Effects of walking exercise on bowel preparation in patients undergoing colonoscopy: evidence from systematic review and meta-analysis

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Abstract: Objective: This meta-analysis aimed to evaluate the effects of walking exercise on bowel preparation in patients undergoing colonoscopy.
Methods: PubMed, Web of Science, EMBASE, Ovid, The Cochrane Library, Wanfang Data, China National Knowledge Infrastructure, Chinese Science and Technology Periodical Database, and Chinese BioMedical Database were searched from their inception to January 2019. Randomized controlled trials (RCTs) and controlled clinical trials (CCTs) examining the effects of walking exercise in patients undergoing colonoscopy were considered for inclusion. After screening literature, extracting data and evaluating methodological quality, RevMan 5.3 software was used for meta-analysis.
Results: Five studies (four RCTs and one CCTs) involved 984 participants were included. The results of meta-analysis demonstrated that the walking exercise group showed significantly higher improvements in the rate of adequate bowel preparation than the control group (risk ratio [RR] = 1.28, 95% confidence interval [CI] [1.03–1.58], \( P < 0.05 \)). In addition, the walking exercise group had lower incidence of vomiting (RR = 0.39, 95% CI [0.23–0.68], \( P < 0.01 \)) and abdominal pain (RR = 0.51, 95% CI [0.29–0.90], \( P < 0.05 \)) with lower heterogeneity.
Conclusions: This systematic review and meta-analysis provided specific evidence that walking exercise during bowel preparation can improve the rate of adequate bowel preparation and reduce the incidence of vomiting and abdominal pain in patients undergoing colonoscopy. Since the conclusion of this meta-analysis was drawn based on the limited number of high-quality RCTs, more rigorous RCTs should be conducted in the future.

Keywords: exercise • colonoscopy • bowel preparation • meta-analysis

1. Introduction

Currently, colonoscopy has become the most common and effective method in the diagnosis and treatment of colorectal diseases. In the medical field, colonoscopy is universally acknowledged as the gold standard for colon cancer screening in the medical practice of 21st century. The success of colonoscopy largely depends on the quality of bowel preparation. Therefore, bowel preparation before colonoscopy has always been an important issue for clinicians and nurses. However, it was reported that in patients undergoing colonoscopy, the proportion of inadequate bowel preparation was as
Effects of walking exercise on bowel preparation in patients undergoing colonoscopy

Previous studies found that exercise could enhance gastrointestinal peristalsis and promote gastrointestinal emptying. In recent years, some researchers have applied exercise intervention to bowel preparation of patients undergoing colonoscopy, finding that the quality of bowel preparation can be improved by instructing patients to do walking exercises. However, the results of different studies were not consistent. At present, there is no systematic review focusing specifically on the effects of exercise on bowel preparation in patients undergoing colonoscopy. Therefore, this study aimed to update and critically evaluate the evidence from randomized controlled trials (RCTs) and controlled clinical trials (CCTs) that has tested the effects of walking exercise on bowel preparation in patients undergoing colonoscopy.

2. Methods

2.1. Search strategy

A literature search was conducted in a variety of electronic databases, including PubMed, Web of Science, EMBASE, Ovid, The Cochrane Library, Wanfang Data, China National Knowledge Infrastructure, Chinese Science and Technology Periodical Database, and Chinese BioMedical Database from their inception to January 2019. At the same time, this meta-analysis also manually searched the references cited in the relevant studies. The research subjects are not limited to race and country, and the literature is limited to Chinese and English. Two researchers independently searched the above-mentioned databases and checked the final retrieval results. Two researchers discussed the discrepancies and processed them. The PubMed search strategy can be seen in “Appendix A”.

2.2. Inclusion and exclusion criteria

We have established strict study criteria for inclusion and exclusion based on the participants, interventions, comparisons, outcomes, and study design principles. The inclusion criteria were as follows: (1) Participants: All of the included participants were patients undergoing bowel preparation for colonoscopy; (2) Interventions: Participants in the intervention group were given walking exercise intervention and routine nursing. The walking exercise intervention should include exercise time and frequency; (3) Comparisons: Participants in the control group received routine nursing; (4) Outcomes: The study should have reported clear outcome indicators, such as intestinal cleaning efficiency and incidence of adverse reactions; (5) Study design: a RCT or non-RCT comparative study. The exclusion criteria were as follows: (1) duplicate published literature; (2) incomplete report data, unrelated to research or unable to convert required data; and (3) review and expert opinion.

