Effects of Acupuncture on Adverse Events in Colonoscopy: A Systematic Review and Meta-analysis of Randomized Controlled Trials

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ABSTRACT

Introduction: Acupuncture has gradually penetrated into many disciplines in clinical medicine, such as surgery, anesthesia, and outpatient examinations. Although a number of clinical trials have investigated the effects of acupuncture on colonoscopy, the results were inconsistent. In this meta-analysis, we analyzed the effects of acupuncture on colonoscopy to provide evidence for subsequent research and clinical application of acupuncture in colonoscopy.

Methods: This meta-analysis was performed using Review Manager version 5.4 and Stata version 16 software. The primary outcome was the incidence of adverse events, and the secondary outcomes included patients’ anxiety score before colonoscopy, time to insert the colonoscope, total detection time, propofol consumption, patients’ pain score, and patient satisfaction rate.

Results: The results showed that the incidence of adverse events (odds ratio [OR] 0.27, 95% confidence interval [CI] 0.16–0.43, \(P = 0.00, \hat{I}^2 = 25\%\)), patients’ pain score (mean difference [MD] –1.03, 95% CI –1.45 to –0.62, \(P = 0.00, \hat{I}^2 = 94\%\)), and time to insert the colonoscope (MD = –2.54, 95% CI –4.96 to –0.13, \(P = 0.04, \hat{I}^2 = 0\%\)) were significantly lower in the treatment group than in the control group. Compared with the control group, the satisfaction rate of patients (OR 2.53, 95% CI 1.56–4.10, \(P = 0.00, \hat{I}^2 = 47\%\)) in the treatment group was significantly improved. There was no significant between-group difference in patients’ anxiety score, the total detection time, and propofol dosage.

Conclusions: During colonoscopy, acupuncture can significantly reduce the incidence of adverse events, relieve patients’ pain, and improve patient satisfaction.

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Keywords: Acupuncture; Adverse events; Colonoscopy; Meta-analysis; Systematic review

**Key Summary Points**

**Why carry out this study?**

Colonoscopy is often accompanied by a number of adverse events, including nausea, vomiting, abdominal pain, intestinal perforation, among others, some of which may be life-threatening.

The results of previous clinical studies that investigated the effects of acupuncture on colonoscopy were inconsistent.

The aim of this systematic review and meta-analysis was to comprehensively analyze the effects of acupuncture on colonoscopy.

**What was learned from the study?**

The incidence of adverse events, patients’ pain score, and the time to insert colonoscope were significantly lower in the treatment group than in the control group, and the satisfaction rate was significantly higher among patients in the treatment group.

In light of these advantages of acupuncture for colonoscopy, clinicians may consider acupuncture as a complementary or alternative approach for colonoscopy.

**INTRODUCTION**

Colonoscopy is the gold standard method for colorectal screening, and is able not only to detect the presence of lesions but also facilitate the removal of lesions [1]. Studies have shown that colonoscopic screening and colonoscopic polypectomy are associated with early detection of colorectal cancer and improved colorectal cancer survival [2–4]. This suggests that the utilization of colonoscopy should be promoted. However, colonoscopy is often accompanied by some adverse events, including nausea, vomiting, abdominal pain, intestinal perforation, among others, some of which may be life-threatening [5]. Due to the potential of adverse effects, patients are more likely to be hesitant to undergo colonoscopy and even refuse to submit to this procedure. This has led to the search for alternative strategies and methods to reduce the adverse events associated with colonoscopy in an attempt to improve patient comfort [6].

Traditional Chinese medicine is increasingly being recognized, and it has been found that acupuncture can not only alleviate the progression of some diseases [7–9], but can also be applied in the perioperative period to reduce the adverse effects related to surgery and anesthesia [10, 11]. Importantly, acupuncture has few side effects and high compliance, effectively demonstrating that it should be considered a valid alternative and/or complementary strategy [12]. A number of clinical trials have investigated the effects of acupuncture on colonoscopy, but the results of these studies were inconsistent [13–16]. Thus, whether acupuncture can optimize the colonoscopy procedure and improve patient comfort is currently unclear.

