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The primary aim of *World Journal of Gastrointestinal Surgery* (*WJGS*, *World J Gastrointest Surg*) is to provide scholars and readers from various fields of gastrointestinal surgery with a platform to publish high-quality basic and clinical research articles and communicate their research findings online.

WJGS mainly publishes articles reporting research results and findings obtained in the field of gastrointestinal surgery and covering a wide range of topics including biliary tract surgical procedures, biliopancreatic diversion, colectomy, esophagectomy, esophagostomy, pancreas transplantation, and pancreatectomy, *etc*.

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META-ANALYSIS

Meta-analysis of electrical stimulation promoting recovery of gastrointestinal function after gynecological abdominal surgery

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Abstract

BACKGROUND

The effects of electrical stimulation on gastrointestinal function recovery after gynecological abdominal surgery was not clear.

AIM

To systematically evaluate the effects of electrical stimulation on gastrointestinal function recovery after gynecological abdominal surgery.

METHODS

The Cochrane Library, Web of Science, PubMed, ProQuest, and the Chinese bio-medical literature databases Wanfang, Weipu, and CNKI were used to search for relevant studies on controlled trials of electrical stimulation in gynecological abdominal surgery patients from self-established databases to May 2024. The RevMan software (version 5.3) was used to analyze the included literature and explore the heterogeneity of each study.

RESULTS

Seven controlled trials, involving 520 patients, were included. The results of meta-analysis showed that electrical stimulation could shorten the recovery time of intestinal sound after gynecological abdominal surgery [odds ratio (OR): -5.11, 95%CI: -5.84 to -4.38, $P < 0.00001$] and improve the time of first anal exhaust (OR: -1.19, 95%CI: -1.38 to -0.99, $P < 0.00001$), improved the time of first anal defecation (OR: -0.98, 95%CI: -1.19 to -0.78, $P < 0.00001$), The difference is significant. According to the funnel plot, if the scatter is symmetrical, it indicates that the funnel plot is unbiased.

CONCLUSION
Electrical stimulation can shorten this reduces the length of time it takes for the patient to recover from bowel sounds and also affects the time to first anal voiding and defecation to some extent, thereby promoting gastrointestinal function recovery after gynecological abdominal surgery. The quality of the studies included in this review was poor, which may have affected the final results. It is necessary to conduct a randomized controlled study with higher quality and more samples to further confirm the promoting effect of electrical stimulation on gastrointestinal function recovery to guide clinical treatment.

Key Words: Electrical stimulation; Gynecology; Abdominal surgery; Gastrointestinal function; Meta-analysis

Core Tip: Electrical stimulation can shorten this reduces the length of time it takes for the patient to recover from bowel sounds and also affects the time to first anal voiding and defecation to some extent, thereby promoting gastrointestinal function recovery after gynecological abdominal surgery.

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INTRODUCTION

Abdominal surgery is a common type of surgery used to treat gynecological diseases and is mainly used to treat pelvic organs[1]. After gynecological abdominal surgery, patients are prone to gastrointestinal dysfunction such as abdominal distension, abdominal pain, loss of appetite, and delay of exhaust and defecation time[2], which can increase the intestinal pressure, slow down the healing of surgical anastomoses, and even cause intestinal obstruction[3]. Simultaneously, it can lead to a rise in the patient's diaphragm, inhibit the chest range of motion, cause dyspnea, and lead to deep venous thrombosis of the lower limbs[4]. All of these conditions negatively affect postoperative rehabilitation. At present, encouraging patients to get out of bed early after surgery, gastrointestinal decompression, and gastric motility drugs are often used in clinical practice to promote recovery of gastrointestinal function, but the effect is not ideal[5]. However, electrical stimulation can stimulate the local nerves and muscle tissue in the abdomen of patients, accelerate the recovery of postoperative gastrointestinal function[6], and effectively reduce postoperative complications. Therefore, this study searched domestic and foreign studies on the application of electrical stimulation to promote gastrointestinal function recovery in patients after gynecological abdominal surgery and analyzed its application effect to provide evidence-based medical data for gastrointestinal function recovery after clinical gynecological abdominal surgery.

