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Review Article

Is It Effective For Acupuncture In Treating Postoperative Ileus? ---- A Systematic Review and Meta-Analysis

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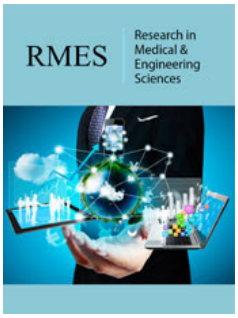

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Abstract

Background: Acupuncture may promote early recovery of postoperative ileus (POI). This meta-analysis aimed to determine the efficacy of acupuncture on outcomes after elective surgery.

Material and Methods: We searched database of PUBMED, EMBASE, the Cochrane Central Register of Controlled Trials from their inception to Aug. 2019, and selection criteria is randomized controlled trials (RCT). Primary outcome was time to first passage of flatus(d). Secondary outcomes included time to tolerated solid food(d), time to first bowel movement(d), time of first defecation(d), duration of hospital stay(d).

Result: We identified 9 studies that recruited 910 participants for inclusion in our review. Compared with other non-pharmacy treatments, acupuncture treatment yielded an improved on mean time to first passage of flatus in postoperative patients (MD=-0.67; 95% CI, [-1.33, -0.01], p= 0.000; I2= 94.7%), a shorten time to tolerated solid food (MD=-0.33; 95% CI, [-0.62, -0.04], p= 0.320; I2`=14.5%), an earlier recovery of bowel movement (MD=-0.43; 95% CI, [-0.74, -0.11], p= 0.004; I2= 73.9%), an improved on mean time of first defecation (MD=-1.33; 95% CI, [-1.90, -0.76], p= 0.000, I2= 83.2%), and reduced hospital stay (MD=-0.43; 95% CI, [-0.68, -0.19], p=0.049, I2=52.6%),

Conclusion: This review identified the evidence of acupuncture for postoperative patients in improving recovery of gastrointestinal function. This benefit of acupuncture should be a potential non-pharmacotherapy in the management of postoperative ileus.

Keywords: Postoperative ileus; Meta-analysis; Acupuncture; Systematic review

Background

Postoperative ileus (POI) is a transient cessation of coordinated propulsive motility following abdominal surgery. The clinical manifestations include abdominal pain, distension, nausea and vomiting, stop passing stools of flatus, or unable to tolerate a solid diet. Postoperative ileus is a transient process, but if this process prolonged, complications such as wound dehiscence, intestinal anastomotic fistula, intra-abdominal infection, intestine ischemia, and aspiration pneumonia may occur [1-3]. Postoperative ileus is a significant predictor of extended hospital stays and postoperative costs in patients undergoing colectomy in the United States [4]. According to statistics, the United States cost more than $1.46 billion in the treatment of POI each year [5].

The treatment strategies of POI consist of perioperative an aesthetic and analgesic management, feeding soon after surgery, avoidance of nasogastric tube feeding, early ambulation, epidural analgesia, fluid restriction and minimally invasive surgery, etc., none of them has been successfully in preventing POI completely [6,7]. Acupuncture therapy is one of traditional Chinese medicine treatment, and its history is more than 3000 years [8]. Stimulation through the points, meridians, makes the treatment effective. Acupuncture combined with electrical stimulation is called electro-acupuncture, ear acupuncture is referred to puncturing the reaction spots of the auricle to treat diseases, and head needle is referred to puncturing the head and neck region as playing a role of treatment. A study reported by Ng SS suggests that electro-acupuncture reduced the duration of postoperative

ileus compared with no acupuncture or sham acupuncture treatment, after laparoscopic colorectal surgery [9]. However, a later study reported that true acupuncture did not reduce POI more significantly than sham acupuncture [10]. Past research showed inconsistent results for acupuncture on postoperative ileus. Until now, there was lack of effective evidence about the curative effect of acupuncture in POI. Therefore, we carried out a systemic evaluation and meta-analysis, on the basis of randomized controlled trials research to evaluate whether acupuncture treatment could shorten the time of postoperative ileus or not.

Methods

The main objective of this review was to examine whether acupuncture could reduce the time of postoperative ileus and promote recovery.

Criteria for considering studies in this review

Inclusion criteria included

Randomized controlled trials (RCTs).

A. Intra-peritoneal surgery patients.

B. Comparing acupuncture treatment or combined therapy with electro-acupuncture with no treatment, sham acupuncture for intraperitoneal surgery patients.

C. Full-text articles and detailed clinical data were available.

We included randomized controlled trials (RCTs) that compared acupuncture with any other treatment for the treatment of postoperative ileus among patients undergoing intraperitoneal surgery. Trials with non-abdominal surgery were excluded. Two investigators (GJ and TW) conducted literature retrieval independently, according to the selection conditions, and reached consensus on each citation.

Primary outcome

Time to first passage of flatus.

Secondary outcomes

Time to tolerated solid food, time to first bowel movement, time of first defecation, duration of hospital stay.