Therefore, the purpose of this review was to evaluate the effect of acupuncture on colonoscopy. The primary outcome was the incidence of adverse events, and the secondary outcomes included patients’ anxiety score before colonoscopy, time to insert colonoscope, total detection time, propofol consumption during colonoscopy, patients’ pain score after colonoscopy, and patients’ satisfaction rate after colonoscopy.

**METHODS**

**Search Strategy**

We performed a systematic search of the PubMed, Medline, EMBASE, Cochrane Library, WANFANG database, and Web of Science databases from their inception to 6 April 2022. The search items in PubMed were: (“Acupuncture”
[MeSH] OR “Manual acupuncture” OR “Electroacupuncture (EA)” OR “Five-element acupuncture” OR “Auricular acupuncture” OR “Auricular needle” OR “Laser needle” OR “Transcutaneous acupoint electrical stimulation” OR “Catgut implantation) AND (“Colonoscopy” [MeSH] OR “Colonoscopies” OR “Colonoscopic surgical procedures” OR “Colonoscopic surgical procedure” OR “Procedure colonoscopic surgical” OR “Procedures colonoscopic surgical” OR “Surgical procedure, colonoscopic” OR “Surgery, colonoscopic” OR “Surgical procedures, colonoscopic” OR “Colonoscopic surgery” OR “Colonoscopic surgeries” OR “Surgeries, colonoscopic”). Search strategies for other databases can be viewed in the Electronic Supplementary Material (ESM).

The retrieved articles were not limited by language and publication year, and we also searched the corresponding references by manually. Two reviewers independently selected the studies, and any disagreements during the selection process were resolved through discussions with a third reviewer. The kappa (κ) value was used to assess the degree of agreement between two reviewers [17].

Eligibility Criteria

We mainly included clinical trials on the effects of acupuncture on colonoscopy, with the following inclusion criteria: (1) participants: patients undergoing colonoscopy; (2) interventions: acupuncture, EA, or transcutaneous electrical acupoint stimulation (TEAS), performed before or during colonoscopy; (3) comparisons: non-acupuncture, placebo acupuncture (PA), or sham acupuncture (SA), performed before or during the colonoscopy (SA refers to the insertion of the needle into a “non-acupoint” position, PA refers to the use of placebo needles to be inserted into the same points as SA, and non-acupuncture means that the patients does not receive any intervention); (4) outcomes: incidence of adverse events, patients’ pain score, time to insert colonoscope, total detection time, propofol dosage, patients’ anxiety score, and patient satisfaction rate; (5) study design: randomized controlled trials (RCTs).

Exclusion criteria were: (1) participants: patients who also underwent other procedures during colonoscopy; (2) interventions: acupressure or acupoint injection; (3) comparisons: sham acupressure or non-acupoint injection; (4) study design: animal studies, reviews, guidelines, and case reports; (5) Chinese articles from non-core journals, with core journals defined as the major journals of a certain discipline, which contain large amounts of high-quality professional information and can represent the development level of the discipline.

Data Extraction

Two reviewers independently extracted the data from each study, and any disagreements during the extraction process were resolved through discussions with a third reviewer. When two control groups appeared in an article, we split the experimental group and made separate comparisons to the control groups. Data were extracted on the primary outcome, namely, the incidence of adverse events, and on the secondary outcomes, which included patients’ anxiety score before colonoscopy, time to insert colonoscope, total detection time, propofol consumption during colonoscopy, patients’ pain score after colonoscopy, and patients’ satisfaction rate after colonoscopy. We also extracted the following data from the included studies: title, authors, year of publication, study design, participant demographics (age, sex, sample size), type of colonoscopy, interventions, and acupoint. If there were missing data, we contacted the authors to obtain the missing data.

