Effect of Stellate Ganglion Block on Postoperative Recovery of Gastrointestinal Function in Patients Undergoing Surgery with General Anaesthesia: A Meta-Analysis.

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Abstract

Background: The return of normal gastrointestinal function is an important signal of postoperative recovery in patients undergoing surgery with general anaesthesia, especially for abdominal surgery. Current methods to resolve this problem are conservative, and the effects are sometimes limited. We aimed to summarize the effects of stellate ganglion block(SGB) on the recovery of gastrointestinal function to explore methods for anaesthesiologists to contribute to postoperative patient recovery. Ru

Methods: Selected databases were searched for relevant studies. Study quality was assessed according to the Cochrane Collaboration's tool for assessing risk of bias. Data extraction was performed independently. The time to peristaltic sound resumption, flatus, postoperative eating and the incidence and degree of abdominal bloating were compared between stellate ganglion and control groups. Meta-analysis was performed using Review Manager software.

Results: In total, 281 studies were identified after searching for relevant articles, and five articles with data for 274 patients were eligible for this analysis. Regarding postoperative flatus time, SGB caused a mean reduction of 15 hours for different surgeries; after excluding a study causing heterogeneity, the mean reduction was still more than 6 hours. For gastrointestinal surgery, the mean reduction was approximately an entire day. When evaluating the recovery of peristaltic sounds in different surgeries, SGB promoted the recovery of regular bowl sounds by an average of 14.67 hours earlier than the control. With regard to nutrients, SGB shortened the total parenteral nutrition time by more than 50 hours in gastrointestinal surgery. Finally, SGB prevented the occurrence of postoperative abdominal bloating without influencing its degree. No complications related to SGB were reported.

Conclusion: SGB promotes postoperative gastrointestinal recovery in patients undergoing different surgeries with general anaesthesia.

1. Introduction

The return of normal gastrointestinal (GI) function is an important signal of postoperative recovery in patients undergoing surgery with general anaesthesia, especially those undergoing abdominal surgery. The delayed recovery of GI function or postoperative disturbances in GI function prevents patients from resuming a normal diet and can cause complications, such as postoperative nausea and vomiting, abdominal distension and intestinal obstruction, as well as increases the incidence of anxiety and insomnia. These events could thus influence patients' quality of life, prolong patients' hospital stay, increase the associated costs, and even increase the perioperative mortality rate[1]. Disrupted GI functional recovery is mainly attributable to the following 3 factors: 1) Functional changes in the autonomic nervous system, including excitation of the sympathetic system and inhibition of the parasympathetic system; surgical trauma and stress enhance the activity of the hypothalamus-pituitary-adrenal (HPA) axis, leading to the release of stress hormones, such as catecholamine, which cause vasoconstriction of the digestive tract and destruction of the protective barrier[2, 3]. 2) The destruction and injury to normal GI structures ,which is followed by inflammation[4]. 3) Intraoperative and postoperative use of analgesics inhibits bowl function[5]. Furthermore, opioid usage can exacerbate GI dysfunction and delay GI recovery by acting peripherally[3]. Of all these factors, the first is the most important and can be easily caused by surgical trauma and manipulation.

With the emergence of the *Enhanced Recovery After Surgery* (ERAS), the safe and effective promotion of the GI function recovery after surgery with general anaesthesia plays an important role in rapid postoperative recovery for surgeons and anaesthesiologists alike. Current methods to resolve this problem are conservative, including early ambulation, reduced opioid use, intravenous fluid, antiemetic administration and nasogastric tube placement; however, the effects are sometimes limited. Since delayed postoperative GI function recovery is often driven and exacerbated by heightened sympathetic tone, for anaesthesiologists, choosing appropriate anaesthesia, maintaining proper intraoperative management and applying appropriate interventions to prevent overexcitation of the sympathetic system are vital to prompt GI recovery.

The stellate ganglion (SG), as a component of the cervical sympathetic chain, is formed by the fusion of the 6th and 7th cervical and the 1st thoracic sympathetic ganglia. It is surrounded by the following structures: 1) the scalene muscles laterally; 2) the longus colli muscle, oesophagus and trachea medially; 3) the recurrent laryngeal nerve; 4) the transverse processes of the cervical vertebral posteriorly; 5) the subclavian artery and the posterior aspect of the pleura inferiorly; 6) and the vertebral vessels at the C7 level anteriorly[6, 7]. SG innervates the superior part of the homolateral body, including the head, neck, superior limbs, and thorax, etc., and plays an important role in regulating systemic autonomic nerve function.