Searching strategy

Database of PUBMED, EMBASE, the Cochrane Central Register of Controlled Trials (CENTRAL) were searched. There were no restrictions used during the search related to the publication year, publication language. The following search strategy was used in EMBASE and was modified accordingly for other databases:[((('intestine obstruction' OR 'postoperative complication' OR ('ileus' OR 'intestine pseudo obstruction' OR 'pseudo obstruction' OR 'pseudo-obstruction' OR 'pseudo obstruction')) AND ('acupuncture' OR 'acupuncture analgesia' OR 'electroacupuncture' OR 'acupuncture point' OR 'acupuncture therapy' OR ('acupuncture' OR 'acupoint' OR 'moxibustion' OR 'acupressure' OR 'auriculotherapy' OR 'auricular acupuncture'))) AND (('randomized controlled trial' OR 'randomization' OR 'controlled study' OR 'multicenter study' OR 'phase 3 clinical trial' OR 'phase 4 clinical trial' OR 'double blind procedure' OR 'single blind procedure') NOT (('animal' OR 'nonhuman':ab,ti) NOT ('human':ab,ti AND ('animal' OR 'nonhuman':ab,ti))))) AND ('gastrointestinal' OR 'digestive system function disorder')].

Data extraction and management

The quality assessment of the methodology was based on Cochrane Handbook for Systemic Reviews of Interventions 5.0.0 (Higgins 2008). "yes, no, unclear" represented a low risk of bias, a high risk of bias, and insufficient detail respectively in the study. The following items: "random sequence generation", "allocation concealment", "blinding of participants and personnel", "blinding of outcome assessment", "incomplete outcome data", "selective reporting", and "other bias" were assessed. Two researchers (GJ and TW) evaluated the eligible trials separately and finally reached a consensus Figure 1 & 2.

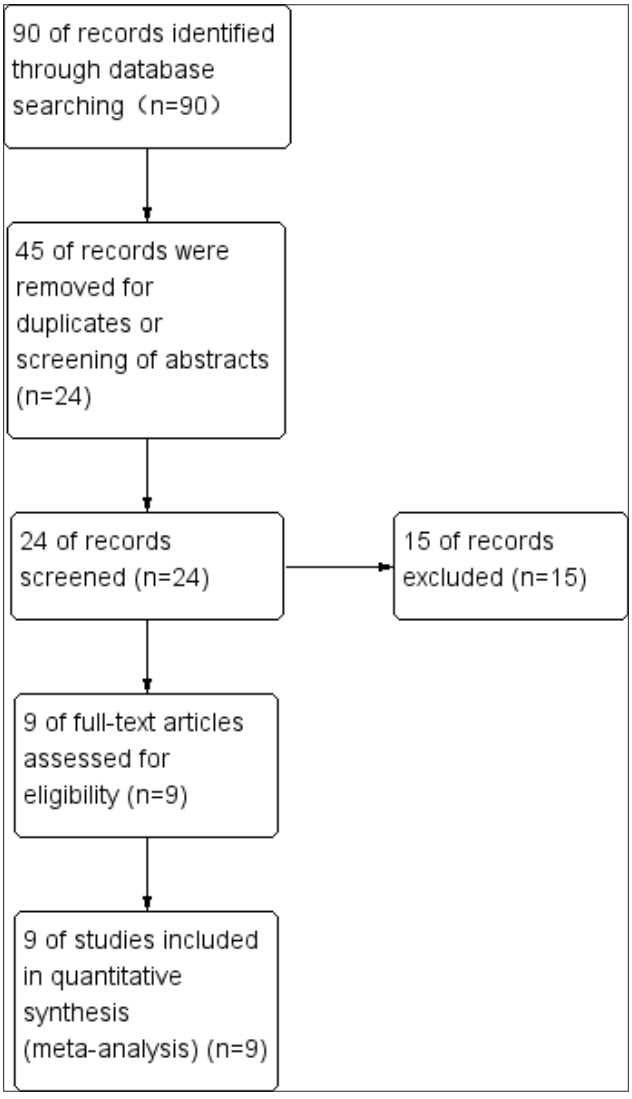


Figure 1: Study flow chart Data from 9 articles included in the meta-analysis.

