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Compound polyethylene glycol electrolyte powder-based bowel preparation protects the intestinal barrier: A retrospective controlled study

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Abstract: **Background**: Preoperative bowel preparation is a crucial perioperative step in gastrointestinal surgery. Traditional mannitol combined with soap enema regimens can easily damage the intestinal mucosa and disrupt the intestinal barrier. Compound polyethylene glycol electrolyte powder (PGEP) has the potential to protect the intestinal barrier; however, multidimensional clinical evidence remains limited. **Objectives**: From the perspective of intestinal barrier protection, this study compares the effects of PGEP and traditional regimens in elective gastrointestinal surgery, analyzing their influence on the intestinal barrier, microecology, stress, intestinal function and anastomotic healing. **Methods**: In this retrospective controlled study, 100 patients undergoing elective surgery at the Department of Gastrointestinal Surgery, Wenzhou Central Hospital, from June 2021 to June 2024 were allocated into an observation group (PGEP group, n=50;28 males, 22 females) and a control group (traditional regimen group, n=50;26 males, 24 females;) Patients were assigned to groups according to the bowel preparation regimen used in routine clinical practice. Relevant laboratory indicators were measured and clinical outcomes were recorded. **Results**: The primary endpoint, serum diamine oxidase (DAO) level on the 1st day after surgery, was significantly lower in the observation group than in the control group ($p < 0.05$). For the secondary endpoints, the observation group also showed superior bowel preparation quality (assessed by BBPS), better preservation of intestinal barrier function, greater gut microbiota stability (higher fecal short-chain fatty acids and more stable pH), a reduced stress response, faster recovery of intestinal function, reduced anastomotic edema, a higher primary healing rate and a lower overall postoperative complication rate (all $p < 0.05$). **Conclusion**: PGEP is clinically superior to traditional methods for preoperative bowel preparation in elective gastrointestinal surgeries. It effectively protects the intestinal mucosal barrier, stabilizes the gut microbiota and reduces stress, aligning with the principles of enhanced recovery after surgery (ERAS) and these results suggest potential clinical value.

Keywords: Anastomotic healing; Bowel function recovery; Compound polyethylene glycol electrolyte powder; Gut microbiota; Intestinal barrier; Preoperative bowel preparation; Stress response

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INTRODUCTION

Perioperative management of gastrointestinal surgery has evolved from simply ensuring surgical safety to protecting organ function, maintaining intestinal homeostasis and accelerating postoperative recovery (Marian *et al*., 2025). As an important digestive, immune and microecological organ, the integrity of the intestinal mucosal barrier and the stability of the internal environment directly determine the intensity of postoperative inflammatory response, tissue repair efficiency and the risk of complications (Wang *et al*., 2026). Traditional preoperative bowel preparation often uses oral mannitol combined with soap enema. Although it can clear intestinal contents to a certain extent, it is prone to mechanical and chemical damage to the intestinal mucosa. At the same time, the fermentation and gas production of mannitol in the colon can increase intestinal pressure, reduce local mucosal perfusion and further damage the integrity of the intestinal mucosal epithelium, thereby increasing intestinal permeability, bacterial and endotoxin translocation, inducing excessive systemic inflammation and stress response, ultimately delaying the recovery of intestinal function, increasing poor anastomotic healing and increasing the risk of postoperative infection (Vecchi *et al*., 2025). Compound PGEP, as an isotonic, non-absorbable and low-irritant intestinal cleanser, can achieve whole-intestinal cleansing through physiological peristalsis and has minimal interference with the internal environment. Theoretically, it can maximize the protection of the intestinal mucosal barrier and intestinal homeostasis (Meine *et al*., 2026).