Risk of Bias Assessment

Bias assessment of the included studies was performed independently by two authors according to the Cochrane Handbook for Systematic Reviews of Interventions. The detailed risk of bias assessment indicators included: random sequence generation (selection bias), allocation concealment (selection bias), blinding of participants and personnel (performance bias), blinding of outcome assessment
(detection bias), incomplete outcome data (attrition bias), selective reporting (reporting bias), and other bias. Each indicator included three evaluation criteria: low risk of bias, unclear risk of bias, and high risk of bias.

**Study Quality**

The Jadad scale was used to assess the quality of studies [18], and the Grading of Recommendations, Assessment, Development and Evaluation (GRADE) methodology was used to assess the quality of evidence [19, 20].

**Statistical Analysis**

Review Manager (RevMan) version 5.4 and Stata version 16 (StataCorp LLC, College Station, TX, USA) software packages were used to perform the statistical analysis. Continuous data was calculated by mean difference (MD) and 95% confidence interval (CI), and discontinuous data was calculated by odds ratio (OR) and 95% CI. $P < 0.05$ indicated that the difference was statistically significant. We used the Chi-square ($\chi^2$) test and the $I^2$ statistic to assess heterogeneity [21]. When the result had significant heterogeneity ($I^2 > 50\%$, $P < 0.05$), we analyzed the source of heterogeneity through subgroup analysis and sensitivity analysis. In addition, we used funnel plots, Begg’s test, and Egger’s tests to assess the bias of publication. $P < 0.05$ indicated that the publication bias is statistically significant.

**Compliance with Ethics Guidelines**

This article is based on previously conducted studies and does not contain any new studies with human participants or animals performed by any of the authors.

**RESULTS**

**Search Results**

Our systematic search of the PubMed, Medline, EMBASE, the Cochrane library, WANFANG, and Web of Science databases using the abovementioned search strategy identified 243 articles of interest. Of these, 143 articles remained after Endnote automatic and manual duplicate checking. Subsequently, 107 articles whose study types did not meet the requirements were excluded. Full-text screening of the remaining 36 articles was performed, resulting in eight articles being selected for inclusion in the meta-analysis (Fig. 1) [13–16, 22–25]. The $\kappa$ value was 0.87, indicating a high degree of agreement between the two reviewers.

**Characteristics of Included Studies**

The characteristics and Jadad score of the eight RCTs included in the meta-analysis are...
| First author (year) | Study design | Type of colonoscopy | Treatment/no. of patients | Control/no. of subjects | Acupoints | Time point | Age (mean, years) | Outcomes* | Jadad score |
|---------------------|--------------|---------------------|---------------------------|-------------------------|-----------|------------|-----------------|-----------|-------------|
| Eberl (2020)[13]    | RCT          | Painless            | EA/51                     | SA/51, PA/51            | ST36, PC6, LI4 | Throughout colonoscopy | 62/65/63 | (4) (6) | 5           |
| Chen (2021)[14]     | RCT          | Painless            | TEAS/16                   | Sham TEAS/16            | PC6       | Before colonoscopy (20 min) | 71.3/71.6 | (1) (5) | 3           |
| Fanti (2003)[22]    | RCT          | Painless            | Acupuncture/10            | SA/10, no acupuncture/10 | LI4, ST36, SP6, SP9, Auricle Shenmen | Before (20 min) and throughout colonoscopy | 63/60/55 | (2) (3) (4) | 5           |
| Chen (2015)[15]     | RCT          | Painless            | TEAS/114                  | Sham TEAS/115           | EX-B2     | Before colonoscopy (30 min) | 49.2/48.2 | (1) (4) (5) | 5           |
| Ni (2009)[16]       | RCT          | Painless            | EA/30                     | No EA/30                | ST36, ST37, SP9, SP6, LI4 | Before colonoscopy (30 min) | 43.25/45.31 | (1) (3) (6) | 2           |
| Luo (2018)[23]      | RCT          | Painless            | Acupuncture/60            | No acupuncture/60       | LI4, PC6, ST36 | Before colonoscopy (30 min) | 43.8/44 | (1) (5) (7) | 3           |
| Luo (2019)[24]      | RCT          | Painless            | Acupuncture/40            | No acupuncture/40       | LI4, PC6, LI10, Ashi, ST36 | Before colonoscopy (20 min) | 48.5/48.8 | (1) (4) (5) | 3           |
| Li (1991)[25]       | RCT          | Painless            | Acupuncture/12            | No acupuncture/12, SA/12 | LI4, PC6, ST36, SP4 | Throughout colonoscopy | 50/47/55 | (4) (6) | 2           |