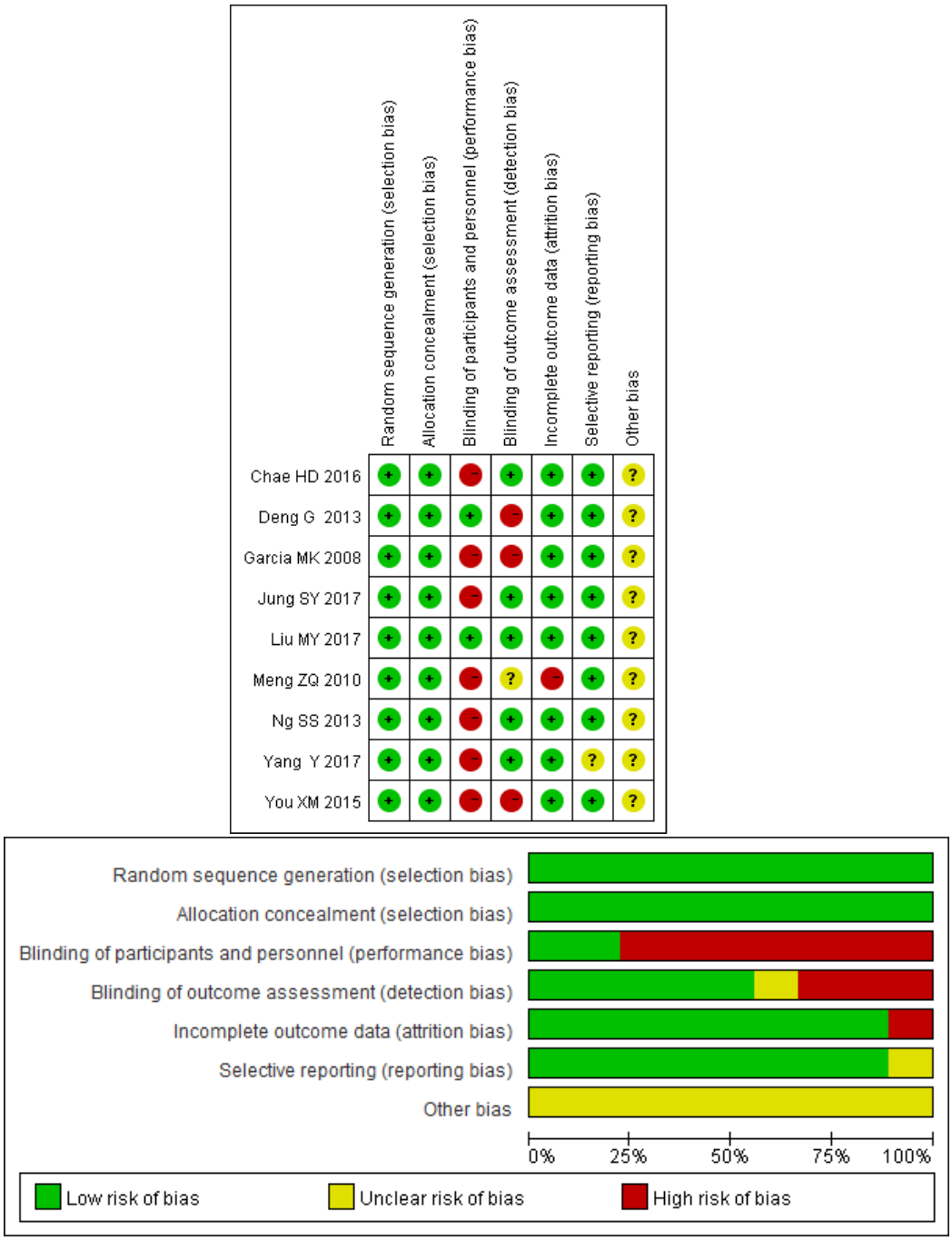


Figure 2: Risk of bias assessment of included studies: Risk of bias graph (A), risk of bias summary (B). The cohrane "risk of bias" tool was used for quality assessment. Green for "yes", red for "no" and yellow for "unclear".

Statistical analysis

This meta-analysis was performed by using Review Manager 5.3 and STATA 14.0. Risk ratios and 95% confidence intervals (CIs) were calculated for dichotomous variables. Mean differences (MDs) and 95% CIs were calculated for continuous variables. Calculated pooled estimates of the mean differences in outcomes between groups by using a random-effects model. Sensitivity analyses was carried out before the comparation between groups. In order to assess the possibility of publication bias, we constructed a funnel plot (Figure 3). We are using Egger test to assess the asymmetry of funnel plot, a p value<0.1 regarded as a significant publication bias. We used the Q test and I^2 testing to assess heterogeneity between studies. Studies with an I^2 statistics ranging from 25% to 50%, indicated low heterogeneity, I^2 statistics ranging from 50% to 75%, indicated moderate heterogeneity, and I^2 statistics >75% was considered to have high heterogeneity. Greater than 50% of the I^2 statistics represented significant heterogeneity in these studies[11].