Previous studies on preoperative bowel preparation have largely focused on simple comparisons of cleansing efficacy and conventional inflammatory markers. However, they lack a multi-dimensional systematic analysis that integrates intestinal barrier protection with microecological indicators, stress response, bowel function recovery and anastomotic repair (Saggu *et al*., 2025). This retrospective controlled study addresses this gap by comprehensively comparing the clinical differences between compound PGEP and traditional intestinal preparation protocols, thereby providing evidence-based support for optimizing perioperative bowel preparation strategies in gastrointestinal surgery.

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MATERIALS AND METHODS

Study subjects

One hundred patients undergoing elective gastrointestinal surgery at the Department of Gastrointestinal Surgery, Wenzhou Central Hospital, from June 2021 to June 2024 were selected. Baseline characteristics, including gender, age and surgical types, were comparable between the two groups (p>0.05). Gender distribution was well balanced: 28 males and 22 females in the observation group and 26 males and 24 females in the control group, with no significant difference (χ^2=0.163, p=0.686).

Inclusion criteria: Age 18–75 years, ASA classification I–III; diagnosed by endoscopy and imaging and scheduled for elective gastrointestinal surgery; no severe infection or systemic inflammatory response syndrome preoperatively; good tolerance to oral bowel preparation medications and good clinical compliance.

Exclusion criteria: Emergency surgery due to acute intestinal obstruction, gastrointestinal perforation, or massive bleeding; severe dysfunction of vital organs such as the heart, liver, kidneys, or lungs; allergy to components of compound PGEP, mannitol, soap solution, etc.; pregnant or lactating women; use of glucocorticoids, immunosuppressants, or other medications that may affect intestinal function and inflammatory status within one week prior to surgery.

This was a retrospective controlled study and the sample size was determined according to the number of eligible patients admitted to our department within the study period. A total of 100 eligible patients were enrolled and allocated into two groups with 50 cases in each group at a 1:1 ratio. Baseline demographic and clinical characteristics were comparable between the two groups, ensuring the rationality and basic statistical efficiency of the sample size for inter-group comparison.

Gender-based difference analysis

No significant gender-based differences were observed in this study. Gender distribution was balanced at baseline (p = 0.686). Subgroup analyses by gender showed consistent results in bowel cleanliness, intestinal barrier function, stress response, intestinal function recovery, anastomotic healing and postoperative complication rates. The beneficial effects of PGEP were consistent in both male and female patients, with no significant gender–treatment interaction. Gender had no significant impact on the efficacy and safety of preoperative bowel preparation.

Grouping and intervention plan

The 100 enrolled patients were allocated into an observation group (PGEP group, n=50; 28 males, 22 females) and a control group (traditional regimen group, n=50; 26 males, 24 females) according to the actually implemented preoperative bowel preparation regimen in clinical practice. No prospective randomization or allocation concealment was performed. Outcome assessors were blinded to group assignment during the retrospective review of medical records and endoscopic images. All patients received standardized preoperative preparation, surgical procedures and postoperative care following the same institutional protocol to control performance bias. The preoperative dietary management plan was the same for both groups: a low-residue diet for 3 days preoperatively, a full liquid diet for 1 day preoperatively, no solid food for 6 hours preoperatively and no oral clear drinks for 2 hours preoperatively.

The observation group received compound PGEP orally for bowel preparation. Starting at 14:00 1 day preoperatively, one box of the medication was dissolved in 1000 mL of warm water and the patient was instructed to drink it evenly over 1 hour. This process was repeated after 1 hour, with a total water intake of 2000 mL. After taking the medication, patients were instructed to get out of bed and move around appropriately until they passed clear, watery, residue-free stools.

The control group received a traditional bowel preparation protocol. One day before surgery, at 3:00 PM, patients received 250 mL of 20% mannitol injection orally, followed by 1500–2000 mL of warm water within 30 minutes. One day before surgery, at 8:00 PM and two hours before surgery, patients received a cleansing enema with 500 mL of 0.1%–0.2% soapy water until the excrement was clear and free of residue.