EA Electroacupuncture, PA placebo acupuncture, RCTs randomized controlled trials; SA sham acupuncture, TEAS transcutaneous electrical acupoint stimulation
*Outcomes: (1), incidence of adverse events; (2) patients’ anxiety score before colonoscopy; (3), time to insert colonoscope; (4), total detection time; (5), propofol consumption during colonoscopy; (6) patients’ pain score after colonoscopy; (7), patients’ satisfaction rate
The Jadad score ranged from 0 to 5. Five of the studies were conducted in China [14–16, 23, 24], and the remaining three were conducted in Germany [25], the Netherlands [13] and Italy [22], respectively. A total of 740 patients were enrolled, including 333 in the treatment groups and 407 in the control groups. Interventions in the treatment groups included acupuncture [22–25], EA [13, 16], and TEAS [14, 15]. Interventions in the control groups included SA [13, 22, 25], PA [13], sham TEAS [14, 15], no acupuncture [22–25], and no EA [16]. Six of the studies had Jadad scores ≥ 3 [13–15, 22–24]. The result of bias assessment is shown in Fig. 2.

Fig. 2 Bias assessment of included studies. a Risk of bias of each included study, b summary of risk of bias of included studies.
Results of Meta-analysis

Incidence of Adverse Events

Five studies, involving 521 patients, investigated the effects of acupuncture on the incidence of colonoscopy-related adverse events. Compared with the control group, the incidence of adverse events was significantly lower in the treatment group (Fig. 3; OR 0.27, 95% CI 0.16–0.43, \( P = 0.00, I^2 = 25\%\)).

Patients’ Anxiety Score Before Colonoscopy

One study, involving 30 patients, scored patients’ anxiety levels prior to examination. The result showed that there was no significant difference between the treatment and control groups in terms of anxiety (Fig. 4; MD = 17.09, 95% CI = 34.78 to 0.60, \( P = 0.06, I^2 = 0\%\)).

Time to Insert Colonoscope

Two studies, involving 90 patients, investigated the effects of acupuncture on the time to insert the colonoscope. According to the results (Fig. 5), the time to insert the colonoscope was significantly shorted in the treatment group than in the control group (MD – 2.54, 95% CI – 4.96 to – 0.13, \( P = 0.04, I^2 = 0\%\)).

Total Detection Time

Five studies, involving 528 patients, investigated the effects of acupuncture on the total detection time. The results showed that there was no significant difference between the treatment and control groups (Fig. 6; MD = 0.95, 95% CI = 5.70 to 3.81, \( P = 0.70, I^2 = 81\%\)).

Propofol Consumption During Colonoscopy

Four studies, involving 461 patients, investigated the effects of acupuncture on the propofol dosage (mg) during colonoscopy. According to the results (Fig. 7), there was no significant difference between the treatment and control groups (MD = 16.07, 95% CI = 40.86 to 8.72, \( P = 0.20, I^2 = 93\%\)).
Patients’ Pain Score

Four studies, involving 478 patients, investigated the effects of acupuncture on patients’ pain score. Compared with the control group, the pain score was significantly lower in the treatment group (Fig. 8; MD -1.03, 95% CI -1.45 to -0.62, \( P = 0.00, I^2 = 94\%\)).