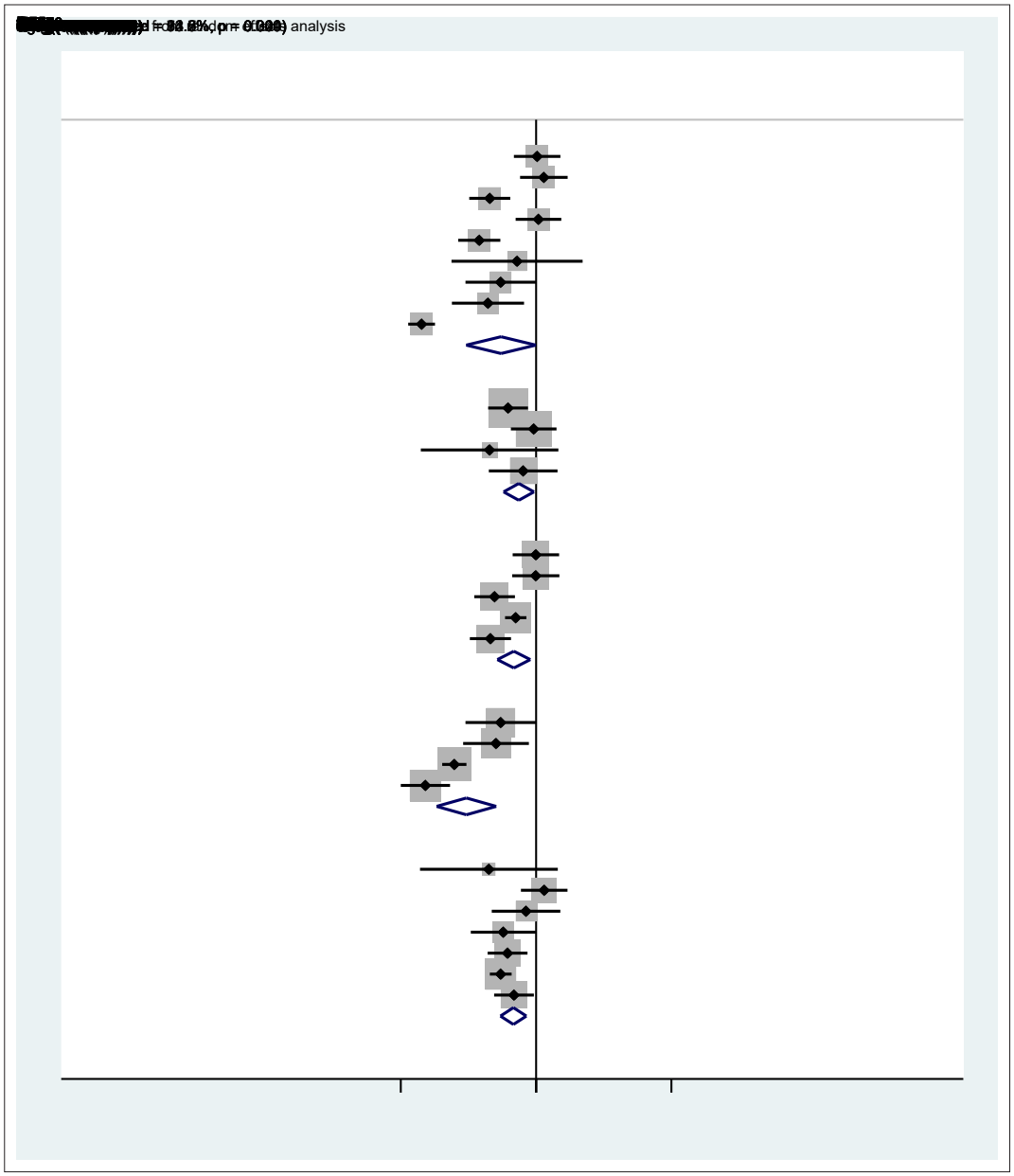


Figure 2: Meta-analyses of acupuncture on postoperative ileus: Outcomes assessed are:(A) time to first passage flatus, (B) time to tolerated solid food, (C) first bowel movement, (D) first defecation (E) hospital stay

Results

A total of 90 records were retrieved by searching various databases. 45 duplicate records were excluded, and 15 records were excluded after review of titles and abstracts. 24 studies were selected as being potentially eligible for inclusion into this systematic review. After reading the full-text articles, 9 RCTs (published between 2008 and 2019) including 910 participants were finally included [9,10]. The process of trial selection was shown in the study flow chart [11-18] (Figure 1).

Characteristics of Included studies

Table 1 shows the characteristics of included studies. Table 2 shows the outcome data of included studies. Figure 2 shows "risk of bias" assessment results. The seven included RCTs were published between 2008 and 2019. 2 trials compared acupuncture combined with traditional Chinese medicine to conventional treatment. 1 trial compared acupuncture against with sham acupuncture ,1 trial compared patients with sham acupuncture and no intervention, 6 trials compared acupuncture against with routine treatment or postoperative nursing. The sample size was ranging from 5 to 189 (449 cases in the treatment group received acupuncture / EA treatment and 461 cases in the control group. A total of 910 participants were included in the data synthesis.)

Table 1: Characteristics of included studies.

Study	Year	Group	Participants(n)	Interventions	Outcomes
Garcia MK [14]	2008	Treatment group	n=38	LI 4, SP 6, ST 36, ST 25, CV 6, CV 12 , Electrical stimulation was applied continuously and bilaterally from LI 4 (positive) to ST 36 (negative) by placing lead wires on the needles connected to an electroacupuncture stimulator (IC 1107, ITO Co, Tokyo,Japan). The unit applied continuous stimulation at 50 Hz and 16 mA throughout the treatment. Acupuncture twice a day, starting on postoperative day 1, for up to 4 consecutive days.	Outcomes measured included bowel function, pain, use of opioid analgesics, nausea, vomiting, insomnia, abdominal distension/ fullness, activity, and sense of well-being. Participants taking low-molecular-weight heparin were evaluated for bleeding Outcomes measured based on the Edmonton Symptom Assessment System (ESAS). The QOLS used in this study was a slightly modified version of the ESAS consisting of 5 items rated using a numeric scale (0–10): pain, nausea, insomnia, abdominal distention, and general sense of well-being.
		control group	n=40	Received no acupuncture and were only observed during the study period.	
Deng G [10]	2013	Acupuncture	n=39	seven pairs of bilateral points (ST-36, PC-6, LI-4, SP-6, SP-9, ST-25, auricular shenmen) for 30 min. Electrical stimulation, 2 Hz, 0.5msec square wave pulses, was applied to ST-36 (negative) and PC-6 (positive).	The primary endpoint was GI-3 Secondary end point: GI-2, emetic episodes before GI recovery (GI-3), need for postoperative nasogastric (NG) tube reinsertion, postoperative pain and nausea, and opioid consumption in morphine equivalent.
		Placebo	0	30 min of sham acupuncture twice daily during their first 3 postoperative days.	Pain and nausea were evaluated on a visual analogue scale (VAS) GI-3 (the later of the following two events: time that the patient first tolerated solid food, AND time that the patient first passed flatus OR a bowel movement) and GI-2 (the later of the following two events: time patient first tolerated solid food AND time patient first passed a bowel movement) were determined. Pain, nausea, vomiting, and use of pain medications were evaluated daily for the first 3 postoperative days.