MATERIALS AND METHODS

Literature search

Using the library's network resources to consult related studies, we attempted to understand the progress of domestic and foreign research. Sources: Cochrane Library, Web of Science, PubMed, ProQuest, and Chinese Biomedical Literature Databases Wanfang, Weipu, and CNKI. We used a combination of subject and free words to manually searched for relevant references, if necessary. Randomized controlled trials on the use of electrical stimulation to promote recovery of gastrointestinal function after gynecological abdominal surgery were collected from January 2010 to May 2024. Simultaneously, the references of the included studies were traced back to supplement the acquisition of relevant studies. The search was carried out by combining subject terms and keywords. The English search terms were: "Electrical stimulation," "Autohemotherapy," "gynecology," "abdominal surgery," "surgery," "gastrointestinal function,". The Chinese keywords included electrical stimulation, gynecology, abdominal surgery, surgery, and gastrointestinal function.

Inclusion and exclusion criteria

Inclusion criteria: (1) Type: Relevant trials published in China and abroad on the promotion of gastrointestinal function recovery after gynaecological abdominal surgery through electrical stimulation, in Chinese or English only; (2) Subjects: Patients who underwent gynecological abdominal surgery and showed abdominal distension, nausea, reduced bowel sounds, and stopped anal exhaust and defecation, which met the diagnostic criteria for postoperative gastrointestinal dysfunction in gastroenterology[7]. The two groups were consistent in terms of age, sex, disease course, and educational level; (3) Intervention measures: The control group received routine treatment after surgery (gastrointestinal decompression, early getting out of bed), and the observation group received electrostimulation based on routine treatment after

surgery. The efficacy of the two groups was compared after treatment; and (4) Outcome indicators: Bowel sound recovery time, first anal exhaust time, first anal defecation time.

Exclusion criteria: (1) The content of the article was incomplete or cannot be extracted; (2) The literature types were review, meeting minutes, experience summary; (3) Experiments with animals as research objects; (4) Non-randomized controlled clinical research articles; (5) Non-Chinese and English literature; or (6) The literature did not set up a suitable control group or lacked the necessary outcome data.

Literature screening and data extraction

Studies that met the research purpose and exclusion criteria were screened, the full text was read further after careful reading of the title, abstract and removal of studies that disagreed with this analysis, while studies with poor design or poor quality content were removed. Indicators such as authors of experiments, specific time of publication and sample size were extracted through Microsoft Excel. The final report had to be screened independently by 2 systematically trained researchers, verified by a third party, if necessary.

Literature quality evaluation

Two researchers independently reviewed the included literature based on the Cochrane Bias Risk Assessment Tool 5.1[8, 9]. The specific bias trends in the included literature were assessed and detailed as high, and unclear, covering items such as: (1) Random allocation of; (2) Distribution scheme hiding; (3) Blind method for the subjects and the implementers of the treatment plan; (4) Blind method to measure the findings of the study; (5) Completeness of outcome data; (6) Purposeful reporting of final results; and (7) Biased provenance regarding other. If the low risk was fully satisfied, it was deemed "Level A," if partially satisfied, it was deemed "Level B," and if not satisfied, it was deemed "level C." All items that were "high risk bias" were eliminated.

Statistical analysis

Statistical analysis was performed using RevMan 5.3, and I^2 was used to evaluate heterogeneity. When I^2 was lower than 50% and P higher than 0.1 indicate too low or no heterogeneity, so meta-analysis was performed by fixed-effects model. However, when $I^2 \geq 50\%$ and $P \leq 0.1$, the heterogeneity was high. In this case, meta-analyses were performed using a random-effects model, and bias was assessed using funnel plots.

RESULTS

Literature search results

According to the above keywords, a total of 172 studies were obtained by searching various databases; 24 were obtained after all duplicated literature, meeting minutes, after removing the reviews and commentaries, and after the titles, abstracts and full text of the articles, the final seven articles were obtained. The search process is illustrated in Figure 1.

Basic features of included studies: Seven studies published between 2013 and 2023 were included, and the case sources were all distributed in China. There were 520 patients with bronchiectasis, Control group (260), experimental group (260), where the minimum and maximum sample sizes were 40 and 120 respectively. Intervention measures: Of these, seven studies exist used electrical stimulation interventions, whereas the control group used routine nursing interventions. The data of all the study subjects are listed in Table 1[10-16].