Patients’ Satisfaction Rate

Three studies, involving 429 patients, investigated the effects of acupuncture on patients’ satisfaction rate. According to the results (Fig. 9), patients’ satisfaction rate was significantly higher in the treatment group than in the control group (OR 2.53, 95% CI 1.56–4.10, \( P = 0.00, I^2 = 47\%\)).

Subgroup Analysis and Sensitivity Analysis

Due to the significant heterogeneity in the results of total detection time, patients’ pain score, and propofol dosage, we performed subgroup analyses for these three outcomes. First, we conducted a subgroup analysis according to the different populations included in the study, and the results are shown in Fig. 10a, b. Subgroup heterogeneity in total detection time was significantly reduced, while subgroup heterogeneity in patients’ pain score remained high. This result suggests that population is the source of heterogeneity in total detection time, but not in patients’ pain score.

We then conducted subgroup analyses of patients’ pain score and propofol dosage according to the different interventions of the treatment groups. The results showed that different treatment methods were still not the source of heterogeneity in patients’ pain score and propofol dosage (Fig. 10c, d).

Finally, we performed the sensitivity analyses on the patient’s pain score and propofol dosage by excluding individual studies. After excluding each study separately, the heterogeneity of the results did not change.
significantly, suggesting that the results were credible (Fig. 11).

Publication Bias

Funnel plots, Egger’s test, and Begg’s test were used to assess the potential publication bias of included studies. The results showed that there was no publication bias in the incidence of adverse events, the total detection time, and patients’ pain score (Fig. 12).

Study Quality

The GRADE methodology was used to assess the quality of evidence, and the results are shown in Table 2. The evidence of three outcomes was of low quality, while the evidence of other four outcomes was of very low quality. Overall, the evidence for this meta-analysis was of low quality.

DISCUSSION

Colonoscopy is not only an important method for the diagnosis and treatment of colorectal diseases [26, 27], but it also is the preferred method for colorectal cancer screening [28, 29]. However, patients undergoing colonoscopy often suffer from severe abdominal pain, abdominal distension, and other uncomfortable symptoms, all of which affects the quality of colonoscopy [30, 31]. Although the use of anesthetics gives the appearance of painless colonoscopy, relieving the discomfort of patients to a certain extent, it can be accompanied by a series of adverse events, such as nausea, vomiting, and dizziness [32–34]. Therefore, it is still necessary to find a complementary method that can alleviate the adverse events of colonoscopy and have minimal side effects. Recent studies have shown that acupuncture can reduce the adverse events related to surgery and anesthesia, such as anxiety, nausea, and vomiting [10], suggesting that acupuncture

Fig. 7 Forest plot of the propofol consumption between the treatment and control groups

Fig. 8 Forest plot of patients’ pain score between the treatment and control groups
might be a potential complementary method to medication for colonoscopy.

However, several studies on the effects of acupuncture on colonoscopy have not resulted in consistent conclusions. Hence, we conducted this meta-analysis and systematic review to determine whether acupuncture can significantly reduce the incidence of colonoscopy-related adverse events. In addition, we also analyzed other outcomes, including patients’ anxiety score before colonoscopy, total detection time, time to insert colonoscope, patients’ pain score, propofol consumption, and patients’ satisfaction rate.

Eight studies satisfied the strict eligibility criteria and were ultimately included in this meta-analysis. Through a series of analyses, we found that acupuncture can significantly decrease the incidence of adverse events, shorten the time to insert the colonoscope, relieve patients’ pain, and increase patients’ satisfaction rate.