Surgical procedures and observation indicators

All surgeries were performed by the same team of senior gastrointestinal surgeons. Anesthesia type, anesthetic agents, dosage and depth of anesthesia were standardized and consistent across all patients to minimize anesthetic-related stress variation. Surgical duration, incision size and operative trauma level were strictly controlled and comparable between groups (p > 0.05). Anesthesia methods, surgical procedures, anastomosis techniques, postoperative anti-infection and fluid support protocols were all consistent.

Serum diamine oxidase (DAO), D-lactic acid and endotoxin were selected as indicators to evaluate intestinal barrier function and all detections were performed in the clinical laboratory of our hospital following routine clinical protocols (consistent with the retrospective nature of this study). The specific assay methods and kits were as follows: DAO was detected by colorimetric method using the DAO assay kit (Cat. No.: A088-1-1, Nanjing Jiancheng Bioengineering Institute, Nanjing, China), with a detection wavelength of 540 nm, operated strictly according to the kit instructions. D-lactic acid was detected by enzyme-linked immunosorbent assay (ELISA) using the D-lactic

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acid ELISA kit (Cat. No.: E-EL-H0139c, Elabscience Biotechnology Co., Ltd., Wuhan, China), with a detection wavelength of 450 nm and quantitative calculation was performed by the standard curve method. Endotoxin was detected by limulus amebocyte lysate (LAL) chromogenic method using the endotoxin detection kit (Cat. No.: PYJ02, Wuxi Puyi Biotechnology Co., Ltd., Wuxi, China), with a detection wavelength of 545 nm and the concentration was calculated according to the standard curve. All detections were performed by professional laboratory technicians following unified standard operating procedures to ensure the reliability of detection results.

The observation indicators included: (1) Bowel cleanliness quality, assessed blinded by a specialist using the Boston Bowel Preparation Scale (BBPS); (2) Intestinal barrier function indicators, measured at serum DAO, D-lactic acid and endotoxin levels 1 day preoperatively, 1 day postoperatively and 3 days postoperatively; (3) Microecological indicators, including fecal acetic acid, propionic acid (short-chain fatty acids, SCFAs, measured by HPLC) and fecal pH (measured by pH meter), determined 1 day preoperatively and 3 days postoperatively; (4) Body stress indicators, measured at serum cortisol and fasting blood glucose levels 1 day preoperatively and 1 day postoperatively; (5) Bowel function recovery indicators, recording the time to first flatus, first defecation and tolerance to a liquid diet postoperatively; (6) Anastomotic repair status, assessed by anastomotic edema score 3 days postoperatively and blinded healing grading 7–10 days postoperatively; (7) Postoperative complications, recording the occurrence of anastomotic leakage, abdominal infection, incision infection, intestinal obstruction and electrolyte disturbances within 7 days postoperatively and calculating the total complication rate; (8) Preparation-related adverse events (nausea, vomiting, abdominal bloating, abdominal pain, oral intolerance and electrolyte disturbances) were recorded and compared between groups.

Bowel cleanliness was evaluated by the Boston Bowel Preparation Scale (BBPS), which is the most widely used and validated scale for assessing bowel preparation quality. Given the retrospective nature of this study, the BBPS assessment was conducted as a retrospective review of endoscopic images and medical records collected during the study period, with no prospective random selection of cases for assessment. The assessment was performed by two independent gastrointestinal specialists who were unaware of patient group allocation (blinded retrospective review) to avoid assessment bias. Prior to formal BBPS assessment, the two specialists received standardized training on BBPS scoring criteria. The training included systematic learning of the scoring rules (0–3 points for each colonic segment, total score 0–9 points), review of standardized scoring examples with typical endoscopic images and joint calibration of 20 randomly selected retrospective cases (from the enrolled patients) to unify scoring standards. Interobserver variability was quantified by calculating the kappa coefficient, which showed substantial agreement between the two assessors (kappa = 0.82, $p < 0.001$), confirming the reliability of the BBPS assessment results.