Incorporating the results of research bias risk assessments: Random allocation was present in all included papers, of which six were randomised controls and one was a non-randomised control. There were no studies describing hidden allocation and blinded selectivity and other biased provenance. The results of the first anal exhaust time were mentioned in 7 studies, those of the first anal defecation time in 5, and those of bowel sound recovery time in 4. To assess the quality of the Cochrane Risk of Bias Assessment Tool (Figure 2).

Therapeutic results of meta-analysis

Bowel sound recovery time after electrical stimulation: Four studies reported the first intestinal sound recovery time after electrical stimulation. Heterogeneity between the 2 groups was ($P = 0.34$, $I^2 = 11\%$), with no heterogeneity. Meta-analysis showed that in terms of bowel sound recovery, the experimental group's recovery time was significantly better than that of the control group, and the difference was meaningful [odds ratio (OR): -5.11, 95%CI: -5.84 to -4.38, $P < 0.00001$; Figure 3A).

Time of first anal exhaust after electrical stimulation: Seven studies reported the time of the first anal exhaust after electrical stimulation. The heterogeneity between the experimental group and the control group showed that $P < 0.00001$, $I^2 = 91\%$, and there was heterogeneity. Meta-analysis showed that after electrical stimulation, the patients in the experimental group had their first anal defecation earlier compared to the control group, and the difference was significant (OR: -1.19, 95%CI: -1.38 to -0.99, $P < 0.00001$; Figure 3B).

Five studies reported the time of the first anal bowel movement after electrical stimulation. Heterogeneity between the experimental and control groups was $P = 0.00001$ and $I^2 = 82\%$. Meta-analysis showed that the experimental group was earlier than the control group in terms of first anal defecation after electrical stimulation. The difference was significant

Table 1 Basic characteristics of the included literature

Ref.	Time of publication (year)	Sample size (control group/experimental group)	Packet mode	Intervention method		Outcome index
				Control group	Experimental group	
Yang and Dong[10]	2020	25/25	Randomized controlled trial	Routine nursing intervention	Electrical stimulation intervention	(2)
Cao[11]	2023	60/60	Randomized controlled trial	Routine nursing intervention	Routine nursing + electrical stimulation intervention	(1) (2) (3)
Liang *et al* [12]	2021	40/40	Non-randomized controlled trial	Routine nursing intervention	Electrical stimulation intervention	(1) (2) (3)
Zhang *et al* [13]	2020	30/30	Randomized controlled trial	Routine nursing intervention	Routine nursing + electrical stimulation intervention	(2) (3)
Chen[14]	2016	20/20	Randomized controlled trial	Routine nursing intervention	Routine nursing + electrical stimulation intervention	(1) (2)
Mu *et al* [15]	2019	55/55	Randomized controlled trial	Routine nursing intervention	Routine nursing + electrical stimulation intervention	(1) (2) (3)
Yin *et al* [16]	2013	30/30	Randomized controlled trial	Routine nursing intervention	Routine nursing + electrical stimulation intervention	(2) (3)

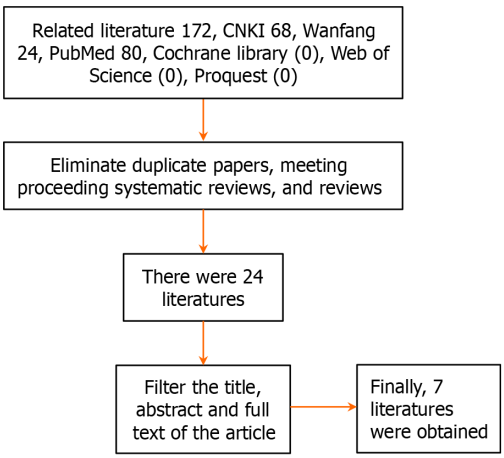

Figure 1 Flow chart of document retrieval.

(OR: -0.98, 95%CI: -1.19 to -0.78, $P < 0.00001$; Figure 3C).

Three studies reported the length of hospital stay after electrical stimulation, heterogeneity between the 2 groups was $P < 0.00001$ ($I^2 = 94\%$). Meta-analysis showed that in terms of length of stay, the experimental group was significantly shorter than the control group, with significant differences (OR: -1.10, 95%CI: -1.37 to -0.84, $P < 0.00001$; Figure 3D).

