	Farmer	11 (18.3%)	8 (13.3%)	12 (20.0%)	
Smoking status, n (%)	No	25 (41.7%)	30 (50.0%)	31 (51.7%)	0.5
	Yes	35 (58.3%)	30 (50.0%)	29 (48.3%)	
Drinking status, n (%)	No	26 (43.3%)	31 (51.7%)	25 (41.7%)	0.5
	Yes	34 (56.7%)	29 (48.3%)	35 (58.3%)	
Surgery location, n (%)	Gall bladder	32 (53.3%)	32 (53.3%)	33 (55.0%)	0.97
	Liver/pancreas	14 (23.3%)	14 (23.3%)	14 (23.3%)	
	Gastrointestinal	6 (10.0%)	6 (10.0%)	8 (13.3%)	
	Others †	8 (13.3%)	8 (13.3%)	5 (8.3%)	
Abdominal flatulence degree ‡, n (%)	No	23 (38.3%)	9 (15.0%)	17 (28.3%)	< 0.01
	Light	17 (28.3%)	14 (23.3%)	20 (33.3%)	
	Medium	16 (26.7%)	20 (33.3%)	15 (25.0%)	
	Severe	4 (6.7%)	17 (28.3%)	8 (13.3%)	
Abdominal flatulence score §, mean ± SD		3.1 ± 0.4	5.1 ± 0.4	3.7 ± 0.4	< 0.01
Time to the rugitus recovery ¶, mean ± SD		29.0 ± 1.8	44.7 ± 2.7	34.5 ± 2.0	< 0.01
Time to the first flatus ¥, mean ± SD		42.1 ± 2.1	67.4 ± 3.1	57.2 ± 1.9	< 0.01
Time to the first defecation ©, mean ± SD		84.1 ± 2.3	117.3 ± 2.9	90.7 ± 1.9	< 0.01

† others including spleen and belly; ‡ abdominal flatulence degree in 12 hours after laparoscopic surgery defined as None = no flatulence, Light = flatulence score from 1 to 5, medium = flatulence score from 6 to 7, and severe = flatulence score from 8 to 9; § directly use abdominal flatulence score after laparoscopic surgery from 0 to 9; ¶ time in hours to the rugitus recovery after laparoscopic surgery; ¥ time in hours to first flatus after laparoscopic surgery; © time in hours to the first defecation after laparoscopic surgery.

The recovery of gastrointestinal function is especially important for patients who had the abdominal surgery. With the development of rehabilitation surgery in clinic chirurgery, the recovery of gastrointestinal function after the laparoscopic surgery is intuitively better than that after the traditional open surgery. In our study, electroacupuncture group (*n* = 60) had averagely 29.0 hours to the rugitus recovery, 42.1 hours to the first flatus, and 84.1 hours to the first defecation after abdominal laparoscopic surgery which are much shorter than results reported in Huang’s study^[3] (54.9 hours to the rugitus recovery, 71.5 hours to the first flatus, and 89.3 hours to the first defecation after abdominal open surgery in electroacupuncture group (*n* = 50).

Anesthesia (this factor has been controlled in our study), intraoperative intestinal traction, or surgical trauma can lead to gastrointestinal dysfunction, and preoperative intestinal preparation could reduce gastrointestinal secretion, both of which delay the first flatus time^[5]. No gastric tube inserted before operation, gas inhalation during anesthesia, incomplete preparation of gastrointestinal tract, fecal accumulation in the intestine, and too much gas making the intestine full are prone to cause postoperative abdominal flatulence^[6]. Long operation time can lead to increased CO₂ absorption that can result in hypercapnia which increases renal H⁺ secretion and reabsorption of HCO₃⁻ that leads to metabolic alkalosis, which can

Table 2 Relative risk ratios (95% confidence interval) for clinical outcomes using multinomial (polytomous) logistic regression comparing electroacupuncture or herb-point sticker group with traditional routine treatment as base outcome in a case-control study of the effectiveness of electroacupuncture on the recovery of the gastrointestinal function after abdominal laparoscopic surgery from November, 2015 to May, 2018.

