

Rectal Remnant Length Affects Functional Outcomes After Laparoscopic Subtotal Colectomy With Antegrade Cecorectal Anastomosis for Slow-Transit Constipation: A Prospective Observational Study

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Abstract

Background

Slow-transit constipation (STC) is often refractory to medical therapy. Laparoscopic subtotal colectomy with antegrade cecorectal anastomosis is effective in selected patients, but the influence of rectal remnant length on outcomes is not well understood.

Methods

This prospective cohort study included 57 consecutive STC patients who underwent laparoscopic subtotal colectomy with antegrade cecorectal anastomosis. Transection level was determined intraoperatively based on disease severity, pelvic adhesions, and vascular concerns—factors directly related to prognosis—rather than randomization, introducing confounding by indication. All patients underwent colonic transit studies, anorectal manometry, balloon expulsion testing, and selective defecography.

Results

Of 57 patients, 32 had a short remnant (< 5 cm) and 25 a long remnant (≥ 5 cm). Disease severity was the primary reason for choosing a short remnant in 26 patients (81.3%), while pelvic adhesions led to a long remnant in 5 patients (20.0%). Baseline characteristics were similar between groups. At 3, 6, and 12 months, the short-remnant group had better Wexner constipation scores, GIQLI scores, and bowel frequency (all $P < 0.05$). The long-remnant group had better Wexner incontinence scores and manometry parameters at 3 and 6 months ($P < 0.05$), but these differences were not significant at 12 months ($P > 0.05$). Both groups had nonzero mean incontinence scores at 12 months (3.02 vs 2.47). The box plot showed no overlap between the two groups' remnant lengths (median 3.4 cm vs 7.2 cm, $P < 0.01$).

Conclusions

Shorter remnants were associated with better constipation relief and quality of life. Longer remnants offered transient continence benefits that were not statistically significant by 12 months. However, due to the non-randomized design and confounding by indication, these findings should be interpreted as associations requiring confirmation in randomized trials. Surgical planning should balance these factors and be individualized.

Background

Chronic constipation affects 10%–15% of adults worldwide, with similar prevalence in Asia [1, 2]. Among its subtypes, slow-transit constipation (STC) is defined by markedly delayed colonic transit without

mechanical obstruction. For patients who remain symptomatic despite maximal medical therapy and behavioral intervention, colectomy becomes the definitive treatment [3].

Total colectomy with ileorectal anastomosis (TC-IRA) has long been the standard. More recently, laparoscopic subtotal colectomy with cecorectal anastomosis (SC-CRA) has emerged as an alternative that preserves the ileocecal valve and cecum, potentially reducing diarrhea and nutritional compromise [4]. In the antegrade (isoperistaltic) configuration used in this study, the cecum is rotated to maintain physiological flow direction—as opposed to retrograde (antiperistaltic) reconstruction, which intentionally reverses the cecal reservoir to slow transit [5].

A more fundamental variable has received far less attention: the length of the retained rectum. The rectum functions as a reservoir, provides sensory feedback, and coordinates the rectoanal inhibitory reflex. Leaving too short a remnant may impair these functions, increasing bowel frequency, urgency, and incontinence [6]. Conversely, retaining an overly long segment may predispose to recurrent constipation due to fecal stasis in a dysmotile distal colon. Surgeons thus face a dilemma: shortening the remnant to maximize symptom relief may come at the cost of early incontinence, while preserving a longer remnant to protect continence may compromise the primary therapeutic goal.

The ASCRS guideline supports TC-IRA for carefully selected patients but does not specify an optimal rectal remnant length, and it acknowledges that the comparative efficacy of cecorectal procedures remains unclear [8]. Transection level is typically decided intraoperatively based on subjective assessment—a non-standardized process. We therefore designed this prospective cohort study to determine whether remnant length affects functional outcomes after antegrade SC-CRA for STC, aiming to provide pragmatic evidence for individualized surgical planning.

Methods

Study design

This prospective cohort study enrolled consecutive STC patients who underwent laparoscopic subtotal colectomy with antegrade cecorectal anastomosis at Hangzhou First People's Hospital between February 2021 and February 2025. No formal sample size calculation was performed; the study was exploratory in nature. Perioperative and follow-up data were collected by dedicated research staff, while clinical decisions were made independently by attending surgeons.

Participants

Inclusion criteria

Rome IV criteria for functional constipation [7]; age 18–75 years; delayed colonic transit confirmed by transit study; constipation severe enough to impair quality of life; documented failure of at least 6

months of supervised medical therapy, including first-line osmotic/stimulant laxatives and, where available, second-line agents (prucalopride, linaclotide, or lubiprostone); absence of organic disease, obstructed defecation syndrome, or neuromuscular disorders; and written informed consent.

Exclusion criteria

severe systemic disease; defecography or manometry findings consistent with ODS; structural colonic abnormalities, neoplasms, or inflammatory bowel disease; severe psychiatric disorders; other motility disorders; prior major colorectal surgery; or inability to complete scheduled follow-up assessments.