The funnel plot of each study indicated the scatter is uniformly symmetric and inverted funnel; so, no bias occurred (Figure 4).

DISCUSSION

Abdominal surgery is a common gynecological procedure. Postoperatively, patients experience abdominal pain, distension, nausea and vomiting, and gastrointestinal dysfunction such as poor exhaust and defecation. If not properly handled in time, complications such as adhesion, tearing and intestinal obstruction may occur, aggravating patients' condition and prolonging their postoperative rehabilitation cycle[17]. Currently, gastrointestinal decompression and gastric motility drugs are commonly used to promote the recovery of gastrointestinal function in patients; however, their overall effect is slow, delaying the rehabilitation process of patients. Relevant studies have found that electrical stimulation can promote the recovery of gastrointestinal function after gastrointestinal surgery, shorten the time of anal exhaust and defecation, and causes fewer adverse reactions[18]. In contrast, other studies have reported that the first defecation and first autonomous exhaust times of patients undergoing uterine fibroid surgery were significantly shortened after intervention with low-frequency pulsed electrical stimulation[19].

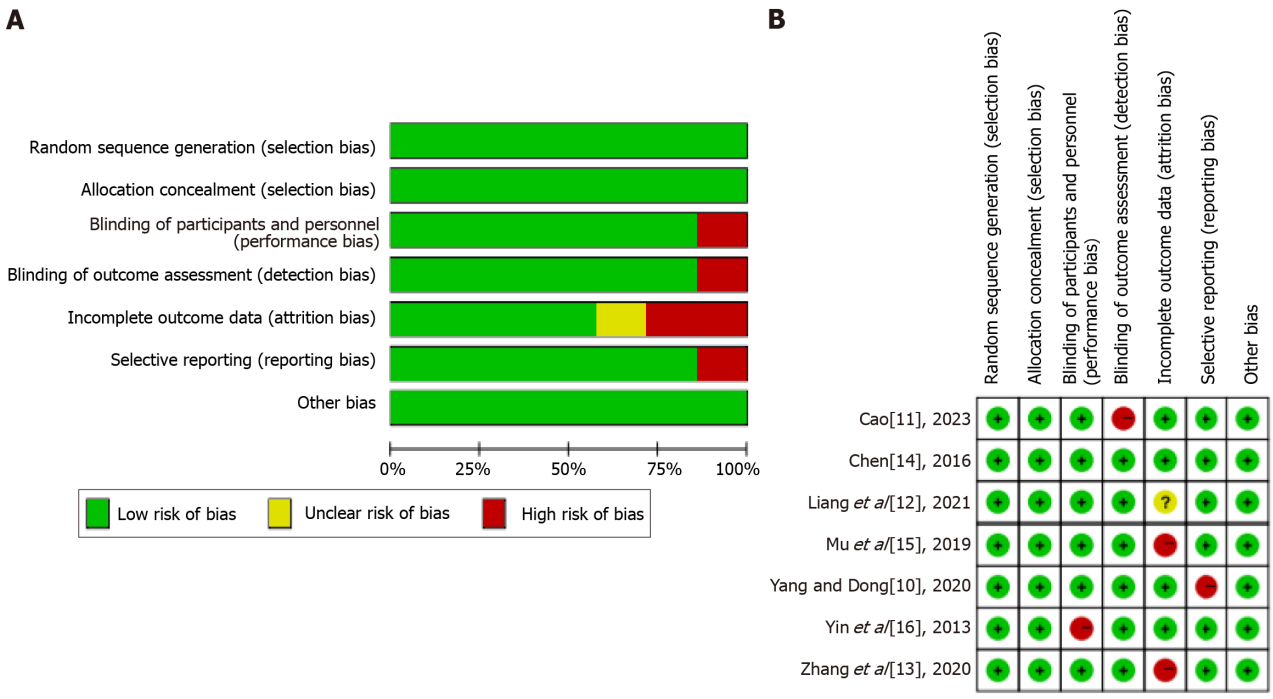

Figure 2 Shows the offset risk scale. A: Bar chart for literature quality evaluation; B: Risk offset entries and applicability summary chart.