Stellate ganglion block (SGB) is currently the most commonly used sympathetic block in medical practice and has a wide range of indications, including complex regional pain syndrome (CRPS) types 1 and 2, postherpetic neuralgia (PHN), intractable angina, post-traumatic stress disorder (PTSD), hyperhidrosis, arrhythmias, hot flushes, cerebrovascular disease and GI dysfunction[7, 8]. Additionally, it can modify the immune response and inhibit inflammation after acute trauma[9, 10]. Furthermore, by blocking sympathetic nerves innervating the GI system, SGB can dilate GI vessels, improve the blood supply and enhance GI motility.

For this compelling rationale, some researchers have performed clinical trials to assess how SGB influences postoperative GI function. It is obvious that individual studies cannot provide sufficient data on their own to influence clinical practice; thus, we sought to conduct a systematic review and meta-analysis of published studies exploring the effects of SGB on the recovery of GI function in patients undergoing surgery with general anaesthesia to establish the influence of SGB on key outcomes of GI recovery and explore methods for anaesthesiologists to contribute to the postoperative recovery of patients.

2. Methods And Materials

This meta-analysis was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Statement[11] and has been registered at the International Prospective Register of Systematic Reviews (number:CRD42020157602).

Search strategy

We searched for relevant human studies published between Jan 1, 1988, and November 11, 2019, by searching databases, including the PubMed, Cochrane library, China National Knowledge Infrastructure (CNKI), Chinese VIP Information (VIP), Wanfang and SinoMed databases. Language was restricted to English and Chinese.

The following combined text and MeSH terms were used for searching: "satellite ganglion" and "gastrointestinal function". The complete search strategy used for PubMed was:(((Stellate Ganglion [Mesh] OR Ganglion, Stellate [Title/Abstract] OR Cervicothoracic Ganglion [Title/Abstract] OR Ganglion, Cervicothoracic [Title/Abstract] OR Cervicothoracic Ganglia [Title/Abstract] OR Ganglia, Cervicothoracic [Title/Abstract] OR Stellate Ganglia [Title/Abstract] OR Ganglia, Stellate [Title/Abstract] OR Ganglias, Stellate [Title/Abstract] OR Stellate Ganglias [Title/Abstract]) OR (Ganglia, Sympathetic [Mesh] OR Ganglion,Sympathetic [Title/Abstract] OR Sympathetic Ganglion [Title/Abstract] OR Sympathetic Ganglia [Title/Abstract] OR Celiac Ganglia [Title/Abstract] OR Ganglia, Celiac [Title/Abstract] OR Celiac Ganglion [Title/Abstract] OR Ganglion, Celiac [Title/Abstract])) AND (Gastrointestinal function [Title/Abstract] OR bowel sounds [Title/Abstract] OR flatulence [Title/Abstract] OR flatus time [Title/Abstract] OR exhaust time [Title/Abstract])))

All potentially eligible studies irrespective of the primary outcome were considered for review. Manual searches were performed using the reference lists of crucial articles.

Inclusion and exclusion criteria

Studies were considered eligible if they were clinical trials involving SGB for patients undergoing surgery with general anaesthesia and reporting postoperative GI function, such as bowel sounds, the incidence and degree of abdominal bloating, time to flatus, and time to eating. The exclusion criteria were as follows: 1) observational and retrospective studies; 2) studies without a control group; 3) studies that did not assess GI function; 4) a reporting language other than English or Chinese.

Study selection, data extraction and quality assessment

Study selection and data extraction were done by three authors (BW, YJW, CZ) independently. Disagreements and difficulties were resolved by group discussion or consultation with another author (ZJF). Titles and abstracts were reviewed first to determine whether studies were related to the theme. Then, full articles were judged according to the inclusion and exclusion criteria. If studies satisfied the inclusion criteria, they were used for detailed analysis and data extraction. Data extracted from the selected studies were as follows: 1) demographic data (total number of participants, age, sex); 2) treatment protocols (methods, side, drug category, drug dosage); 3) outcomes mentioned above; and 4) any complications. The quality of the included studies was assessed according to the Cochrane Collaboration's tool for assessing risk of bias.