Ng SS [9]	2013	Electroacupuncture Sham Acupuncture	n =55	Zusanli (ST-36), Sanyinjiao (SP-6), Hegu (LI-4), and Zhigou (TE-6), Sterile acupuncture needles (length, 25 mm; diameter, 0.22 mm; Hwato; Suzhou Medical Appliance Factory, Suzhou, China) were inserted into these acupoints, with a depth of insertion of about 20 mm. 100 Hz, lasted for 20 minutes. Shorter needles (length, 13 mm; diameter, 0.22 mm; Hwato, Suzhou Medical Appliance Factory, Suzhou, China) were placed 15 mm away from the acupoints at a shallower depth of insertion (2 mm) to avoid de qi. Pseudostimulation was provided by deliberately connecting the needle to the incorrect output socket of the electroacupuncture device, and thus there was no flow of electric current.	The primary outcome of the study was the time to defecation. The secondary outcomes of the study included time of first passing flatus, time that the patients tolerated a solid diet, time to walk independently, duration of hospital stay, pain scores and postoperative analgesic requirement.
		No Acupuncture	n =55		
Meng ZQ [12]	2010	Acupuncture	n =44	SJ-6:Zhigou, GB-34:(Yanglingquan), ST-36:(Zusanli). ST-37(Shangjuxu) once a day, remained in place for approximately 20 min with each treatment, starting on postoperative day 1, for six consecutive days or until the first bowel movement, continuously to two pairs of points [SJ-6 (positive) and GB-34 (negative)] bilaterally by placing lead wires on the needles connected to an electro-acupuncture stimulator applied consistent stimulation throughout the treatment at a frequency of 2 Hz.	The main outcome measure of bowel motility was assessed by asking patients to record the exact date and time that they first passed flatus and the exact date and time of their first bowel movement after surgery. Time 0 was the time anesthesia ended according to the anesthetic record. The total numbers of hours between time 0 and the passage of flatus and between time 0 and the first bowel movement were then calculated. PPOI was defined as having no bowel movement for more than 96 h (4 d) after surgery
		No Acupuncture	n =41	Patients in the control group received standard postoperative care with no acupuncture.	Secondary measures included EGEG and QOL assessments Quality of Life Status (QOLS).
Chae HD [14]	2016	Acupuncture	n=5	Bilateral ST 36(Zusanli), SP 6 (Sanyinjiao), LI 4 (Hegu), TE 6 (Ziagou), LV 3 (Taichong), LI 11 (Quchi), and unilaterally at GV 20 (Baihui), EX HN3 (Yintang), GV 26 (Shuigou), and CV 24 (Chengjiang).	The primary endpoint was the number of remnant Sitz markers in the small intestine that did not pass through ileocecal (IC) valve measured by radiography.

				Electrical stimulation of 100-Hz frequency was applied at bilateral ST 36, SP 6, LI 4, and TE 6.	The secondary outcomes included time to first flatus, start of sips water, start of soft diet, hospital stay, serum albumin level, and white blood cell (WBC) count and C-reactive protein (CRP) level
		No Acupuncture	n=5	No acupuncture treatment was performed in the NA group, and the same postoperative management was applied in both groups.	
Liu MY [16]	2017	EA group	n=21	PC6 (Neiguan), ST36 (Zusanli), and ST37 (Shangjuxv) EA stimulation was performed for a duration of 20 min at a frequency of 15 Hz with a continuous wave. Te participants received two EA treatments within 24 h before surgery, one at 10:00 a.m. and another at 16:00 p.m.	The the main outcome indicators: the incidence and degree of abdominal distension after surgery The secondary outcomes: the times of first flatus and defecation and duration of hospitalization
		RT group(routine treatment group)	n=21	Routine nursing care, and early walking, with no further EA treatments in EA group.	
Jung SY [15]	2017	Acupuncture	n=18	Bilateral ST 36(Zusanli), SP 6 (Sanyinjiao), LI 4 (Hegu), TE 6 (Ziagou), LV 3 (Taichong), LI 11 (Quchi), and unilaterally at GV 20 (Baihui), EX HN3 (Yintang), GV 26 (Shuigou), and CV 24 (Chengjiang). Electrical stimulation of 100-Hz frequency was applied at bilateral ST 36, SP 6, LI 4, and TE 6.	The primary endpoint the numbers of remnant sitz markers in the small intestine that did not pass through the ileocecal valve, as measured radiographically. The secondary outcomes of this study included time to first flatus, start of sips of water, start of soft diet, and hospital stay. Other secondary endpoints included white blood cell (WBC) count and C-reactive protein (CRP) level
		No Acupuncture	n=18	No acupuncture treatment was performed in the NA group, and the same postoperative management was applied in both groups.	
You XM [17]	2015	SMD+ acupuncture	n=55	received oral SMD decoction (Hansen Co., Ltd, Yiyang, Hunan Province, China, 10 mL/dose) 3 times per day beginning on the first day after hepatectomy	Primary endpoints: time to first flatus and time to defecation, which were recorded daily by nursing staff. Secondary endpoints: length of hospital stay and postoperative complications such as fever, pneumonia, wound infection, and bleeding.
		Chewing gum	n=53	patients was instructed to chew commercially available sugarless chewing gum	
		No intervention	n=54	did not receive any postoperative intervention	