However, electrical stimulation can significantly improve gastric motility and stimulate the local nerve and muscle tissue of the abdomen of patients; using continuous and stable current[20] can regulate the gastrointestinal electrical rhythm, improve the level of gastrointestinal endocrine hormones, accelerate the recovery of postoperative gastrointestinal function, and effectively reduce postoperative complications. Previous studies have shown that percutaneous acupoint electrical stimulation can accelerate recovery of gastrointestinal function in patients with gastrointestinal dysfunction after gynecological abdominal surgery[21]. Percutaneous acupoint electrical stimulation therapy is superior to Western medicine in improving gastrointestinal motility and relieving pain. However, the sample sizes of the relevant published studies were small, resulting in a lack of validity, comprehensiveness, and systematic research. Therefore, the present study provides a medical basis for clinical work by analysing the recovery of gastrointestinal function in patients after gynaecological abdominal surgery with electrical stimulation.

Results of meta-analysis in this study

Seven studies There were 260 people in the control group and 260 in the experimental group. The recovery time of intestinal sounds after electrical stimulation, time of first anal exhaust, time of first anal bowel movement, and time of postoperative hospitalization the experimental group was superior as compared to the control group. The difference was significant ($P < 0.05$).

Electrical stimulation can shorten the recovery time of intestinal sound after gynecological abdominal surgery

In this study, the control group received routine care such as early getting out of bed, gastric motility drugs, and gastrointestinal decompression. Getting out of bed early can induce intestinal reflex in patients by changing body position, accelerating systemic blood circulation, improving local gastrointestinal blood supply, and promoting intestinal group peristalsis, thus shortening the recovery time of intestinal sounds after gynecological abdominal surgery, but the overall effect is slow[22]. However, kinetotropic drugs can enhance the contractile force of the gastrointestinal smooth muscle, coordinate the gastrointestinal motility law, promote gastrointestinal emptying and transport, and promote the recovery of gastrointestinal function, but they are prone to intestinal torsion, anastomotic rupture, stump fistula, and other serious complications, which are not conducive to the condition of patients[23]. Enema and other gastrointestinal decompression measures can increase pain in patients and are not easily accepted. In this study, we found that electrical stimulation can significantly shortened the recovery time of intestinal sounds after gynecological abdominal surgery. This may be because electrical stimulation can improve the autonomic nervous function of innervating visceral organs, reduce the excitability of sympathetic nerves, increase the tension of parasympathetic nerves, promote the release of acetylcholine[24], stimulate the expression and secretion of Ach, further act on smooth muscle M receptors, open the L-type Ca^{2+} channel of the plasma membrane, accelerate Ca^{2+} inflow, and enhance the contractile force of gastrointestinal smooth muscle. Thus, it promotes the recovery of gastrointestinal motor function, regulates gastrointestinal movement, and accelerates the recovery of intestinal sounds[25].