Statistical analysis

We assessed the effect of SGB on postoperative GI recovery in terms of four outcomes: time to resumption of peristaltic sounds, time to flatus, time to postoperative eating, incidence and degree of abdominal bloating. The first three were analysed as continuous variables. As the last involved ranked data, we converted it into continuous variables as follows: no abdominal bloating, 1; mild abdominal bloating, 2; moderate abdominal bloating, 3; and severe abdominal bloating, 4. After this transformation, this variable was also analysed as continuous. We reported absolute differences different between different interventions and calculated pooled estimates of the mean differences in all four of these outcomes between intervention groups. If the heterogeneity was low (I^2 <50%), a fixed-effects model was used for pooled analysis, while a random-effects model was used if the heterogeneity was high to account adequately for the additional uncertainty associated with different studies. Publication bias was not assessed for the small number of included trials. We used the Cochran I^2 test to assess the existence and magnitude of heterogeneity between studies[12]. Heterogeneity was considered low, moderate, or high for I^2 values <25%, 25–50%, and >50%, respectively.

Review Manager (RevMan 5.3) was used for all statistical analyses. P≤0.05 was considered statistically significant.

3. Results And Discussion

In all, 281 studies were identified after searching for relevant articles; five articles[13-17] with data for 274 patients were eligible for this analysis. Figure 1 shows the process of study selection.

Summary characteristics of the included studies

The characteristics of the included studies are shown in table 1. These five studies were all published from 2013 to 2019 and met both the inclusion and exclusion criteria. Three of them were studies on GI surgery[14-16], one was on posterior spinal surgery[17], and one was on laparoscopic gynaecological surgery and only involved female patients[13]. Regarding the time of SGB, it was performed before the induction of general anaesthesia in three studies[14-16]; in two studies, SGB was performed after the induction of anaesthesia and before the beginning of surgery[13, 17]. The left SG was blocked in one study[14], and the right SG was blocked in three studies[13, 15, 17]; one study did not mention whether SGB was conducted on the left or right[16]. Regarding local anaesthetics, 0.5% ropivacaine was used in one study[14], while 1% lidocaine was used in the others[13, 15-17], and the volume of local anaesthetics injected into the SG varied among these five studies. Furthermore, three studies performed a sham procedure in the control group with 0.9% NS (normal saline) in the same volume of local anaesthetics[13, 14, 17], while in the other two studies, no operations were performed on the SG in the control group[15, 16].

Quality of the included studies

The quality of the studies was assessed according to the Cochrane Collaboration's tool for assessing risk of bias. Figures 2 and 3 show detailed information about this assessment. All studies had complete outcome data and reported all anticipated outcomes. Four studies reported how the random sequence was generated[13-15, 17], while one only stated that patients were randomly allocated into two groups but did not mention how randomization

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Table 1 *Characteristics of the included studies.*

Study ID	Type of operation	Age (years)	Sex M/F	Time of SGB (before or after induction of general anaesthesia)	Treatment of the SGB group (sample size; drugs; volume)	Treatment of the control group (sample size; drugs; volume)	Time to resuming peristaltic sound	Flatus tin
Chunying Z [13]	Laparoscopic gynaecological surgery	43.57±9.06	0/41	After	Right SGB; 21; 1% Lidocaine; 2ml	Right SGB; 20; 0.9% NS; 2ml	SGB group: 22±20.298 Control group: 30.3±20.145	SGB group: 15.4±4.4; Control g 20.7±5.1
Lihua C [14]	GI surgery	57.69±9.47	41/14	Before	Left SGB; 18; 0.5% Ropivacaine; 7ml	Left SGB; 37; 0.9% NS; 7ml	SGB group: 46±31; Control group: 73±36	SGB group: 66±34; Control g 95±45
Renbo S [16]	GI surgery	62.07±15.86	43/35	Before	SGB; 39; 1% Lidocaine; 8-10ml	-	-	SGB group: 27.58±6. Control g 54.64±8.
Peng K [17]	Posterior spinal surgery	43.60±9.05	21/19	After	Right SGB; 20; 1% Lidocaine; 6ml	Right SGB; 20; 0.9% NS; 6ml	SGB group: 16.2±24.901; Control group: 32.1±24.787	SGB group: 12±4.4; group: 14.7±4.6
Yuxin S [15]	GI surgery	57.45±8.12	48/12	Before	Right SGB; 39; 1% Lidocaine; 8-10ml	-	-	SGB group: 72.15±17 Control g 85.8±20.

Data are described as the mean ± SD. Items that could not be extracted from the original articles are described as "-". SGB, stellate ganglion block; GI, gastrointestinal; NS, normal saline; h, hours.

leading to a high risk of selection and performance bias[15, 16]. Furthermore, no studies described blinding of outcome assessments. All studies had no other bias.