Yang Y [18]	2017	SMD+acupuncture	n=196	Take oral SMD decoction (10 mL/dose; Hansen, Yiyang, Hunan, China) three times per day beginning on the first day after colorectal resection. They also received bilateral injections of vitamin B1 (50 mg×2) at the tsusanli acupoint once per day. This intervention was performed for 5 consecutive days or until flatus	Primary outcomes: time to first bowel motion, time to first flatus and time to defecation, on days 1–5 after resection.
		Chewing gum	n=197	chew commercially available sugar-free gum (Extra & Reg, Wm. Wrigley Jr., Shanghai, China) three times daily starting on the first postoperative morning. They were instructed to chew the piece of gum for at least 10 min. This intervention was performed for 5 consecutive days or until flatus.	Secondary endpoints: length of hospital stay, hospital mortality, and postoperative clinical complications such as vomiting, fever, pneumonia, wound infection, and bleeding
		No intervention	n=197	not to undertake any postoperative intervention that might influence recovery of bowel function, including SMD, acupuncture, chewing gum, or adjuvant drugs.	

Table 2: Outcome data of included studies.

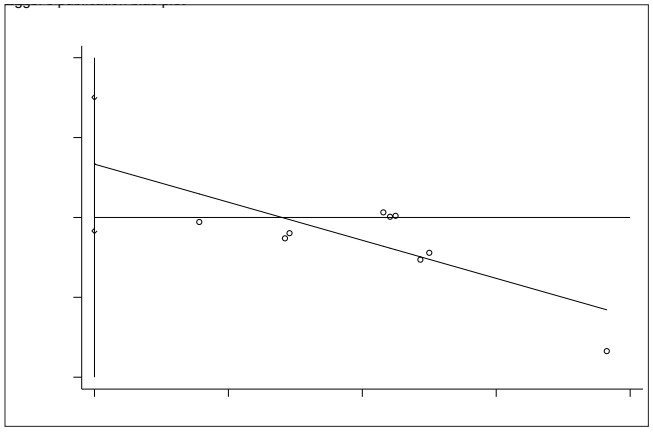
Study	Time to The First Passage Of Flatus(H)			Time to The First Defecation(H)			Time to First Bowel Movement(H)			Duration of Hospital Stay (Day)			Complications		
	Intervention	Control	P	Intervention	Control	P	Intervention	Control	P	Intervention	Control	P	Intervention	Control	P
Garcia MK [13]	52.4± 21.0(h)	52.0± 19.2(h)	0.87	NR	NR	NR	59.2± 22.2(h)	59.3± 25.9(h)	0.75	5.10 ± 5.42 (d)	4.45± 2.54 (d)	0.83	NR	NR	NR
Meng ZQ [12]	68.26 ± 23.38(h)	65.24 ± 17.5(h)	0.36	NR	NR	NR	119.04 ± 47.97(h)	119.38 ± 60.21(h)	0.77	NR	NR	NR	NR	NR	NR
Deng G [10]	149 ± 71(h)	146 ± 62(h)	0.9	NR	NR	NR	149 ± 71(h)	152 ± 60(h)	0.8	NR	NR	NR	NR	NR	NR
Ng SS [9]	48± 21.6	68.4 ± 24.4	0.003	NR	NR	NR	85.9±3 6.1(h)	122.1 ± 53.5(h)	0.001	6.5 ± 2.2	8.5 ± 4.8	0.007	6 (10.9%)	10 (18.2%)	0. 318
Chae HD 2016	57.6± 13.2	62.4± 13.2	0.549	NR	NR	NR	NR	NR	NR	9.4± 2.07	11.2± 1.92	0.206	NR	NR	NR
Liu MY 2017	70.56± 15.36	81.36± 16.56	0.132	67.44± 12.24	76.8± 12.2	0.022	NR	NR	NR	5.33± 0.68	5.75± 0.66	0.049	NR	NR	NR
Jung SY 2017	55.92± 11.76	70.56± 19.2	0.009	70.56± 15.36	81.36± 16.56	0.054	NR	NR	NR	9.72± 2.29	10.17± 2.38	0.572	NR	NR	NR
You XM 2015	51.4± 14.9	70.6± 20.13	0.012	60± 22.8	112.8± 27	0.003	19.6± 9.43	20.9± 13.23	0.014	14± 4.9	16.5± 6.8	0.014	34 (62.5%)	52 (96.3%)	<0.001
Yang Y 2017	46.2± 8.6	64.1± 7.75	0.021	75.2± 35.43	125.8± 29.08	0.033	17.1± 5.45	19.1± 4.82	0.236	9± 2.13	10.5± 2.3	<0.001	100 (53.8%)	181 (95.3%)	<0.001

Quality assessment

Risk-of-bias assessment of the included studies is presented in Figure 2. The 9 included RCTs had a low risk of bias in randomized sequence generation and allocation concealment. In some of the selected studies, there was no detailed explanation on how to blind patients for acupuncture treatment [9,12,13] which suggested that might cause study bias.