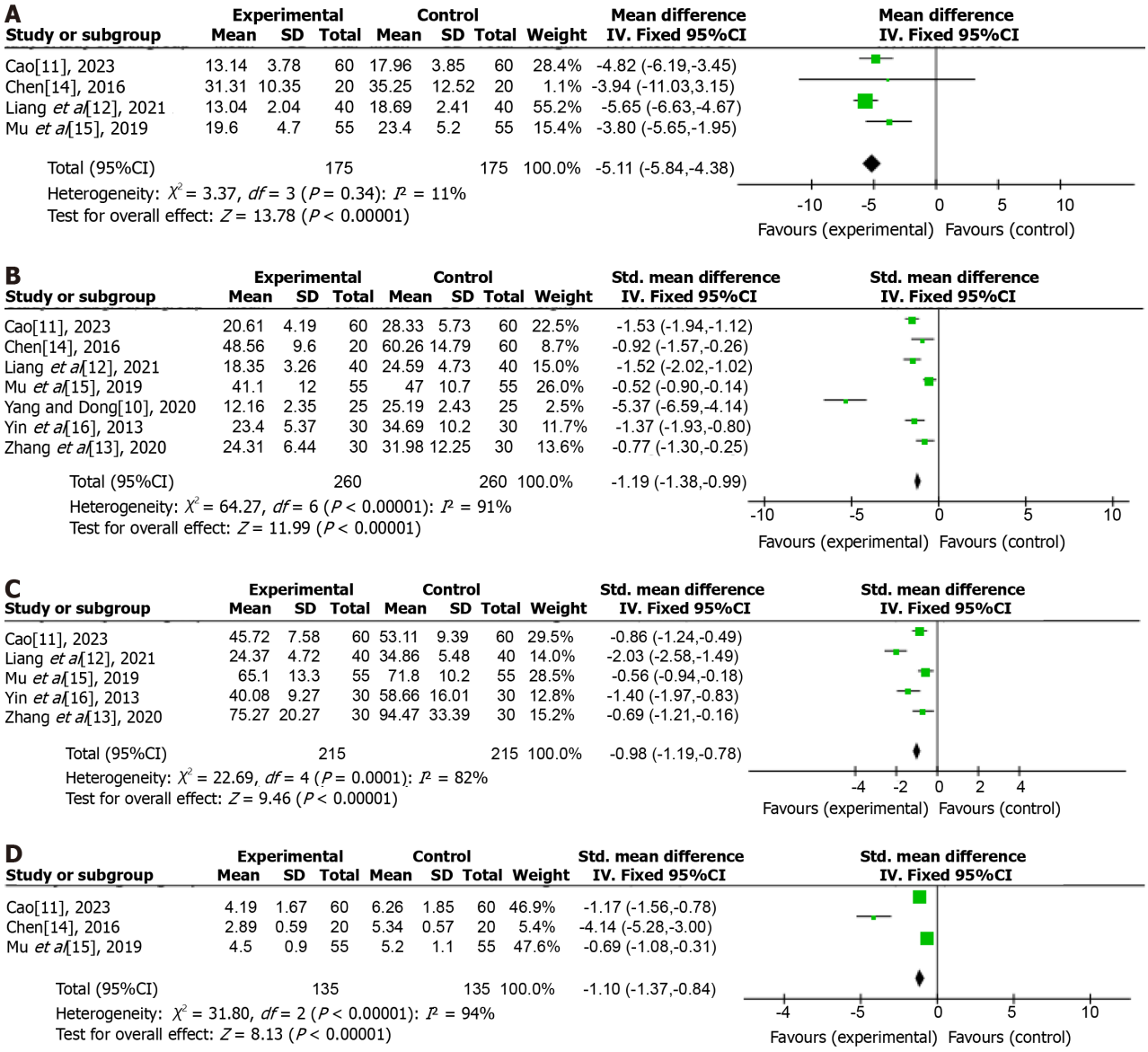

Figure 3 Time after electrical stimulation. A: The recovery time of intestinal sound after electrical stimulation; B: The first anal exhaust time after electrical stimulation; C: The first anal defecation time after electrical stimulation; D: Hospital stay after electrical stimulation.

Electrical stimulation can improve the time of first anal exhaust after gynecological abdominal surgery

In the process of abdominal surgery, external stimulation of the organs can cause reflex gastrointestinal smooth muscle spasm, which can lead to postoperative gastrointestinal dysfunction such as abdominal distension, abdominal pain, anal exhaust obstruction, and eventually intestinal paralysis, which seriously affects the appetite and psychological state of patients and is not conducive to later rehabilitation and nursing. At present, in clinical practice, the recovery of gastrointestinal function after gynecological abdominal surgery is mainly promoted by early getting out of bed activities and motility-promoting drugs, which makes the anus vent as early as possible, but the overall effect is general, and intestinal torsion, anastomotic rupture, and other complications occur easily, aggravating the condition of patients, and is not conducive to postoperative rehabilitation. Therefore, it is of key importance to find a method that significantly improves the recovery of gastrointestinal function in patients after section abdominal surgery. In this study, patients in the experimental group had their first anal defecation earlier than the control group after the electrical stimulation intervention, indicating that electrical stimulation can improve anal exhaust time after gynecological abdominal surgery, which is similar to the findings of Zhou[26]. This may be because electrical stimulation can produce stable and continuous effects, stimulate postoperative parasympathetic excitability, increase plasma ghrelin and motilin concentrations, stimulate gastric acid secretion, promote gastric emptying, activate acetylcholinase, further promote contraction of the gastric body and antrum ring muscle, improve and enhance intestinal movement, accelerate the return time of the jejunum, reverse intustion, and promote intestinal group peristalsis. The first anal exhaust time of patients after gynecological abdominal surgery can be improved to promote the recovery of gastrointestinal function[27,28].