2.3. Data extraction

Two reviewers independently extracted data from the included studies based on a data extraction table. The extracted information included: (1) the first author and publication years; (2) country of study origin; (3) study designs; (4) experiment interventions (exercise time and frequency); (5) control interventions; (6) the score scale of bowel preparation; and (7) main outcomes. In addition, when reported data were insufficient, we attempted to contact the corresponding author to request missing information.

2.4. Risk of bias

Two investigators independently assessed the risk of bias for each study based on the Cochrane Risk of Bias Assessment Tool. A third investigator was consulted to resolve differences in opinions. The Cochrane Risk of Bias Assessment Tool includes seven assessment domains, including random sequence generation, allocation concealment, blinding of participants and personnel, blinding of outcome assessment, incomplete outcome data, selective reporting, and other sources of bias. Each domain was assessed as low, high, or unclear risk of bias. For the assessment of results, the study bias was classified as either “unclear,” “low risk,” or “high risk.”

2.5. Statistical analysis

In this study, Review Manager (RevMan) 5.3 software was used for meta-analysis. The specific steps are as follows: (1) Data conversion and database establishment for all studies that meet the inclusion criteria. (2) Chi-squared test and $I^2$ value were applied to
estimate the influence of heterogeneity based on the results of this meta-analysis. According to the Cochrane review guidelines, the random-effect models would be selected if the results of Heterogeneity test were $I^2 > 50\%$ and $P < 0.1$. Otherwise, the fixed-effect models would be chosen.\textsuperscript{15} (3) Combining effect values and drawing forest plot. The risk ratio (RR) and weighted mean difference were used for dichotomous variables and continuous variables, respectively, with a corresponding 95% confidence interval (CI) used to compare the outcomes between the walking exercise and the control groups.

3. Results

3.1. Search results and included studies

Our literature search generated 431 results based on the utilized search terms. A total of 212 studies remained after duplicates were removed. A further 201 studies were excluded after screening the titles and abstracts. The full texts of 11 studies were assessed, while 6 studies were excluded for the following reasons: 1 article contained outcome variables that were different from the interest of this review, interventions in four articles did not meet the requirements, and one article did not have a routine control group. Finally, 5 studies involving 984 participants were included in this meta-analysis (Figure 1).

3.2. Description of the included studies

A description of the included studies is reported in Table 1. The meta-analysis include five articles, with a total sample size of 984 (496 in the intervention group and 488 in the control group). Most of the include studies were RCTs, except for one CCT. The research areas of included studies were focused mainly in China and Korea, and all studies compared a co-intervention of walking exercise and routine care with a control of routine care alone. Baseline characteristics of included studies are summarized in Table 1.

3.3. Risk of bias assessment

The risk of bias in each randomized clinical trial was evaluated by the Cochrane Collaboration’s risk of bias assessment tool\textsuperscript{14} and summarized in Figure 2 and Figure 3. Four RCTs\textsuperscript{10–13,16} reported the random sequence generation in detail, and one article\textsuperscript{10} conducted the concealment of allocation by using a list of computer-generated random numbers. Because of the intervention feature, blinding of participants and personnel to the intervention is impracticable. Thus, only one article\textsuperscript{10} clearly reported the implementation of personnel blinded. Three articles\textsuperscript{10,13,16} performed endoscopist-blinding methods, whereas others did not mention blindness to the endoscopists. All of included studies had low selective reporting bias risk and did not have the missing data. The risk of other bias was considered not present. Allocation concealment was the most common factor for the risk of bias.

3.4. Meta-analysis

3.4.1. The rate of adequate bowel preparation

All included studies\textsuperscript{10–13,16} compared the effects of walking exercise and routine nursing on intestinal cleaning efficiency, and 984 subjects were included. When all the studies were summarized, we found that 311 of 496 patients receiving exercise intervention had adequate bowel preparation, while 238 of 488 patients receiving routine bowel preparation were effective. Heterogeneity test showed that the results of the study were heterogeneous, and a meta-analysis was carried out with random-effect model. Meta-analysis results showed that RR = 1.28, 95% CI [1.03–1.58]. After Z-test for overall effect, it was found that $Z = 2.25 (P = 0.02)$, indicated that walking exercise during bowel preparation can improve the rate of adequate bowel preparation in patients undergoing colonoscopy (Figure 4).