Preoperative diagnostic protocol

Preoperative diagnostic protocol

The preoperative workup was standardized and included colonic transit studies, colonoscopy, anorectal manometry, balloon expulsion testing, and selective defecography.

Colonic Transit Testing

Transit was assessed using the Bouchoucha method. Patients ingested a capsule containing 20 radiopaque markers on day 0, followed by a plain abdominal radiograph on day 5 (120 hours). Delayed transit was defined as retention of > 20% of markers at 120 hours. Medications affecting gastrointestinal motility—including laxatives, prokinetics, anticholinergics, opioids, and calcium channel blockers—were withheld for at least 72 hours before testing. Transit studies were repeated when initial results were equivocal. The pattern of delayed transit was classified as diffuse (pan-colonic) or segmental. Whole-colon transit time was calculated using standard formulae.

Colonoscopy

All patients underwent complete colonoscopy to exclude organic pathology.

Anorectal Manometry and High-Resolution Manometry

Anorectal manometry was performed using a water-perfused catheter system (Medtronic, USA) with an 8-channel radial catheter. Resting anal pressure (RAP) was recorded as the mean of three stable readings. Maximum squeeze pressure (MSP) was defined as the peak increment above resting pressure during three voluntary squeeze maneuvers. The rectoanal inhibitory reflex (RAIR) was evaluated using balloon inflation at incremental volumes (10, 20, 30, 40, and 50 mL). RAIR was classified as positive when a sustained reduction in resting anal pressure of at least 10 mmHg lasting more than 5 seconds was observed; cases not meeting these criteria were recorded as negative [15]. High-resolution manometry was used to assess for dyssynergic defecation patterns. All manometric assessments were performed by trained technicians masked to patient group assignment.

Balloon Expulsion Testing

All patients underwent balloon expulsion testing with a 50 mL water-filled balloon; expulsion within 60 seconds was considered normal.

Defecography

Patients with clinical features suggestive of ODS underwent dynamic defecography (or MRI defecography). Those with defecography or manometry findings consistent with ODS were excluded. Defecography was performed selectively based on clinical suspicion rather than routinely in all patients.

Psychological and Psychiatric Assessment

Formal psychological or psychiatric evaluation was performed in patients with a history of severe psychiatric disorders or when clinically indicated.

Surgical procedure

Laparoscopic subtotal colectomy with isoperistaltic (antegrade) cecorectal anastomosis was performed under general anesthesia via a five-port technique. Complete mobilization of the right colon, transverse colon, left colon, and proximal sigmoid was achieved, consistent with ASCRS guidelines [8]. The rectum was mobilized along the presacral plane, with dissection confined to the upper rectum above the peritoneal reflection. The mesorectum was partially divided only as needed to achieve the desired transection level. The hypogastric nerves and pelvic autonomic plexuses were identified and preserved in all cases.

The intended transection level was above the peritoneal reflection, corresponding to the upper rectum near the sacral promontory. Intraoperative adjustments were made when indicated: if the rectal stump appeared ischemic, a more proximal transection was performed; if the rectal wall was severely dilated, the transection was extended distally to the point where dilatation resolved. In patients with dense pelvic adhesions, transection was performed at the sacral promontory to avoid inadvertent injury. Group allocation was determined by intraoperative clinical judgment based on anatomical and disease-specific findings, not randomization.

All procedures were performed by a consistent surgical team. The ileocolic artery was preserved; the right and middle colic arteries were ligated. The terminal ileum was not resected; the cecum was preserved. The colon was transected approximately 5 cm proximal to the ileocecal valve using a linear stapler, with concurrent appendectomy. The anastomosis was reinforced with barbed sutures under laparoscopic visualization. The right colon was rotated 180° counterclockwise for isoperistaltic anastomosis, completed transanally (Fig. 1).

Measurement details

Rectal remnant length was measured along the anterior wall using a sterile flexible ruler, following the natural bowel curvature rather than as a straight-line distance. The ruler was placed gently along the anterior surface of the residual rectum without tension, from the anastomotic edge to the lowest identifiable point of the peritoneal reflection. The "lowest point of the peritoneal reflection" was defined as the most distal point where the peritoneum reflects from the anterior rectal wall onto the posterior pelvic wall. The same attending surgeon (Y.S. or K.C.) performed all measurements. Three consecutive measurements were obtained; the mean value was used for analysis.

Figure 1. Schematic illustration of laparoscopic subtotal colectomy with antegrade cecorectal anastomosis. (a) Extent of colonic resection during laparoscopic subtotal colectomy, including appendectomy, with preservation of the ileocecal junction and a portion of the rectal remnant. (b) Mechanical end-to-end antegrade cecorectal anastomosis. (c) Short-remnant anastomosis, defined as a rectal remnant length of < 5 cm above the peritoneal reflection. (d) Long-remnant anastomosis, defined as a rectal remnant length of ≥ 5 cm above the peritoneal reflection.