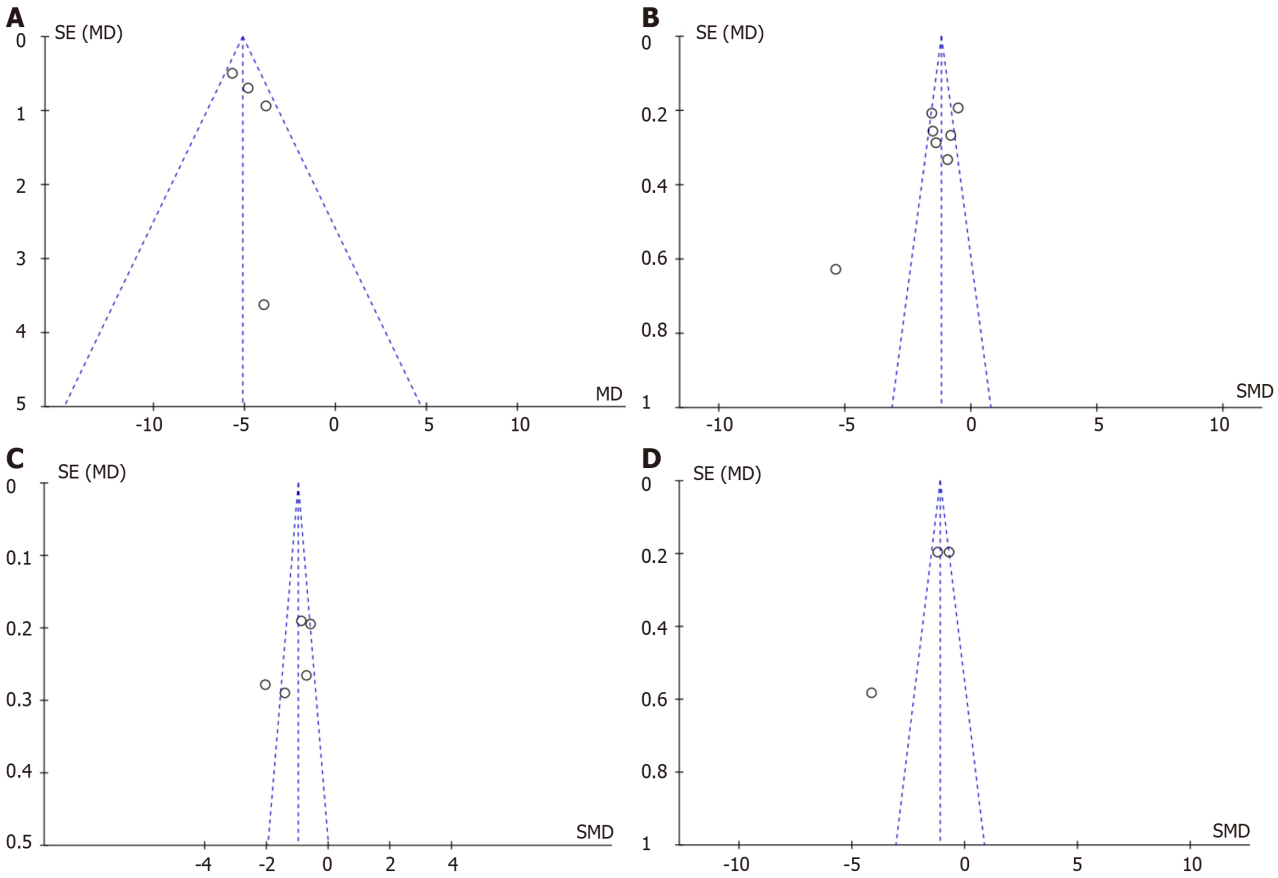

Figure 4 Shows the funnel diagram of each study. A: Funnel diagram of bowel sound recovery time; B: Funnel diagram of first anal exhaust time; C: Funnel diagram of first anal defecation time; D: Funnel diagram of hospital stay.