To clarify the interpretation of study results, primary and secondary endpoints were clearly defined. The primary endpoint was intestinal barrier function assessed by serum DAO level on the 1st day after surgery, which is a commonly used marker of intestinal mucosal injury and permeability, consistent with the core objective of this study (evaluating intestinal barrier protection of PGEP bowel preparation). Secondary endpoints included: (1) Bowel cleanliness evaluated by BBPS; (2) Intestinal microecological indicators (fecal acetic acid, propionic acid, fecal pH); (3) Systemic stress markers (serum cortisol, fasting blood glucose); (4) Postoperative bowel function recovery time (time to first flatus, first defecation, liquid diet tolerance); (5) Anastomotic edema score, anastomotic healing grade and postoperative complications.

Statistical analysis

SPSS 26.0 was used for analysis. Continuous variables were tested for normality using the Shapiro–Wilk test and are expressed as mean ± SD or median (IQR), with comparisons made by t-test or Mann–Whitney U test as appropriate. Categorical variables were compared using the χ^2 test. Repeated measurements were analyzed using repeated-measures ANOVA with Bonferroni correction. All tests were two-sided and $p < 0.05$ was considered statistically significant.

RESULTS

Baseline characteristics

Baseline characteristics (age, sex, surgical type and ASA classification) were comparable between the two groups (all $p > 0.05$, as shown in table 1).

Comparison of Bowel cleanliness between the two groups

The observation group had significantly better bowel preparation quality than the control group, as reflected by higher BBPS scores ($p < 0.05$; table 2).

Comparison of intestinal barrier markers between the two groups

The observation group had significantly better intestinal barrier function than the control group, as shown by lower postoperative levels of DAO, D-lactic acid and endotoxin (all $p < 0.05$; table 3).

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Table 1: Comparison of baseline characteristics between the two groups ($\bar{x}$±s).

Characteristic	Observation group (n=50)	Control group (n=50)	χ^2/t	*P*
Age (years), Mean ± SD	58.4 ± 12.7	60.1 ± 11.5	t = -0.702	0.484
Sex, n (%)			χ^2 = 0.163	0.686
Male	28 (56.0)	26 (52.0)		
Female	22 (44.0)	24 (48.0)		
ASA classification, n (%)			χ^2 = 0.154	0.926
I	15 (30.0)	16 (32.0)		
II	25 (50.0)	23 (46.0)		
III	10 (20.0)	11 (22.0)		
Diagnosis type, n (%)			χ^2 = 0.413	0.982
Stomach cancer	18 (36.0)	17 (34.0)		
Colorectal cancer	20 (40.0)	21 (42.0)		
Perforated peptic ulcer	7 (14.0)	6 (12.0)		
Intestinal obstruction	5 (10.0)	6 (12.0)		
Surgical procedure, n (%)			χ^2 = 0.160	0.983
Gastrectomy	18 (36.0)	17 (34.0)		
Colectomy	20 (40.0)	21 (42.0)		
Repair of perforation	7 (14.0)	6 (12.0)		
Enterectomy/obstruction relief	5 (10.0)	6 (12.0)		

Note: Data are presented as Mean ± SD or n (%). SD, standard deviation; ASA, American Society of Anesthesiologists. χ^2 test was used for categorical variables and t-test for continuous variables. All tests were two-sided, and $\alpha = 0.05$ was considered significant. Global comparisons for all baseline characteristics showed **P** > 0.05, indicating comparability between groups.

Table 2: Comparison of intestinal cleanliness quality between the two groups ($\bar{x}$±s).

Group	n	BBPS total score	Excellent cleaning rate [n (%)]
Observation group	50	8.12±1.06*	48 (96.00)*
Control group	50	6.65±1.13	40 (80.00)

Note: * indicates $p < 0.05$ vs. control group.

Table 3: Comparison of intestinal barrier function indicators between the two groups ($\bar{x}$±s).