Postoperative flatus time

Figure 4 shows a comparison of the postoperative flatus time between the SGB and control groups. All included studies reported this outcome, but with great heterogeneity ($P<0.00001$, $I^2=98\%$). Our analysis showed an overall effect size (mean difference, MD) of -15.07 h (95% CI: -27.58, 2.56), with a Z value of 2.36 ($P=0.02<0.05$). However, as shown in Figure 5, when we deleted a study[16], the heterogeneity was reduced greatly ($P=0.02<0.05$, $I^2=71\%$), and the overall effect size (MD) became -6.77 h (95% CI: -11.67, 1.88), with a Z value of 2.71 ($P=0.007<0.05$). We think that this phenomenon was caused by the low quality of that study, as shown in Figures 1 and 3; this study did not describe how the random sequence was generated, the SG did not receive any treatment in the control group, and the side on which SGB was performed in the SGB group was not reported. Furthermore, the population in this study was the oldest among those of all five studies, and the surgery was performed to treat GI tumours. However, despite the heterogeneity, whether that study was included did not influence the effect of SGB on the postoperative flatus time.

Three of the included studies were on GI surgery[14-16], and in all of these studies, SGB was performed before the induction of general anaesthesia, so we performed an additional analysis of this group of studies, as shown in Figure 6. The overall effect size (MD) was -23.92 h (95% CI: -36.49, 11.35), with a Z value of 3.73 (P=0.0002<0.05), indicating that SGB before anaesthesia significantly shortened the time to flatus after GI surgery.

Overall, our analysis suggests that SGB can shorten the postoperative flatus time in patients undergoing different surgeries with general anaesthesia, with a mean time reduction of more than 6 h. This reduction was even more obvious in GI surgery, with a mean reduction of approximately an entire day.

Time to resumption of peristaltic sounds

Three of the included studies reported the time to resumption of peristaltic sounds after surgery; these studies were on GI, laparoscopic gynaecological and posterior spinal surgery, respectively[13, 14, 17]. However, the data were in the form of the number of patients whose bowel sounds recovered within a period of time after the operation, such as before 12 h, 24 h, 36 h, 48 h, and 72 h postoperatively. For convenience, we converted these data, as follows: the average time of the time points was used as the time to resumption of peristaltic sounds of patients in this period; thus, this outcome was also analysed as continuous. Figure 7 shows a comparison of the postoperative peristaltic sound resumption time between the SGB and control groups. As presented in Figure 7, the overall effect size (MD) was -14.67 h (95% CI: -23.21, -6.12), with a Z value of 3.36 (P=0.0008<0.05). Furthermore, the heterogeneity was low (P=0.25>0.05, I^2=28%), indicating the combined analysis of these three studies is reasonable. This outcome shows that SGB can promote GI movement after different surgeries with general anaesthesia.

Time to postoperative eating

Two of the included studies reported time of postoperative eating, with high similarity, as follows[15, 16]. First, both studies were on GI surgery. Second, SGB was performed before the induction of general anaesthesia in both studies. Third, local anaesthetics consisted of 8-10 ml of 1% lidocaine in both studies. Last, neither study had a sham group, and no treatment was applied in the control group. Figure 8 shows the data for this outcome. There was no heterogeneity between these 2 studies (P=0.80>0.05, I^2=0%). The overall effect size (MD) was -53.86 h (95% CI: -57.43, -50.29), with a Z value of 29.60 (P< 0.00001). This result suggests that in GI surgery under general anaesthesia, performing SGB before the induction of anaesthesia can significantly shorten the time to postoperative eating by more than 2 days.

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Incidence and degree of postoperative abdominal bloating

Two studies included data on the incidence and degree of postoperative abdominal bloating[13, 17]. One study was on laparoscopic gynaecological surgery[13], and the other was on GI surgery[17]. Both articles described this index by degree (mild, moderate and severe), as ranked data. To facilitate data analysis, we converted different abdominal bloating degrees to scores from 1-4, with no abdominal bloating defined as 1, mild abdominal bloating as 2, moderate abdominal bloating as 3, and severe abdominal bloating as 4, so that this variable could be analysed as continuous. As shown in Figure 9, after analysis, no heterogeneity was found (P=0.98>0.05, I^2=0%), and the overall effect size (MD) was -0.68 (95% CI: -2.96,1.61), with a Z value of 0.58 (P=0.56>0.05). However, as shown in Figure 10, if we analysed this outcome as dichotomous (whether abdominal bloating occurred), the overall effect size (odds ratio, OR) was 0.18 (95% CI: 0.06, 0.51), with a Z value of 3.22 (P =0.001<0.05). These results indicate that SGB reduced the incidence of postoperative abdominal bloating, but there was no significance between the SGB and control groups regarding the degree of abdominal bloating, suggesting that SGB might have no effect on the degree of postoperative abdominal bloating.