Outcome	Relative risk ratio (95% confidence interval)	
	Electroacupuncture	Herb-point sticker
Flatulence degree †	None	1.00 (reference)
	Light	0.48 (0.17, 1.35)
	Medium	0.31 (0.11, 0.86)*
	Severe	0.09 (0.02, 0.35)*
Flatulence score ‡		0.82 (0.72, 0.92)*
Time to the rugitus recovery (hours) §		0.94 (0.92, 0.97)*
Time to the first flatus (hours) ¶		0.92 (0.90, 0.95)*
Time to the first defecation (hours) ¥		0.90 (0.87, 0.93)*

† abdominal flatulence degree in 12 hours after laparoscopic surgery defined as None = no flatulence, Light = flatulence score from 1 to 5, medium = flatulence score from 6 to 7, and severe = flatulence score from 8 to 9; ‡ directly use abdominal flatulence score after laparoscopic surgery from 0 to 9; § time in hours to the rugitus recovery after laparoscopic surgery; ¶ time in hours to the first exhaust after laparoscopic surgery; ¥ time in hours to the first defecation after laparoscopic surgery; *statistically significant based on 95% confidence interval for relative risk ratio, and relative risk ratios have no significant difference between crude and adjusted for other factors including smoking status (yes/no), drinking status (yes/no), occupation (0 = worker (working in the manufactory , labor worker, etc.), 1 = officer (working in the office including teacher, doctor, nurse, student), and farmer (working in the farm), surgery location (gall bladder = 0, liver/pancreas = 1, stomach/intestine = 2, and others including spleen and belly = 3).

also cause hypokalemia, thus causing or aggravating abdominal flatulence^[7].

From the perspective of traditional Chinese medicine, whether the first flatus after the laparoscopic surgery goes smoothly is related to the balance of Yin and Yang, the regulation of Qi, the cumulation of evil Qi and other factors. Flatus obstruction is often caused by stagnation of the Qi of Liver, obstruction of Qi mechanism, disorder of Qi circulation, dereliction of duty of gastrointestinal conduction, or deficiency of Qi and Blood, and weakness of gastrointestinal conduction after operation. If flatus and defecation do not go smoothly for a long time, then Qi circulating not well, Qi in the Fu organs blocked, and the turbid Qi not dropping may cause abdominal flatulence, abdominal pain, hiccup, poor appetite, sleep uneasiness, etc, particularly unfavorable for patients with heart disease and hypertension. Clinically, there is no effective medicine we can use except drugs to promote gastrointestinal peristalsis but their effect is very limited and there are some side effects.

At present, laparoscopic surgery has becoming popular. To achieve the optimal treatment effect, we used electroacupuncture to promote the recovery of gastrointestinal function after abdominal laparoscopic surgery and relatively classic and commonly used acupuncture points were selected for electroacupuncture based on individual patient’s symptoms and signs. According to the traditional Chinese medicine principle of internal disease treated externally, it is important to regulate the function of Fu organs, to promote Qi circulation, to enhance gastrointestinal peristalsis, and to promote the flatus and defecation.

Point Neiguan is a collateral acupoint of hand Jueyin pericardial meridian, which is one of the eight intersecting points. It has the effects of calming vomiting, widening Chest and regulating Qi, soothing Liver and relieving its depression. Point Zusanli is a lower confluent point of Stomach and a confluent point of Stomach channel

Table 3 Relative risk ratios (95% confidence interval) for clinical outcomes using multinomial (polytomous) logistic regression comparing electroacupuncture or Herb-point sticker group with traditional routine treatment as base outcome stratified by gender in a study of the effectiveness of electroacupuncture on the recovery of the gastrointestinal function after abdominal laparoscopic surgery from November, 2015 to May, 2018.

Outcome among women		Relative risk ratio (95% confidence interval)	
		Electroacupuncture	Herb-point sticker
Flatulence degree †	None	1.00 (reference)	1.00 (reference)
	Light	0.45 (0.10, 2.01)	1.50 (0.30, 7.53)
	Medium	0.10 (0.02, 0.54)	0.64 (0.13, 3.03)
	Severe	0.19 (0.03, 1.40)	0.75 (0.11, 5.24)
Flatulence score ‡		0.76 (0.62, 0.93)*	0.92 (0.77, 1.09)
Time to the rugitus recovery (hours) §		0.94 (0.90, 0.98)*	0.98 (0.95, 1.01)
Time to the first flatus (hours) ¶		0.92 (0.88, 0.96)*	0.99 (0.96, 1.02)
Time to the first defecation (hours) ¥		0.88 (0.83, 0.93)*	0.92 (0.87, 0.96)*
Outcome among men		Relative risk ratio (95% confidence interval)	
		Electroacupuncture	Herb-point sticker
Flatulence degree †	None	1.00 (reference)	1.00 (reference)
	Light	0.50 (0.11, 2.21)	0.46 (0.11, 1.96)
	Medium	0.58 (0.14, 2.43)	0.30 (0.07, 1.30)
	Severe	0.06 (0.01, 0.41)*	0.13 (0.03, 0.59)*
Flatulence score ‡		0.84 (0.72, 0.99)*	0.83 (0.71, 0.97)*
Time to the rugitus recovery (hours) §		0.94 (0.91, 0.98)*	0.96 (0.93, 0.99)*
Time to the first flatus (hours) ¶		0.92 (0.89, 0.95)*	0.96 (0.94, 0.99)*
Time to the first defecation (hours) ¥		0.91 (0.88, 0.95)*	0.93 (0.90, 0.96)*