Index	Group	1 day before surgery	Postoperative day 1	Postoperative day 3
DAO (U/L)	Observation group	5.12±1.06	12.36±2.15*	8.25±1.63*
	Control group	5.18±1.09	18.69±3.22	13.56±2.41
D-lactic acid (mmol/L)	Observation group	0.36±0.08	0.89±0.15*	0.52±0.11*
	Control group	0.38±0.09	1.36±0.21	0.93±0.16
Endotoxin (EU/mL)	Observation group	0.15±0.04	0.42±0.09*	0.23±0.06*
	Control group	0.16±0.05	0.68±0.12	0.41±0.08

Comparison of intestinal micro ecological indicators between the two groups

The observation group had significantly better gut microbiota stability than the control group, as shown by higher fecal short-chain fatty acids (acetic acid and propionic acid) and more stable fecal pH (all $p < 0.05$; table 4).

Comparison of Stress markers between the two groups

The observation group had significantly lower stress responses than the control group, as shown by lower postoperative serum cortisol and fasting blood glucose levels both $p < 0.05$; table 5.

Comparison of bowel function recovery between the two groups

The observation group had a significantly shorter time to liquid diet tolerance than the control group ($p < 0.05$; table 6). For other recovery indicators (time to first flatus and time to first defecation), no significant intergroup differences were observed (Table 6).

Comparison of anastomotic healing and edema between the two groups

The observation group had significantly less anastomotic edema and a higher rate of Grade A healing than the control group (both $p < 0.05$; table 7).

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Table 4: Comparison of microecological related indicators between the two groups ($\bar{x}$±s).

Index	Group	1 day before surgery	Postoperative day 3
Acetic acid (mmol/g)	Observation group	32.6±5.1	26.8±4.2*
	Control group	31.9±4.9	18.3±3.5
Propionic acid (mmol/g)	Observation group	12.3±2.1	9.6±1.8*
	Control group	11.9±2.0	6.2±1.4
Fecal pH	Observation group	6.1±0.3	6.4±0.3*
	Control group	6.2±0.3	7.1±0.4

Note: * indicates $p < 0.05$ vs. control group.

Table 5: Comparison of stress indicators between the two groups ($\bar{x}$±s).

Index	Group	Preoperative	Postoperative day 1
Cortisol (nmol/L)	Observation group	386±42	569±63*
	Control group	391±45	725±71
Fasting blood glucose (mmol/L)	Observation group	5.1±0.4	6.8±0.5*
	Control group	5.2±0.4	8.3±0.7

Note: * indicates $p < 0.05$ vs. control group.

Table 6: Comparison of bowel function recovery time between the two groups (h, $\bar{x}$±s).

Group	n	First exhaust	First bowel movement	Liquid diet tolerance
Observation group	50	32.6±6.1	48.5±8.2	24.3±3.5*
Control group	50	47.9±7.3	69.3±9.5	36.8±4.2

Note: * indicates $p < 0.05$ vs. control group.

Table 7: Comparison of anastomotic edema and healing between the two groups ($\bar{x}$±s).

Group	n	Edema score ($\bar{x}$±s)	Grade A healing [n (%)]	Grade B healing [n (%)]	Grade C healing [n (%)]
Observation group	50	1.12±0.31*	47 (94.00)*	2 (4.00)	1 (2.00)
Control group	50	2.35±0.42	39 (78.00)	7 (14.00)	4 (8.00)

Note: Anastomotic healing was graded as A (best), B (moderate), or C (worst) based on endoscopic and clinical assessment at postoperative days 7–10. * indicates $p < 0.05$ vs. control group.

Table 8: Comparison of postoperative complications between the two groups [n (%)].

Group	n	Anastomotic leakage	Abdominal infection	Surgical site infection	Intestinal obstruction	Electrolyte imbalance	Total complications
Observation group	50	0 (0.00)	1 (2.00)	1 (2.00)	0 (0.00)	1 (2.00)	3 (6.00)*
Control group	50	2 (4.00)	3 (6.00)	3 (6.00)	2 (4.00)	1 (2.00)	11 (22.00)

Note: * indicates $p < 0.05$ vs. control group.
Electrolyte disturbance was defined as serum potassium < 3.5 mmol/L or sodium < 135 mmol/L occurring within 7 days postoperatively.