Among these, significant heterogeneity (MD = 1.03, 95% CI = 1.45 to −0.62, P = 0.00, I² = 94%) was found in the results of patients’ pain score. Through subgroup analysis, we found that differences in populations and treatment methods were not the sources of this heterogeneity. We speculated that other possible reasons for this heterogeneity would include differences in the depth of acupuncture, and differences in the interventions of the control group. It was noted that different studies did not follow the systematic acupuncture depth standards; for example, some studies did not clearly describe the acupuncture depth [15, 16]. This lack of adherence to acupuncture depth may have had an impact on the study results [35], resulting in high heterogeneity of the results. Also, there were differences in the interventions of control groups in different studies, including SA, PA, and non-acupuncture. The double-blindness of studies including an untreated control group may be compromised, which in turn affects subjective findings, including patients’ pain score. We did not perform subgroup analyses for these differences due to the limited number of included studies, but we confirmed the stability of the results by sensitivity analysis. As to the total detection time, the total MD was −0.95 (95% CI −5.70 to 3.81, P = 0.70, I² = 81%), and there was no significant difference between the two groups. When we performed subgroup analysis according to different populations, we found that acupuncture could significantly shorten the total detection time in the Asian population (MD = 5.81, 95% CI 7.41 to −4.21, P = 0.00, I² = 0%), but there was no significant difference in the total detection time in the European population (MD = 1.39, 95% CI −2.22 to 5.00, P = 0.45, I² = 37%). The patient’s comorbid illnesses, abdominal surgery experience, the level of the surgeon’s colonoscopy skills, and the definition of total detection time will all lead to different results [36, 37]. For example, Lee et al. found that a history of abdominal surgery can increase the difficulty of colonoscopy [38],

![Fig. 9](image1.png)  
**Fig. 9** Forest plot of patients’ satisfaction rate between the treatment and control groups

![Fig. 10](image2.png)  
**Fig. 10** Subgroup analysis. Subgroup analysis of the total detection time by population (a), of patients’ pain score by population (b), of patients’ pain score by treatment method (c), and of propofol consumption by treatment method (d)
### A

#### Treatment vs Control

| Study or Subgroup | Mean Difference | 95% CI         | Z  | P-value |
|-------------------|-----------------|----------------|----|---------|
| Chen 2015         | 1.08 (0.86, 1.30)| 0.59           | 0  | 0.56    |
| Li 2019           | 2.01 (1.50, 2.52)| 1.21           | 0  | 0.22    |

#### Mean Difference vs Randomized, 95% CI

| Study or Subgroup | Mean Difference | 95% CI         | Z  | P-value |
|-------------------|-----------------|----------------|----|---------|
| Chen 2015         | 1.08 (0.86, 1.30)| 0.59           | 0  | 0.56    |
| Li 2019           | 2.01 (1.50, 2.52)| 1.21           | 0  | 0.22    |

### B

#### Treatment vs Control

| Study or Subgroup | Mean Difference | 95% CI         | Z  | P-value |
|-------------------|-----------------|----------------|----|---------|
| Chen 2015         | 0.57 (0.26, 0.88)| 0.34           | 0  | 0.73    |
| Li 2019           | 1.47 (1.06, 1.88)| 0.92           | 0  | 0.35    |

#### Mean Difference vs Randomized, 95% CI

| Study or Subgroup | Mean Difference | 95% CI         | Z  | P-value |
|-------------------|-----------------|----------------|----|---------|
| Chen 2015         | 0.57 (0.26, 0.88)| 0.34           | 0  | 0.73    |
| Li 2019           | 1.47 (1.06, 1.88)| 0.92           | 0  | 0.35    |

### C

#### Treatment vs Control

| Study or Subgroup | Mean Difference | 95% CI         | Z  | P-value |
|-------------------|-----------------|----------------|----|---------|
| Li 2019           | -0.39 (-0.68, -0.10)| -0.59         | 0  | 0.56    |
| Li 2019           | -0.39 (-0.68, -0.10)| -0.59         | 0  | 0.56    |

#### Mean Difference vs Randomized, 95% CI

| Study or Subgroup | Mean Difference | 95% CI         | Z  | P-value |
|-------------------|-----------------|----------------|----|---------|
| Li 2019           | -0.39 (-0.68, -0.10)| -0.59         | 0  | 0.56    |
| Li 2019           | -0.39 (-0.68, -0.10)| -0.59         | 0  | 0.56    |