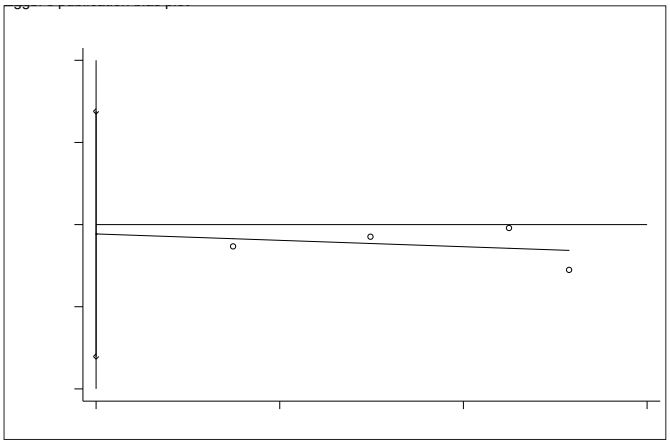
Primary endpoint

Time to first passage flatus: In a pooled analysis of all 9 studies, the treatment of acupuncture led to a greater improvement for time to first passage flatus than other non-pharmacy treatments, with statistically significant between-study heterogeneity [Heterogeneity chi-squared = 151.86 (d.f. = 8), p= 0.000; I^2= 94.7%; Figure 2.]. In this analysis, no publication bias was evident (P>|t|= 0.101, Figure 3a), however, further sensitivity analysis shows no substantial change in the effect size of the combined effect -0.67 (-1.33, -0.01).



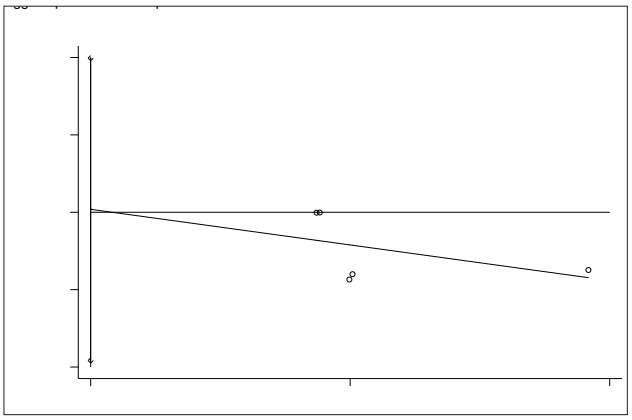
3- (A) time to first passage flatus

Secondary endpoints



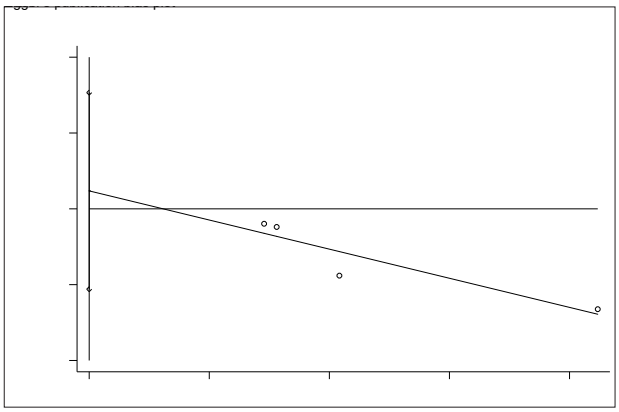
3-(B) time to tolerated solid food

First tolerated solid food: Pooled analysis of the 4 studies that assessed time to tolerated solid food showed a higher likelihood of quickly recovery when patients treated with acupuncture compared with other treatment, with low between-study heterogeneity [Heterogeneity chi-squared =3.51 (d.f. = 3), p= 0.320; $I^{2`}$=14.5% Figure 2]. In this analysis no publication bias was evident (P>|t|=0.773, Figure 3b & 3c). sensitivity analysis shows no substantial change in the effect size of the combined effect was found -0.33(-0.62, -0.04)



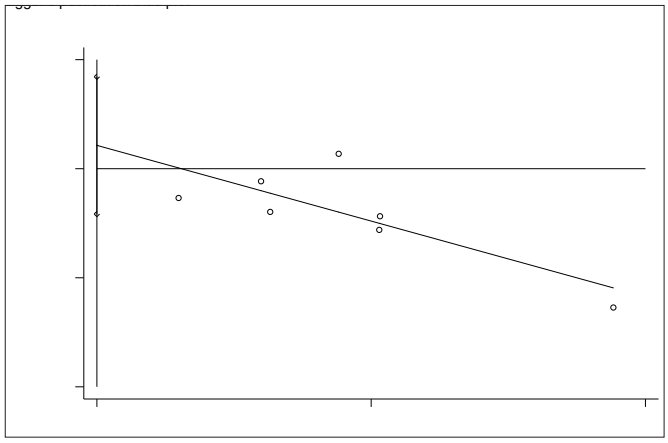
3-(C) first bowel movement

First bowel movement: Pooled analysis of the 5 studies that assessed time of first bowel movement showed a higher likelihood of quickly recovery when patients treated with acupuncture compared with other treatment, with statistically significant between-study heterogeneity [Heterogeneity chi-squared=15.31 (d.f. = 4), p= 0.004; I^2= 73.9%, Figure 2]. In this analysis no publication bias was evident (P>|t|=0.955, Figure 3d). Sensitivity analysis shows no substantial change in the effect size of the combined effect was found -0.42(-0.74, -0.11)



3-(D) first defecation

First defecation: Pooled analysis of the 4 studies that assessed time of first defecation showed a higher likelihood of quickly recovery when patients treated with acupuncture compared with other treatment, with statistically significant between-study heterogeneity [Heterogeneity chi-squared =17.84 (d.f. = 3), p= 0.000, I^2= 83.2%, Figure 2]. In this analysis no publication bias was evident (P>|t|=0.515, Figure 3e). Sensitivity analysis shows no substantial change in the effect size of the combined effect was found -1.33(-1.90, -0.76)



3-(E) hospital stay.