Adverse events

The most common adverse events were bloating, abdominal discomfort and mild nausea, all significantly less frequent in the observation group than in the control group ($p < 0.05$). Electrolyte disturbances and oral intolerance were rare and mild in both groups, with no significant intergroup difference ($p > 0.05$). All adverse events were mild to moderate and resolved spontaneously without special treatment.

Postoperative complications

The observation group had a significantly lower overall postoperative complication rate than the control group (6/50, 12.0% vs. 14/50, 28.0%; $\chi^2 = 4.000$, $p = 0.046$; table 8). Individual complication types, including anastomotic leakage, abdominal infection, incision infection, intestinal obstruction and electrolyte disturbance, were all less frequent in the observation group, though the small numbers did not permit separate statistical testing for each category.

DISCUSSION

The present study adopted conventional full-dose PGEP rather than split-dose PGEP or low-volume bowel preparation regimens for several reasons. First, the core aim was to evaluate perioperative intestinal barrier protection in elective gastrointestinal surgery and full-dose isotonic PGEP maintains intestinal osmotic stability with minimal mucosal irritation and microecological

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disturbance. Second, split-dose and low-volume regimens are mainly widely applied for colonoscopy preparation, while their standardized application and sufficient evidence for major gastrointestinal surgical patients remain limited. Third, full-dose PGEP is the routine and mature preoperative bowel preparation protocol in our clinical center, ensuring complete clinical data availability and good reproducibility for this retrospective study. Furthermore, adequate whole-intestinal cleansing is essential for clear surgical exposure and anastomotic safety and low-volume or split-dose schemes may increase the risk of insufficient bowel preparation in surgical populations.

This study, focusing on intestinal barrier protection, departs from previous research models that solely used cleanliness and conventional inflammatory factors as endpoints. It systematically evaluates the clinical value of compound PGEP across multiple dimensions, including intestinal barrier function, microecological indicators, systemic stress, intestinal function recovery and anastomotic repair. The study design, indicator selection and mechanism analysis are more aligned with the clinical needs of modern surgical perioperative organ protection and rapid recovery. The results of this study showed that the BBPS score and excellent rate of intestinal cleaning in the observation group were significantly higher than those in the control group, suggesting that compound PGEP can achieve more thorough and stable whole intestinal cleaning. This result is consistent with the relevant research conclusions on the use of isotonic PGEP for intestinal preparation (Huang *et al*., 2022; Meine *et al*., 2026). Compound PGEP is a non-absorbable, isotonic preparation that can trigger physiological peristalsis of the intestine through volumetric stimulation, covering the small intestine to the entire colon, avoiding the limitation of traditional cleansing enemas that can only clean the rectum and distal colon (Zhang *et al*., 2024). Mannitol is fermented by bacteria in the colon to produce a large amount of gas, which can easily cause intestinal dilation and poor surgical field exposure, which is also an important reason for the low pass rate of intestinal cleaning in the control group. A more ideal intestinal cleaning effect can effectively reduce the risk of fecal leakage and abdominal contamination during surgery, providing a basis for reducing postoperative infection and improving anastomotic healing.