3.4.2. The incidence of vomiting

Three studies\textsuperscript{11–13} reported the number of patients with vomiting symptoms during bowel preparation. There were 408 subjects: 204 in the intervention group and 204 in the control group. The result of heterogeneity test was $I^2 = 0\% (P > 0.1)$, which indicated that there was no heterogeneity. Meta-analysis was carried out using the fixed-effect model. The results showed that RR = 0.39, 95% CI [0.23–0.68]. Z-test was performed for the overall effect, and the result was $P < 0.001$, suggesting that walking exercise during bowel preparation can reduce the incidence of vomiting (Figure 5).

3.4.3. The incidence of abdominal pain

Four studies reported\textsuperscript{11–13,16} the number of cases with abdominal pain during bowel preparation, and 628 subjects were included. The incidence of abdominal pain was 5% (16/314) in the intervention group and 10% (32/314) in the control group. The result of heterogeneity test was $I^2 = 1\% (P > 0.1)$. Therefore, we used the fixed-effect model to conduct meta-analysis. The results
showed that RR = 0.51, 95% CI [0.29–0.90]. The Z-test for the overall effect was Z = 2.33 (P = 0.02), suggesting that walking exercise during bowel preparation can reduce the incidence of abdominal pain (Figure 6).

3.4.4. Willingness to accept the same bowel preparation again

There was only one study assessing the willingness to accept the same bowel preparation in the future. The result of this trial showed that the bowel preparation preference for future colonoscopy in the exercise group was significantly higher than that in the routine group ($X^2 = 8.455, P = 0.004$).

4. Discussion

To our knowledge, this is the first meta-analysis about the impact of walking exercise on bowel preparation.
in patients undergoing colonoscopy. This systematic review and meta-analysis provided evidence to support the effectiveness of walking exercise on bowel preparation; it is hoped that walking exercise will be applied and popularized in bowel preparation in the future.

In this study, several studies were combined and analyzed. The results showed that walking exercise could improve the rate of adequate bowel preparation, which was consistent with the results of most RCTs. In addition, a number of investigations have also confirmed this conclusion. A survey conducted by Zhang et al.\(^\text{17}\) showed that the quality of bowel preparation was closely related to walking time during medication. The longer the patient walks, the better the intestinal cleanliness. (OR 0.350, 95% CI [0.205–0.598], \(P=0.000\)).

Hu et al.\(^\text{18}\) explored the correlation between walking function and intestinal preparation quality in elderly patients undergoing colonoscopy. This study found that there was a positive correlation between walking function and intestinal cleaning quality in elderly patients \((r=0.177, P<0.05)\). The adequacy rate of bowel preparation in the walking difficulty group was significantly lower than that in the walking normal group \((55.8\% \text{ vs } 72.8\%, P<0.05)\). The possible reason is that walking exercise promotes the digestive gland secretion as well as the digestive tract movement and speeds up the gastrointestinal emptying, thereby improving the intestinal cleanliness of patients.\(^\text{19}\)

| Study         | Country | Design | Intervention group (Regimen)                                                                 | Control group (Regimen) | Prep score | Main outcomes                                                                 |
|---------------|---------|--------|---------------------------------------------------------------------------------------------|-------------------------|------------|--------------------------------------------------------------------------------|
| Kim et al.    | Korea   | RCT    | Drink 250 mL of PEG solution and then walk at least for 5 min at intervals of 10 min \((n=182)\) | Routine care \((n=174)\) | Grade score | a. The quality of bowel preparation \n
| Fang et al.   | China   | RCT    | Walk 30 min after each meal 3 days before the colonoscopy and walk for 1 h after taking the medicine on the day of colonoscopy \((n=34)\) | Routine care \((n=34)\) | Grade score | a. The quality of bowel preparation \nb. Incidence of adverse reactions |
| Chen et al.   | China   | RCT    | Drink 250 mL of PEG solution and then walk at least for 200 steps \((n=60)\) | Routine care \((n=60)\) | BBPS       | a. The quality of bowel preparation \nb. Incidence of adverse reactions |
| Zhang et al.  | China   | CCT    | Drink 600 mL of PEG solution and then walk for 15 min \((n=110)\) | Routine care \((n=110)\) | OBPS       | a. The quality of bowel preparation \nb. Incidence of adverse reactions \nc. Willingness to accept the same bowel preparation again |
| Qin et al.    | China   | RCT    | Walk more than 10 min after ingesting each liter of PEG solution \((n=110)\) | Routine care \((n=110)\) | BBPS       | a. The quality of bowel preparation \nb. Incidence of adverse reactions |

Notes: OBPS, Ottawa bowel preparation score; BBPS, Boston bowel preparation score; RCT, Randomized controlled trial; CCT, Controlled clinical trial.