With the continuously increasing incidence of disease with surgical indications, the number of patients who need general anaesthesia is also increasing. As mentioned in the introduction, both surgical manipulation and analgesia, including surgical methods and sites, anaesthesia methods and analgesic drugs, blood perfusion, inflammation and neuroendocrine changes, can lead to postoperative GI dysfunction. Normally, after GI surgery, gastric motility recovers in 24-48 h, small intestinal motility in 12-24 h, and colonic motility in 3-5 days[18]. The inhibition of GI function can bring about GI dysfunction and discomfort, causing nausea, vomiting, abdominal bloating, and delayed flatus and defecation; more seriously, it could lead to systematic inflammation and even multiple organ dysfunction syndrome[19]. Such outcomes prolong the hospitalization duration and increase the cost of care, the postoperative mortality rate, and burden on both the hospital and patient.

There have been many studies aiming to explore methods to facilitate postoperative GI recovery, including the following: 1) multimodal analgesia to reduce the use of opioids, e.g., other analgesic methods and non-steroidal anti-inflammatory drugs (NSAIDs)[20, 21]. 2) laparoscopic surgery[22]; 3) goal-directed fluid therapy[22]; 4) early enteral nutrition[23]; 5) gum chewing[24]; 6) opioid receptor antagonist[25]; 7) traditional Chinese medicine[26]. All of these methods play a limited role.

We know that the digestive system is mainly governed by the autonomic nervous system. As a major stressor, surgery under general anaesthesia leads to functional changes in this system, causing stimulation of the sympathetic system, inhibition of the parasympathetic system and the release of catecholamine. Based on this thesis, sympathetic blockade might play an important role in the recovery of GI function. The blockage of cervical sympathetic nerves has a long history; this approach promotes the establishment of homeostasis via regulation of the neuro-endocrine-immune system[27], and the SG, which provides sympathetic input to the ipsilateral upper extremity, chest, face, and head, is the most commonly blockaded cervical ganglion, with wide applications[7, 8]. SGB can be applied blindly or with imaging guidance (computed tomography, ultrasound) [6, 28]. A series of local anaesthetics, such as lidocaine, bupivacaine and ropivacaine, can be chosen for reversible blockade, and neurolytic agents, such as alcohol, can be used for permanent blockade. Manifestations including Horner's syndrome, an increase in skin temperature, loss of the galvanic skin response and an increase in blood flow in the innervated areas all indicate success of the block. With the popularization of ultrasound, performing SGB under ultrasound guidance, which provides direct visualization of soft tissue structures around the sympathetic chain, appears to offer increased safety and efficacy[6].

To determine whether SGB plays a role in postoperative GI function, we performed this meta-analysis. Although the included studies had different patients undergoing different surgeries, the results still suggest that SGB can promote postoperative GI recovery in patients undergoing surgery with general anaesthesia. As shown in Figures 4-6, SGB caused a mean reduction of 15 h in the time to flatus after different surgeries; after excluding a study causing heterogeneity, the mean reduction was still greater than 6 h. further analysis of only GI surgery showed a mean reduction of approximately an entire day. Data regarding the recovery of peristaltic sounds are shown in Figure 7; the results suggest that in different surgeries, SGB can promote the recovery of regular bowl sounds earlier than the control group by 14.67 h on average. Regarding nutrients, early enteral nutrition facilitates postoperative recovery, and as indicated in Figure 8, the use of SGB in GI surgery can shorten the total parenteral nutrition time by more than 50 h. Finally, as shown in Figures 9 and 10, SGB can prevent the occurrence of postoperative abdominal bloating; however, once abdominal bloating occurs, SGB does not affect the degree. All studies included reported no complications related to SGB. SGB can be performed in different kinds of surgeries in both men and women on either the right or left and with different local anaesthetics at different volumes. Among the included studies, SGB was performed after and before the induction of anaesthesia in two and three studies, respectively. In our opinion, performing SGB before induction can provide visible evidence of block success, such as Horner's syndrome but prevents blinding of the patients and doctors, while performing SGB after induction can allow blinding but increases the difficulty of judging block efficacy. However, if the operator is skilled or can perform SGB under ultrasound guidance, performing SGB after induction is a good choice theoretically.