### D

#### Treatment vs Control

| Study or Subgroup | Mean Difference | 95% CI         | Z  | P-value |
|-------------------|-----------------|----------------|----|---------|
| Chen 2015         | 3.13 (2.86, 3.40)| 4.17           | 0  | 0.00    |
| Chen 2015         | 3.13 (2.86, 3.40)| 4.17           | 0  | 0.00    |

#### Mean Difference vs Randomized, 95% CI

| Study or Subgroup | Mean Difference | 95% CI         | Z  | P-value |
|-------------------|-----------------|----------------|----|---------|
| Chen 2015         | 3.13 (2.86, 3.40)| 4.17           | 0  | 0.00    |
| Chen 2015         | 3.13 (2.86, 3.40)| 4.17           | 0  | 0.00    |

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which may be related to adhesions and anatomic alteration [39]. In addition, one of the included studies did not exclude patients with a history of abdominal surgery [22], and there were more of these patients in the acupuncture group than the control group. Therefore, all of these factors may have a certain degree of influence on the final analysis of results. Similarly, these factors not only affected the detection time but also indirectly affected the consumption of propofol. To sumarize, for this study, we did not have sufficient evidence to prove that acupuncture could significantly shorten the total detection time and reduce the dosage of propofol in colonoscopy. For accurate conclusions, more high-quality RCTs are warranted to investigate these indicators.

The mechanism by which acupuncture has many beneficial effects on colonoscopy remains unclear. Traditional theories suggest that acupuncture can treat diseases by stimulating the acupoints located on the meridians to restore the balance of yin and yang in the body [40]. From the perspective of modern medicine, the mechanism of acupuncture treatment of diseases includes central and peripheral mechanisms, and mainly includes three levels: peripheral, spinal cord, and brain [41, 42]. The inhibitory effect of acupuncture on nausea and vomiting may be through the following mechanisms: (1) blocking the transmission of 5-HT₃ and increasing the release of endogenous β-endorphins in the cerebrospinal fluid [10, 43, 44]; (2) regulating the function of the vagus nerve, the secretion of hormones, and the blood circulation of the gastrointestinal tract [45]; and (3) playing an indirect preventive effect by reducing the application of opioid analgesics [46]. Zhang et al. have shown that acupuncture may exert analgesic effects through the following three levels: (1) in the periphery, acupuncture stimulation promoted the release of endogenous opioids, and then inhibited the nociception of peripheral nerve endings; (2) at the spinal level, acupuncture blocked nociceptive transmission while increasing levels of opioids, norepinephrine, and 5-HT; (3) in the brain, acupuncture worked mainly by inhibiting the production of pain sensations and emotional components [42]. The authors of a previous study also mentioned that acupuncture can promote the level of β-endorphins in the peripheral blood of patients undergoing colonoscopy [47]. However, in another study, the levels of β-endorphins in the blood of patients in the acupuncture group were found to be significantly lower than those in the control group at the end of the examination [16]. Some researchers mentioned that the research on endogenous opioids in acupuncture analgesia should not be limited to β-endorphins, but should also include enkephalins, dynorphins, among others [48]. Elevated plasma levels of β-endorphin may also be a response to stress [49]. Therefore, acupuncture analgesia may be the result of a combination of...
the above mechanisms, rather than a single regulation. Furthermore, acupuncture may stabilize hemodynamics by reducing sympathetic nerve activity and increasing parasympathetic nerve activity [50–54].