Electrical stimulation can improve the time of first anal defecation after gynecological abdominal surgery

Gastrointestinal disorders such as abdominal pain, distension, and poor defecation often occur after gynecological abdominal surgery and are prone to complications such as adhesion, tearing, and intestinal obstruction, which can prolong the postoperative recovery time of patients and are not conducive to postoperative rehabilitation. Therefore, the recovery of gastrointestinal function is a key component of rehabilitation after gynecological abdominal surgery. In this study, patients in the experimental group had their first anal defecation earlier than the control group after receiving electrical stimulation, which suggests that electrical stimulation can improve the time to anal defecation after gynaecological abdominal surgery, which is similar to the conclusion of Li *et al*[29]. This may be because electrical stimulation can stimulate local smooth muscle or skeletal muscle, act on Cajal interstitial cells, intestinal pacemaker cells, and autonomic nerves of the intestinal wall, enables the stimulation of muscle movement and the simulation of voluntary movement, thus effectively improving the function of some muscles in terms of activity and further promoting blood supply, enhancing colon peristalsis, and accelerating the time of anal bowel movement[30].

Electrical stimulation can shorten the length of hospital stay after gynecological abdominal surgery

The postoperative hospitalization of gynecological abdominal surgery patients is mainly for observation, treatment, and rehabilitation. During hospitalization, doctors can closely observe changes in the patient's condition, deal with possible complications in a timely manner, ensure the safety of the patient, and formulate a personalized rehabilitation plan according to the patient's recovery situation to help the patient recover as soon as possible. In this study, the hospital stay of patients in the experimental group after electrical stimulation intervention was found to be shorter than that of the control group, indicating that electrical stimulation can improve hospital stay after gynecological abdominal surgery, which is similar to the conclusion by Lin *et al*[31]. The reasons for this may be: As a noninvasive treatment, electrical stimulation can promote the recovery of gastrointestinal function in patients, enabling them to resume normal diet and activities earlier, reduce the use of drugs, and reduce the burden on the body, thereby avoiding complications, improving the comfort and acceptance of patients, accelerating the overall rehabilitation process of patients, and ultimately shortening the length of postoperative hospitalization[32].

Limitations of this study

(1) Some studies did not mention explicit random methods and hidden methods, which may have caused a selectivity bias; (2) Due to the differences in disease and disease duration between the subjects in this study, it makes the final results of the meta-analysis will receive statistical and clinical heterogeneity; (3) Of the included studies, most were of low

quality, and there is a high possibility of potential bias, which may affect the accuracy of the research results; and (4) The specific details of routine nursing operations, determination of outcome indicators, use of electrical stimulation, and course of treatment were inconsistent among the included patients, and there was some clinical heterogeneity, which led to the possibility of bias in the results of the meta-analysis. These limitations also suggest not only is it important to improve the quality of the trial, but also to expand the sample size to further confirm application value of electrical stimulation after gynecological abdominal surgery. Therefore, the validity of the study results can be further strengthened in subsequent studies to improve the overall quality of the trial by: (1) Use randomized controlled trials to expand the sample size of the study and strictly formulate the electrical stimulation operation method to obtain more accurate result data; (2) Establish standardized protocols for electrical stimulation interventions after gynecological surgery to enhance comparability between studies and thus reduce methodological variability; (3) Define demographic methods and indicator evaluation methods, and provide researchers with strict training. At the same time, standardized first-level literature is used to evaluate scale indicators, so as to reduce the impact of statisticians' subjective consciousness on research results; (4) In the process of result sorting, 2-3 result reviewers should be arranged to check the statistical results and eliminate the data results that are obviously low or high to ensure the universality of the results; and (5) Long-term follow-up of patients should be conducted to clarify the reported results of patients' length of stay, postoperative complications and postoperative quality of life, so as to better understand the clinical benefits of electrical stimulation.

CONCLUSION

The study revealed that electrical stimulation in the form of electrical stimulation can not only significantly shorten the recovery time of midgut sounds in patients during gynaecological abdominal surgery, but also reduce their time of defecation and hospital stay, which is conducive to promoting the recovery of patients, and deserves to be widely used in clinical practice. However, in this study, due to a variety of factors, therefore, further controlled trials based on the principles of multicentre, randomisation and double-blindness were conducted to test the results.

FOOTNOTES

Author contributions: Chen Y designed research; Huang XX performed research; Gu HF and Shen PH contributed new reagents or analytic tools; Chu BL analyzed data; Huang XX wrote the paper.

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