†abdominal flatulence degree in 12 hours after laparoscopic surgery defined as None = no flatulence, Light = flatulence score from 1 to 5, medium = flatulence score from 6 to 7, and severe = flatulence score from 8 to 9; ‡ directly use abdominal flatulence score after laparoscopic surgery from 0 to 9; § time in hours to the rugitus recovery after laparoscopic surgery; ¶ time in hours to the first exhaust after laparoscopic surgery; ¥ time in hours to the first defecation after laparoscopic surgery; *statistically significant based on 95% confidence interval for relative risk ratio.

of foot Yangming, which can help strengthen Qi, regulate Spleen and Stomach, widen Chest and benefit Diaphragm. Point Shangwan has the function of benefiting Qi and Stomach, reducing adverse reactions and stopping spasm. Zhongwan is not only the Mu point of Stomach meridian of foot Yangming, but also the influential point of Fu organs. It has the effects of promoting Stomach Yang, helping corruption, regulating middle Jiao, and relieving depression of Liver. Point Tianshu is the Mu point of Colorectum. Points Tianshu and Qihai have the function of unblocking Fu organs, promoting Qi and reducing adverse reactions. Point Tanzhong is the influential point of Qi, which has the effects of widening Chest and regulating Qi. Point Taichong is the original point of the Liver meridian of foot Jueyin, and Hegu is the original point of the Colorectum meridian. The two points are matched to regulate the Qi of the Liver meridian and relieve stagnation. Point Sanyinjiao is the junction point of the three Yin meridians, which can not only strengthen the Spleen and Stomach and help transport but also nourish Blood and Liver, replenish Kidney and its essence. Point Taixi is the original point of Kidney meridian, which has the effect of nourishing Yin and benefiting Kidney. Point Guanyuan has the functions of strengthening Kidney, reinforcing Qi and returning Yang, and collecting Qi and Blood from the Small Intestine.

Acupuncture at the above points in our study improved gastrointestinal function, eliminates symptoms of gastrointestinal

Table 4 Relative risk ratios (95% confidence interval) for clinical outcomes using multinomial (polytomous) logistic regression comparing electroacupuncture or Herb-point sticker group with traditional routine treatment as base outcome stratified by smoking status in a study of the effectiveness of electroacupuncture on the recovery of the gastrointestinal function after abdominal laparoscopic surgery from November, 2015 to May, 2018.

Outcome among never smoker		Relative risk ratio (95% confidence interval)	
		Electroacupuncture	Herb-point sticker
Flatulence degree †	None	1.00 (reference)	1.00 (reference)
	Light	0.75 (0.18, 3.17)	1.39 (0.34, 5.66)
	Medium	0.38 (0.09, 1.59)	0.50 (0.12, 2.10)
	Severe	0.56 (0.09, 3.52)	0.86 (0.15, 5.00)
Flatulence score ‡		0.89 (0.75, 1.06)	0.92 (0.78, 1.09)
Time to the rugitus recovery (hours) §		0.96 (0.92, 0.99)*	0.98 (0.96, 1.01)
Time to the first flatus (hours) ¶		0.94 (0.90, 0.97)*	0.99 (0.97, 1.01)
Time to the first defecation (hours) ¥		0.88 (0.83, 0.93)*	0.92 (0.87, 0.96)*
Outcome among smoker		Relative risk ratio (95% confidence interval)	
		Electroacupuncture	Herb-point sticker
Flatulence degree †	None	1.00 (reference)	1.00 (reference)
	Light	0.30 (0.06, 1.51)	0.35 (0.06, 1.90)
	Medium	0.25 (0.05, 1.18)	0.30 (0.06, 1.52)
	Severe	0.02 (0.001, 0.17)*	0.09 (0.02, 0.51)*
Flatulence score ‡		0.75 (0.63, 0.89)*	0.82 (0.69, 0.97)*
Time to the rugitus recovery (hours) §		0.93 (0.89, 0.97)*	0.96 (0.92, 0.99)*
Time to the first flatus (hours) ¶		0.90 (0.86, 0.94)*	0.95 (0.92, 0.99)*
Time to the first defecation (hours) ¥		0.89 (0.85, 0.94)*	0.93 (0.89, 0.97)*