However, there are still some limitations to our study. First, only 5 studies were included in our analysis, limiting the subgroup analysis and yielding an inadequate sample size. These five studies were on 3 different surgeries, with only 1 or 3 studies for each kind of surgery, and thus lacked repeatability. Second, all included clinical trials were carried out in People's Republic of China, restricting the generalizability of our conclusions. Moreover, SGB is an invasive treatment, and block success needs to be verified by some manifestations, making blinding impossible; thus, the quality of the included studies was not very high.

As a result, further clinical trials of high quality are needed to confirm these results and apply SGB in other surgeries and other countries.

4. Conclusion

This meta-analysis suggests that SGB is an effective and safe method to promote postoperative recovery of GI function in patients undergoing general anaesthesia. It can reduce postoperative flatus time, promote recovery of peristaltic sounds, shorten total parenteral nutrition time after GI surgery and prevent the occurrence of postoperative abdominal bloating.

As one of the powerful tools of anaesthesiologists, could nerve blockade be used as a feasible method to promote postoperative GI function recovery?

The answer is, of course, yes, it can.

Abbreviations

SGB: stellate ganglion block; GI: gastrointestinal; ERAS: Enhanced Recovery After Surgery; SG: stellate ganglion; CRPS: complex regional pain syndrome; PHN: postherpetic neuralgia; PTSD: post-traumatic stress disorder; PRISMA: Systematic Reviews and Meta-Analyses; CNKI: China National Knowledge Infrastructure; VIP: Chinese VIP Information.

Declaration

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Ethics approval and consent to participate

Not appilcable.

Consent for publication

Not appilcable.

Availability of data and materials

All data generated or analyzed during this study are included in this published article.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

B W, Z F designed Study, B W, Y W and C Z searched and screened literature search, B W, Y W were responsible for the data extraction and analysis, B W, Y W wrote the first draft of manuscript, Z F had primary responsibility for final content. All authors read and approved the

final manuscript.

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Figures

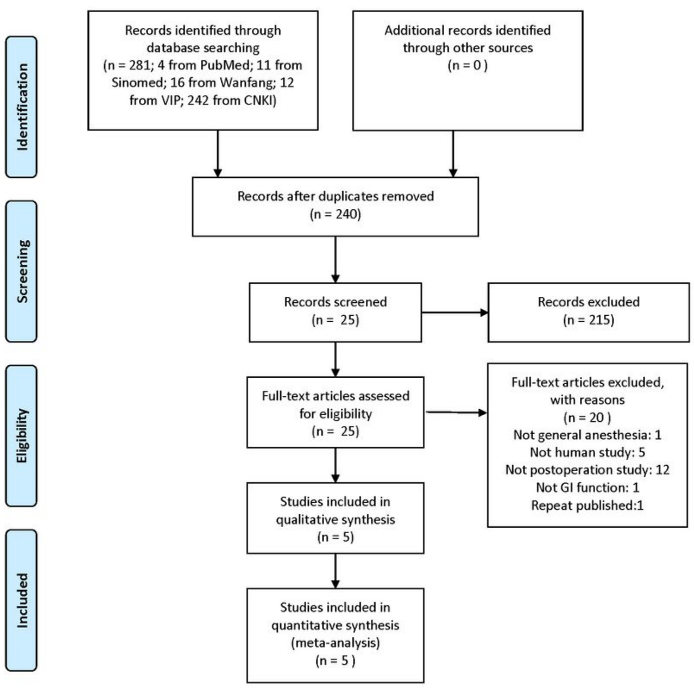

Figure 1

PRISMA flowchart of the study selection process11. CNKI, China National Knowledge Infrastructure; VIP, Chinese VIP Information; GI, gastrointestinal.

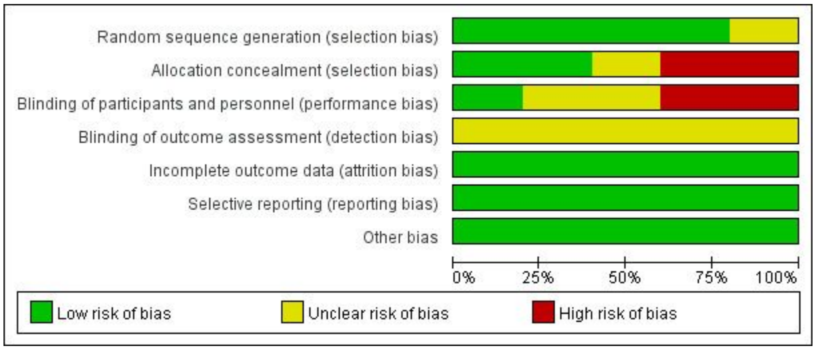

Figure 2

Risk of bias graph.