Figure 3: Egger test of acupuncture on postoperative ileus: , , ,

Hospital stay

Pooled analysis of the 7 studies that assessed time of hospital stay showed a higher likelihood of quickly recovery when patients treated with acupuncture compared with other treatment, with moderate between-study heterogeneity [Heterogeneity chi-squared =12.65 (d.f. = 6), p=0.049, I^2=52.6%, Figure 2]. In this analysis no publication bias was evident (P>|t|=0.423, Figure 3f). Sensitivity analysis shows no substantial change in the effect size of the combined effect was found -0.43(-0.68, -0.19)

Discussion

In this meta-analysis, we identified 9 RCTs investigating the effect of acupuncture on postoperative patients. Our result show that, compared with non-pharmacy treatment, acupuncture treatment can shorten the time to first passage flatus after operation. Furthermore, compared with other control treatment, acupuncture offers faster recovery time to tolerated solid food, first bowel movement, first defecation and shorter hospital stay. Thus, evidence seems to support that acupuncture improve postoperative gastrointestinal motor function.

As two important indicators of bowel activity, the time of first bowel movement and first passage of flatus have been widely used, however, these indicators also have limitations, such as objective measurement of motility and time consuming [19,20]. Various clinical endpoints of POI have been used in studies regarding POI diagnosis, but there is no consensus on which clinical parameter is the best one for assessment of gastrointestinal (GI) transit [6,21,22]. Recent years, new techniques have been used to assess the function of gastrointestinal movements. For example, Sitz marker has been used to evaluate postoperative recovery of small bowel movement, by counting the number of remnants Sitz markers in the small intestine that did not pass through ileocecal valve through radiography [23]. The Smart Pill is another swallowable device that record parameters within gastrointestinal tract, such as pH, temperature and intracavitary pressure, to analyze gastrointestinal transit times and smooth muscle activity in vivo. Innovative devices lead to a visualization or physical and chemical monitoring of the complete GI tract. More and more objective parameters could be provided to record and evaluate the duration and severity of POI, which is conducive to improving the reliability of clinical research [1,24].

Patients accepting acupuncture intervention had a significant shortened hospital stay, data were extracted from five included studies [12-16]. Hospital stay was affected by a number of factors, in particular postoperative complications. Whether acupuncture would affect postoperative complications for POI, better-quality studies would be needed for future update. We didn't combine and analyze the data of postoperative complications in this study since insufficient data was reported.

As shown in Figures 2 & 3. Robust and consistent findings were produced by our study that suggest benefits of acupuncture treatment on improving POI (time to first passage flatus, time to tolerated solid food, first bowel movement, first defecation, hospital stay). Not only that acupuncture has a similar effect has been reported from several animal models and clinical studies [9,14,25]. However, few researches have been contributing to new insights into the mechanisms of acupuncture improving POI. The hypothesis that acupuncture may help regulate the gastrointestinal tract through the autonomic nervous system has been confirmed. Several animal studies have shown that the effect of acupuncture is mediated through parasympathetic efferent pathways [26,27] especially, the effect of acupuncture on gastrointestinal function might through the vagus nerve [25,28]. Acupuncture has been used to treat functional gastrointestinal diseases and symptoms in Asian countries for thousand years. It is being widely accepted by clinicians and patients in the world today. Similarly, our study revealed the clinical effects of acupuncture on improving POI, further large sample experiment was suggested, and further mechanism research should be carried out.

There are some limitations of this meta-analysis. First, Insufficient quantity studies were included, some of published studies in this review have a small sample size, which may skew the results. We have retrieved acupuncture treatment of postoperative ileus (database of PUBMED, EMBASE, and CENTRAL). Unfortunately, there were a small quantity of RCTs or observational studies, and most of them are not in line with inclusion criteria of this study. further large sample experiment was suggested. Second, the potential exists to cause bias. For example, publication bias might exist because research with statistically significant results is potentially more likely to be submitted and published than work with null or non-significant results [29]. Third, various acupuncture methodologies of the included studies also made bias inevitable. The acupoints selection and treatment strategies used in the included studies were much the same. Beyond that, there were several factors influencing on the efficacy of acupuncture (moment of treatment and time interval, acupuncture manipulation, patient's

age, somatotype, physical and functional status, etc.) [30]. Among the included studies, Ng SS et al. [9] selected the elderly patients to observe the postoperative GI function, which was different from other studies on age. Age was found to be an independent predictor for either prolonged ileus or duration of ileus [31]. Various acupoints selected during acupuncture treatment, treatment sessions, duration and frequency of electric stimulation might also contribute to the main cause of bias [32]. Homogeneity of interventions should be handled carefully. High and moderate heterogeneity was detected in this study on the comparison of endpoints. Sensitivity analysis and subgroup analysis methods were also used to deal with high heterogeneity. We used the random effects model to justify the treatment effects in this meta-analysis [33]. Notwithstanding its limitation, our findings can clearly indicate the benefits of acupuncture in the clinical management of postoperative ileus.

Conclusion

In summary, we conducted a meta-analysis of 9 RCTs to investigate the effect of acupuncture treatment in POI. This review identified the evidence of acupuncture for postoperative patients in improving recovery of gastrointestinal function. This benefit of acupuncture should be a potential non-pharmacotherapy in the management of postoperative ileus.

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