†abdominal flatulence degree in 12 hours after laparoscopic surgery defined as None = no flatulence, Light = flatulence score from 1 to 5, medium = flatulence score from 6 to 7, and severe = flatulence score from 8 to 9; ‡ directly use abdominal flatulence score after laparoscopic surgery from 0 to 9; § time in hours to the rugitus recovery after laparoscopic surgery; ¶ time in hours to the first exhaust after laparoscopic surgery; ¥ time in hours to the first defecation after laparoscopic surgery; *statistically significant based on 95% confidence interval for relative risk ratio.

dysfunction, promoted postoperative gastrointestinal peristalsis, and improved postoperative gastrointestinal symptoms. Our method combining electroacupuncture and laparoscopic technology together helped promote the recovery of gastrointestinal function in patients after the surgery in our study, which is an innovative and effective treatment for the patients to get recovered fast from the surgery, promotes the concept development of modern medicine postoperative accelerated rehabilitation surgery, and reduces the labor intensity of medical staff. Eventually, this new treatment can help save cost for patients and medical insurance.

There are some strengths and limitations in this study. There were two controls-herb-point sticker and traditional routine treatment control designed in this study. Some risk factors including age, gender, occupation, disease location, smoking and alcohol drinking status had been adjusted and their effect modifications had also been examined. The sample size, however, is 60 which may be not big enough for the confounding and effect modification analyses. This is a case-control study; in the future, randomized clinical trials are needed to examine the effect of electroacupuncture on the recovery of the gastrointestinal function after surgery. More research is needed to be done on biological mechanisms of why electroacupuncture has the effect on the recovery of gastrointestinal function after surgery, and why the effects of herb-point sticker were modified by gender, smoking, and drinking status individually.

Table 5 Relative risk ratios (95% confidence interval) for clinical outcomes using multinomial (polytomous) logistic regression comparing electroacupuncture or herb-point sticker group with traditional routine treatment as base outcome stratified by drinking status in a study of the effectiveness of electroacupuncture on the recovery of the gastrointestinal function after abdominal laparoscopic surgery from November, 2015 to May, 2018.

Outcome among never alcohol user		Relative risk ratio (95% confidence interval)	
		Electroacupuncture	Herb-point sticker
Flatulence degree †	None	1.00 (reference)	1.00 (reference)
	Light	0.37 (0.09, 1.52)	1.22 (0.27, 5.59)
	Medium	0.10 (0.02, 0.54)	0.50 (0.10, 2.43)
	Severe	0.25 (0.04, 1.47)	0.60 (0.09, 3.99)
Flatulence score ‡		0.81 (0.68, 0.97)*	0.91 (0.77, 1.08)
Time to the rugitus recovery (hours) §		0.96 (0.92, 0.99)*	0.98 (0.96, 1.01)
Time to the first flatus (hours) ¶		0.94 (0.90, 0.97)*	0.99 (0.97, 1.01)
Time to the first defecation (hours) ¥		0.88 (0.85, 0.94)*	0.93 (0.89, 0.97)*
Outcome among alcohol user		Relative risk ratio (95% confidence interval)	
		Electroacupuncture	Herb-point sticker
Flatulence degree †	None	1.00 (reference)	1.00 (reference)
	Light	0.65 (0.13, 3.19)	0.60 (0.12, 2.89)
	Medium	0.59 (0.14, 2.50)	0.38 (0.09, 1.65)
	Severe	0.03 (0.003, 0.31)*	0.14 (0.03, 0.65)*
Flatulence score ‡		0.80 (0.67, 0.94)*	0.82 (0.69, 0.96)*
Time to the rugitus recovery (hours) §		0.93 (0.89, 0.97)*	0.96 (0.92, 0.99)*
Time to the first flatus (hours) ¶		0.90 (0.86, 0.94)*	0.95 (0.92, 0.99)*
Time to the first defecation (hours) ¥		0.91 (0.87, 0.95)*	0.92 (0.89, 0.96)*

†abdominal flatulence degree in 12 hours after laparoscopic surgery defined as None = no flatulence, Light = flatulence score from 1 to 5, medium = flatulence score from 6 to 7, and severe = flatulence score from 8 to 9; ‡ directly use abdominal flatulence score after laparoscopic surgery from 0 to 9; § time in hours to the rugitus recovery after laparoscopic surgery; ¶ time in hours to the first exhaust after laparoscopic surgery; ¥ time in hours to the first defecation after laparoscopic surgery; *statistically significant based on 95% confidence interval for relative risk ratio.

In summary, electroacupuncture promoted the recovery of the gastrointestinal function in patient after the abdominal laparoscopic surgery faster than either herb-point sticker or traditional routine treatment. Results for electroacupuncture were neither confounded nor modified by any factor investigated in this study. Results for herb-point sticker were modified by gender, smoking, or drinking status. Electroacupuncture should be recommended for the patients after surgery or having abdominal diseases.

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