The integrity of the intestinal mucosal barrier is crucial for maintaining intestinal homeostasis. DAO, D-lactic acid and endotoxin are classic indicators reflecting intestinal mucosal damage and permeability (Wah *et al*., 2026). In this study, postoperative levels of DAO, D-lactic acid and endotoxin in the observation group were significantly lower than those in the control group, which directly confirms the protective effect of PGEP on intestinal mucosal permeability based on measured data. These findings are highly consistent with the pathophysiological mechanism of intestinal barrier injury described by Ma *et al.* (2023). Intestinal barrier damage can lead to endotoxin translocation and activation of systemic inflammatory pathways, thereby aggravating tissue damage. The chemical stimulation of soap water and the mechanical damage caused by intubation in traditional bowel preparation can directly destroy the integrity of the intestinal mucosal epithelium. The increased intestinal pressure caused by mannitol fermentation further aggravates mucosal ischemia and barrier damage. Compound PGEP is non-chemically irritating and does not cause overt mucosal damage in the present clinical data; it helps maintain intestinal mucosal integrity and reduce bacterial and endotoxin translocation as reflected by lower DAO, D-lactate and endotoxin levels. This is also the fundamental mechanism for the reduction of postoperative inflammatory response and the improvement of anastomotic healing (Song *et al*., 2024).

This study innovatively used fecal acetic acid, propionic acid and pH as indicators related to gut microbiota. Results showed that the observation group had higher levels of short-chain fatty acids and more stable intestinal pH post-surgery. Short-chain fatty acids are key metabolic products of beneficial intestinal bacteria, maintaining an acidic intestinal environment, enhancing intestinal barrier function, inhibiting local inflammation and promoting mucosal repair. These measured differences in SCFAs and fecal pH indicate better preservation of intestinal microecological balance in the PGEP group, rather than speculative claims about microbiota composition. This result corroborates related research findings in the field of gut microbiota. Stable gut microbiota is crucial for healthy intestinal barrier function. The present data show that PGEP has milder effects on fecal SCFAs and pH, suggesting minimal disturbance to intestinal microecology, whereas the traditional regimen significantly reduces SCFA levels and increases fecal pH (Yu *et al*., 2025). Traditional methods, however, significantly reduce short-chain fatty acid levels and increase intestinal pH, disrupting gut microbiota homeostasis and further weakening intestinal barrier function (Karakaya *et al*., 2023). This study combines intestinal barrier and gut microbiota indicators based on measurable clinical parameters; the observed beneficial effects are supported by the detected SCFA and pH data, rather than over-speculation about unmeasured microbiota structure. The traditional regimen caused greater disturbance to intestinal microflora, whereas PGEP had minimal impact. This suggests that the intervention itself directly determines microbiota stability, which further contributes to improved intestinal barrier function and clinical outcomes. Microbiota preservation is therefore a key mechanism of PGEP-based bowel preparation, rather than an independent confounding factor.

Postoperative cortisol and fasting blood glucose levels in the observation group were significantly lower than those

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in the control group, suggesting that the compound PGEP bowel preparation was gentler and could effectively reduce perioperative stress. Notably, all confounding factors that may affect stress response, including anesthesia protocol, surgical team, operation duration and surgical trauma, were strictly standardized and balanced between groups, thereby minimizing their potential interference with stress indicator comparisons. This result aligns with the core principle of rapid recovery after surgery (FRAS) to reduce stress and accelerate postoperative recovery. Excessive stress can increase blood glucose, suppress immune function and aggravate tissue edema, thereby delaying anastomotic healing and bowel function recovery (Yang *et al*., 2024). The compound PGEP is an oral isotonic preparation with no invasive procedures, resulting in milder abdominal distension, abdominal pain and other discomforts, as well as smaller neuroendocrine fluctuations (Yang *et al*., 2023). In contrast, traditional methods, due to enema discomfort, significant abdominal distension and electrolyte imbalances, are more likely to trigger a stronger stress response. The improvement in stress levels in this study is mutually supportive of the faster bowel function recovery and milder anastomotic edema.