Table 1. Baseline characteristics of included studies.

Figure 2. Risk of bias graph: reviewers’ judgments about each risk of bias item presented as percentages across all included studies.
At present, several studies indicate that patients who receive colonoscopy are prone to poor tolerance and adverse reactions due to taking a large number of bad-tasting purgatives during bowel preparation. Chan et al.\textsuperscript{20} found that 19.7% of patients with colonoscopy had abdominal pain and 16.4% had vomiting during bowel preparation. Once adverse reactions occur during bowel preparation, it may result in incomplete medication, significantly reducing the quality of bowel preparation.\textsuperscript{21} Our meta-analysis showed that after taking large doses of solution, walking exercise during bowel preparation can reduce the incidence of abdominal pain and vomiting. The main reason for this was that walking exercise can promote the blood circulation of digestive organs. By enhancing the secretion of digestive glands and the movement of digestive ducts, it can accelerate the absorption and excretion of bowel-cleansing agents, thus significantly improve the tolerance and comfort of patients during bowel preparation.

This study has some limitations. First, the studies and sample size included in this meta-analysis are relatively small, and the power of our research may be overestimated to some extent. Second, most of the studies included are deficient in allocation concealment, and one study does not satisfy random sequence generation, so some bias may occur. Furthermore, since most of the studies we have included originated in China, our findings may have some limitations. Finally, due to the different intervention schemes in different studies, no further subgroup analysis has been done in our meta-analysis. Therefore, for the frequency and duration of walking exercise, we need rigorous RCTs to draw more accurate and reliable conclusions in the future.

5. Conclusions

In conclusion, this systematic review and meta-analysis provided specific evidence that walking exercise during bowel preparation can improve the rate of adequate bowel preparation and reduce the incidence of vomiting and abdominal pain in patients undergoing colonoscopy. However, since the conclusion of this meta-analysis was drawn based on the limited number of high-quality RCTs, the results of this study should be carefully evaluated. The effects and safety of walking exercise for bowel preparation in patients undergoing colonoscopy still need the support of clinical multicenter, large-sample RCTs in the future. In addition, considering that the current walking program has not yet been unified, in-depth exploration is urgently required.
Ethics approval

Ethical issues are not involved in this article.

Conflicts of interest

All contributing authors declare no conflicts of interest.

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Appendix A. Search strategies

PUBMED
#1 “Exercise” [Mesh]
#2 Exercises
#3 Physical Activity
#4 Activities, Physical
#5 Activity, Physical
#6 Physical Activities
#7 Exercise, Physical
#8 Exercises, Physical
#9 Physical Exercise
#10 Physical Exercises
#11 Acute Exercise
#12 Acute Exercises
#13 Exercise, Acute
#14 Exercises, Acute
#15 Exercise, Isometric
#16 Exercises, Isometric
#17 Isometric Exercises
#18 Isometric Exercise
#19 Exercise, Aerobic
#20 Aerobic Exercise
#21 Aerobic Exercises
#22 Exercises, Aerobic
#23 Exercise Training
#24 Exercise Trainings
#25 Training, Exercise

#26 Trainings, Exercise
#27 #1 OR #2 OR #3 OR #4 OR #5 OR #6 OR #7
OR #8 OR #9 OR #10 OR #11 OR #12 OR #13
OR #14 OR #15 OR #16 OR #17 OR #18 OR
#19 OR #20 OR #21 OR #22 OR #23 OR #24
OR #25 OR #26
#28 “Colonoscopy” [Mesh]
#29 Colonoscopies

#30 Colonoscopic Surgical Procedures
#31 Colonoscopic Surgical Procedure
#32 Procedure, Colonoscopic Surgical
#33 Procedures, Colonoscopic Surgical
#34 Surgical Procedure, Colonoscopic
#35 Surgery, Colonoscopic
#36 Surgical Procedures, Colonoscopic
#37 Colonoscopic Surgery

#38 Colonoscopic Surgeries
#39 Surgeries, Colonoscopic
#40 #28 OR #29 OR #30 OR #31 OR #32 OR #33
OR #34 OR #35 OR #36 OR #37 OR #38 OR #39
#41 #27 AND #40
#42 randomized controlled trial[pt] OR con-
trolled clinical trial[pt] OR randomized[tiab] OR
placebo[tiab] OR clinical trials astopic[mesh: noexp]
OR randomly[tiab] OR trial[ti]
#43 #41 AND #42