**Limitations**

This review has several limitations. First, the limited number of studies and patients included in this study makes it impossible to conduct a comprehensive and sufficient analysis. Secondly, according to the results of the study, there was significant heterogeneity in the results of patients’ pain score and propofol consumption. Although we confirmed the stability of the results by sensitivity analysis, the source of heterogeneity was ultimately not identified. This may require more RCTs to further explore the effects of acupuncture on these two outcomes. Thirdly, two of the eight studies included had a low score (<3) on the Jadad scale, which may affect the accuracy of the results. Finally, this review did not include unpublished studies, which may affect the credibility of the results. Therefore, we need to pay close attention to the latest research in this

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**Fig. 12** Funnel plots. Funnel plot for adverse events (a), total detection time (b), and patients’ pain score (c)
Table 2  Summary of the meta-analysis

| Outcomes                      | No. of studies | No. of participants | OR/MD [95% CI]       | Heterogeneity ($I^2$), % | Quality of evidence (GRADE) |
|-------------------------------|----------------|---------------------|-----------------------|--------------------------|-----------------------------|
| Incidence of adverse events  | 5              | 521                 | 0.27 [0.16, 0.43]     | 25                       | $\oplus\oplus\oplus$2 low  |
| Patients’ anxiety score before colonoscopy | 1              | 30                  | $-17.09 [-34.78, 0.60]$ | 0                        | $\oplus\oplus\oplus$#& low |
| Time to insert colonoscope   | 2              | 90                  | $-2.54 [-4.96, -0.13]$ | 0                        | $\oplus\oplus\oplus$1/#& very low |
| Total detection time         | 5              | 528                 | $-0.95 [-5.70, 3.81]$ | 81                       | $\oplus\oplus\oplus$2* very low |
| Propofol consumption during colonoscopy | 4              | 461                 | $-16.07 [-40.86, 8.72]$ | 93                       | $\oplus\oplus\oplus$2* very low |
| Patients’ pain score after colonoscopy | 4              | 478                 | $-1.03 [-1.45, -0.62]$ | 94                       | $\oplus\oplus\oplus$2* very low |
| Patients’ satisfaction rate after colonoscopy | 3              | 429                 | 2.53 [1.56, 4.10]     | 47                       | $\oplus\oplus\oplus$2 low  |

CI Confidence interval, MD mean difference, OR odds ratio

*The quality of evidence was assessed according to the GRADE method. $1$, Downgrade for serious risk of bias; $2$, downgrade for very serious risk of bias; #, downgrade for serious reporting bias (only 1 study or two studies); &, downgrade for serious imprecision (total number of participants is < 300); *, downgrade for serious inconsistency ($I^2 > 50$%)

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Having stated that, this review has numerous merits. First, this review, which included articles from both non-English and English journals, is the first study to analyze the effects of acupuncture on colonoscopy comprehensively. The findings of this review will provide a reference for the subsequent application of acupuncture in colonoscopy. Additionally, it is well known that adverse events are the major factors affecting patient satisfaction, and the occurrence of these events during examination will greatly reduce the quality of examination and increase the difficulty of examination. Therefore, we took the incidence of adverse events as the main outcome of this review, and comprehensively analyzed whether acupuncture could significantly reduce the occurrence of adverse events during colonoscopy. Finally, variables that need to be carefully controlled in future acupuncture studies with colonoscopy patients have been carefully discussed in this review.

In recent years, we found integrated traditional Chinese and Western medicine to be the general trend. The essence of integrated traditional Chinese and Western medicine is harmony in diversity, and the relationship between disease and syndrome should be viewed dialectically. The goal of integrated medicine is to maximize the advantages of traditional Chinese and Western medicine to solve medical problems. As an important part of traditional Chinese medicine, acupuncture stands out for its good therapeutic effect. Compared with other interventions, acupuncture also has the advantages of minimal side effects, low cost, and high patient compliance. Therefore, we should further study the therapeutic mechanism and potential therapeutic effect of acupuncture, and actively promote this excellent treatment method.

CONCLUSIONS

In summary, we found that acupuncture can significantly decrease the incidence of adverse events, time to insert the colonoscope, and patients’ pain score, and increase patients’ satisfaction rate. There was no significant difference between the treatment and control groups regarding patients’ anxiety score, total detection time, and anesthetics consumption. It goes without saying that due to the limited number of studies included in this meta-analysis, more RCTs need to be performed to validate the results of this study.

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Data Availability. The datasets generated during and/or analyzed during the current
study are available from the corresponding author on reasonable request.

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