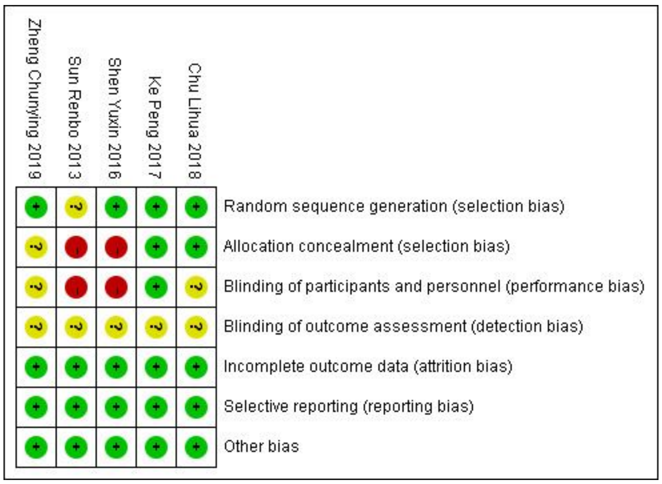

Figure 3

Risk of bias summary

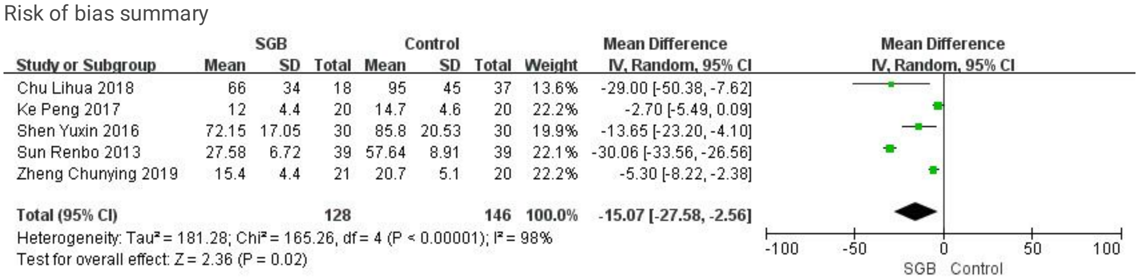

Figure 4

Comparison of postoperative flatus time between SGB and control groups.

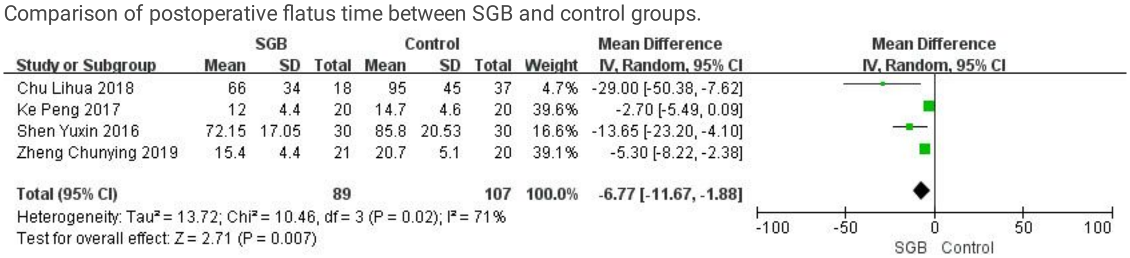

Figure 5

Comparison of postoperative flatus time between SGB and control groups after

	SGB			Control				Mean Difference
Study or Subgroup	Mean	SD	Total	Mean	SD	Total	Weight	IV, Random, 95% CI
Chu Lihua 2018	66	34	18	95	45	37	19.7%	-29.00 [-50.38, -7.62]
Shen Yuxin 2016	72.15	17.05	30	85.8	20.53	30	36.2%	-13.65 [-23.20, -4.10]
Sun Renbo 2013	27.58	6.72	39	57.64	8.91	39	44.1%	-30.06 [-33.56, -26.56]
Total (95% CI)			**87**			**106**	**100.0%**	**-23.92 [-36.49, -11.35]**

Heterogeneity: Tau² = 89.98; Chi² = 10.00, df = 2 (P = 0.007); I² = 80%
Test for overall effect: Z = 3.73 (P = 0.0002)

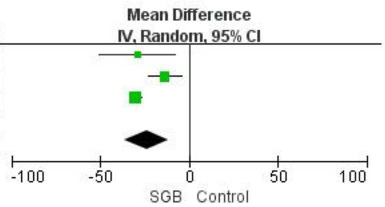

Figure 6

Comparison of postoperative flatus time between SGB and control groups.