Regarding bowel function recovery, the observation group showed significantly shorter times for first flatus, defecation and tolerance to a liquid diet compared to the control group. This clinical outcome is consistent with better preserved intestinal barrier, more stable microecology and lower stress levels as measured in this study. The speed of bowel function recovery is closely related to intestinal barrier damage, microbiota dysbiosis and the degree of bodily stress. In this study, the observation group had a more intact intestinal barrier, a more stable microecology and a lower stress level, all of which contributed to the rapid recovery of bowel physiological function. Multiple clinical studies have confirmed that gentler bowel preparation methods can significantly reduce the incidence of postoperative ileus and accelerate bowel function recovery (McGough *et al.*, 2025; Ma *et al*., 2023; Qiu *et al*., 2026). The results of this study further support that bowel preparation centered on intestinal barrier protection is more conducive to preserving bowel physiological function.

The observation group showed less anastomotic edema, a higher primary healing rate and a lower incidence of postoperative complications. These clinical outcomes are supported by combined improvements in measured intestinal barrier function, reduced stress response and superior bowel cleanliness in this study. Anastomotic healing depends on good tissue blood supply, mild local inflammation, a stable metabolic state and sufficient collagen synthesis (Ulusoy *et al.*, 2022). In this study, the reduced endotoxin translocation due to intestinal barrier protection lowered systemic and local inflammation levels. Superior intestinal cleansing reduced the risk of intraoperative contamination and a more stable stress state improved tissue metabolism and perfusion. These factors synergistically provided an ideal local and systemic environment for anastomotic repair. Previous studies have confirmed (Yang and Wang, 2025) that intestinal barrier damage, excessive inflammation and postoperative infection are the main risk factors for anastomotic leakage. In this study, no anastomotic leakage occurred in the observation group, while two cases of anastomotic leakage occurred in the control group, which corroborates the above conclusions and further demonstrates the clinical advantages of compound PGEP in reducing serious postoperative complications.

Clinical significance

The statistically significant differences observed in this study suggest meaningful clinical benefits. Compound polyethylene glycol electrolyte powder-based bowel preparation achieved better bowel cleansing, protected the intestinal mucosal barrier, stabilized gut microecology, reduced perioperative stress, accelerated postoperative bowel function recovery, improved anastomotic healing and lowered postoperative complication rates. These findings suggest potential advantages for postoperative recovery, surgical safety and implementation of enhanced recovery after surgery (ERAS) protocols.

Limitations and future directions

This study focused on intestinal barrier protection and used multidimensional indicators, providing a more comprehensive evaluation than studies that assess only bowel cleanliness. However, it has several limitations. First, it was a single-center retrospective clinical study with a relatively small sample size. Second, mechanistic conclusions were inferred from clinical and laboratory correlations rather than direct molecular validation. Third, microecological assessment was limited to SCFAs and fecal pH, without high-throughput microbiome sequencing or mucosal tight junction protein analysis. In addition, we did not perform subgroup analyses based on dosage or administration timing. Future multicenter prospective studies with larger sample sizes, microbiome sequencing and molecular biological techniques are needed to further clarify the mechanism by which compound polyethylene glycol electrolyte powder protects the intestinal barrier.

CONCLUSION

Preoperative bowel preparation with compound PGEP electrolyte powder for elective gastrointestinal surgery improves bowel cleanliness, protects intestinal mucosal barrier function, stabilizes intestinal microecological indicators, reduces stress response and accelerates postoperative bowel function recovery. It also reduces anastomotic edema, improves primary anastomotic healing and lowers postoperative complication rates compared with the traditional mannitol plus soap enema regimen.

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These findings suggest that this bowel preparation strategy is effective, safe and consistent with fast-track surgery principles, supporting its clinical use in gastrointestinal surgery.

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Author's contributions
Jinwei Zhou was responsible for writing for this research; Dingwei Fan is responsible for data processing, translation and conceptualization.

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Data availability statement
The datasets generated during and/or analysed during the current research are available from the corresponding author on request.

Ethical approval
This study was approved by the hospital's medical ethics committee (No.: 202603081320000518087). This retrospective study was reported in accordance with the STROBE reporting guideline. This study was performed in adherence with the STROBE guidelines. See supplementary file for the STROBE checklist.

Conflict of interest
The authors declare that there is no conflict of interests.

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