	SGB			Control				Mean Difference
Study or Subgroup	Mean	SD	Total	Mean	SD	Total	Weight	IV, Fixed, 95% CI
Chu Lihua 2018	46	31	18	73	36	37	21.5%	-27.00 [-45.43, -8.57]
Ke Peng 2017	16.2	24.901	20	32.1	24.787	20	30.8%	-15.90 [-31.30, -0.50]
Zheng Chunying 2019	22	20.298	21	30.3	20.145	20	47.7%	-8.30 [-20.68, 4.08]
Total (95% CI)			**59**			**77**	**100.0%**	**-14.67 [-23.21, -6.12]**

Heterogeneity: Chi² = 2.76, df = 2 (P = 0.25); I² = 28%
Test for overall effect: Z = 3.36 (P = 0.0008)

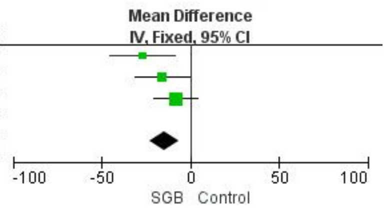

Figure 7

Comparison of time to resumption of peristaltic sound between SGB and control groups.

	SGB			Control				Mean Difference
Study or Subgroup	Mean	SD	Total	Mean	SD	Total	Weight	IV, Fixed, 95% CI
Shen Yuxin 2016	179.8	41.74	30	229.35	83.63	30	1.1%	-49.55 [-83.00, -16.10]
Sun Renbo 2013	32.46	6.29	39	86.37	9.54	39	98.9%	-53.91 [-57.50, -50.32]
Total (95% CI)			**69**			**69**	**100.0%**	**-53.86 [-57.43, -50.29]**

Heterogeneity: Chi² = 0.06, df = 1 (P = 0.80); I² = 0%
Test for overall effect: Z = 29.60 (P < 0.00001)

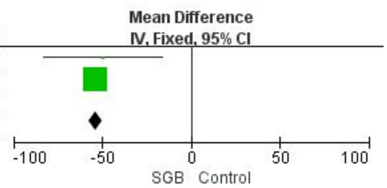

Figure 8

Comparison of time to postoperative eating between SGB and control groups.

	SGB group			Control group				Mean Difference
Study or Subgroup	Mean	SD	Total	Mean	SD	Total	Weight	IV, Fixed, 95% CI
Ke Peng 2017	1.1	5.9221	20	1.75	3.196	20	60.2%	-0.65 [-3.60, 2.30]
Zheng Chunying 2019	1.286	6.698	21	2	5.071	20	39.8%	-0.71 [-4.34, 2.91]
Total (95% CI)			**41**			**40**	**100.0%**	**-0.68 [-2.96, 1.61]**

Heterogeneity: Chi² = 0.00, df = 1 (P = 0.98); I² = 0%
Test for overall effect: Z = 0.58 (P = 0.56)

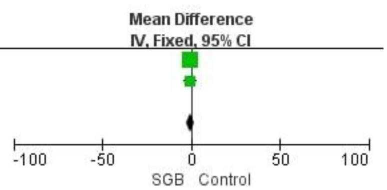

Figure 9

Comparison of postoperative abdominal bloating degree between SGB and control groups.

	SGB		Control			Odds Ratio
Study or Subgroup	Events	Total	Events	Total	Weight	IV, Fixed, 95% CI
Ke Peng 2017	2	20	9	20	38.3%	0.14 [0.02, 0.75]
Zheng Chunying 2019	5	21	12	20	61.7%	0.21 [0.05, 0.80]
Total (95% CI)		**41**		**40**	**100.0%**	**0.18 [0.06, 0.51]**
Total events	7		21			

Heterogeneity: Chi² = 0.15, df = 1 (P = 0.70); I² = 0%
Test for overall effect: Z = 3.22 (P = 0.001)

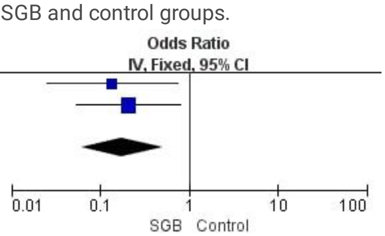

Figure 10

Comparison of the incidence of postoperative abdominal bloating between SGB and control groups.