Rationale for the 5-cm cutoff

Endorectal ultrasound studies have shown that the peritoneal reflection can be consistently identified on the anterior rectal wall [9]. The rectal ampulla, which extends proximally from this reflection, is typically 3–5 cm in length, supporting the use of this anatomical zone as a practical reference for grouping remnant lengths. Previous studies on ileorectal anastomosis have suggested that preserving a rectal remnant of at least 5 cm may help maintain reservoir function and reduce postoperative incontinence risk [10]. However, this threshold has not been specifically validated for cecorectal anastomosis in constipation surgery. The 5-cm threshold was predefined as the grouping criterion for this observational study.

Outcome measures

Baseline characteristics included sex, age, BMI, NRS-2002, comorbidities, ASA classification, constipation duration, pharmacological agents used, reasons for treatment failure, and colonic transit parameters. Perioperative variables included operative time, estimated blood loss, time to first flatus, hospital stay, and Clavien–Dindo complications [11]. The primary outcome was the Wexner Constipation Score at 12 months. Secondary outcomes included GIQLI, bowel frequency, Wexner Incontinence Score, and anorectal manometry parameters at 3, 6, and 12 months. Patients were evaluated preoperatively and at 3, 6, and 12 months using the Wexner Constipation Score [12] (0–30, higher = more severe), Wexner Fecal Incontinence Score [13] (0–20), GIQLI [14] (0–144), and abdominal pain/bloating frequency (0–4 scale derived from the GIQLI items addressing these symptoms [14]). Anorectal manometry [15] assessed RAIR positivity, RAP, and MSP. Antidiarrheal medication use was documented at each follow-up visit. All questionnaires were administered in Chinese using validated translations. The Wexner Constipation Score [12], Wexner Fecal Incontinence Score [13], and GIQLI [14] are validated instruments previously published in the literature. Abdominal pain and bloating frequency were assessed using the

corresponding items from the GIQLI questionnaire [14]. All follow-up assessments were performed by investigators masked to group assignment.

Statistical analysis

Statistical analyses were performed using SPSS 26.0. Normality was assessed using the Shapiro–Wilk test. Normally distributed data were compared using the t-test, and non-normally distributed data using the Mann–Whitney U test. Longitudinal data were analyzed using linear mixed-effects models with Bonferroni correction. Effect sizes with 95% confidence intervals are reported. A two-sided $P < 0.05$ was considered statistically significant. No adjustment was made for multiple comparisons. Remnant length was analyzed as a continuous variable using Spearman's correlation and multivariable linear regression. Sensitivity analyses were performed using alternative cutoffs (4 cm and 6 cm).

Results

Patient flow

Of 82 STC patients evaluated for surgery, 25 were excluded: 8 did not meet Rome IV criteria, 6 had normal colonic transit studies, 5 had ODS confirmed by defecography or manometry, 4 had organic disease, and 2 declined surgery. The remaining 57 patients were enrolled and underwent surgery: 32 assigned to the short-remnant group (< 5 cm) and 25 to the long-remnant group (≥ 5 cm). All 57 patients completed 3-month, 6-month, and 12-month follow-up. Complete questionnaire and manometric data were available for all patients at all time points. The patient flow is shown in Fig. 2.

Baseline characteristics

Of 57 patients, 32 were in the short-remnant group (11 males, 21 females; mean age 66.91 ± 8.52 years; BMI 22.38 ± 2.46) and 25 in the long-remnant group (8 males, 17 females; mean age 68.20 ± 10.53 years; BMI 22.44 ± 2.16). The two groups were similar in sex, age, BMI, NRS-2002, comorbidities, and ASA classification (all $P > 0.05$) (Table 1). Disease-specific indicators also lined up: constipation duration (8.5 vs 9.0 years, $P = 0.588$); multiple laxative use (81.3% vs 80.0%, $P = 0.905$); 120-hour marker retention (68.4% vs 70.2%, $P = 0.579$); whole-colon transit time (96.8 vs 98.2 hours, $P = 0.770$); RAP (69.1 vs 69.8 mmHg, $P = 0.815$); and MSP (142.36 vs 144.27 mmHg, $P = 0.765$).

Table 1
Baseline characteristics of patients according to rectal remnant length

Characteristic	Short remnant (< 5 cm) (n = 32)	Long remnant (≥ 5 cm) (n = 25)	P value
Demographic data			
Sex, male/female	11 / 21	8 / 17	0.849
Age, years, mean ± SD	66.91 ± 8.52	68.20 ± 10.53	0.610
BMI, kg/m ² , mean ± SD	22.38 ± 2.46	22.44 ± 2.16	0.917
NRS-2002 score, mean ± SD	1.62 ± 0.51	1.58 ± 0.48	0.763
ASA classification, n (%)			0.766
– I	20 (62.5)	16 (64.0)	
– II	12 (37.5)	9 (36.0)	
– ≥III	0	0	
Hypertension, n (%)	8 (25.0)	6 (24.0)	0.803
Diabetes mellitus, n (%)	3 (9.4)	2 (8.0)	
COPD, n (%)	2 (6.3)	1 (4.0)	
Disease-specific data			
Constipation duration, years, median (IQR)	8.5 (5.0–12.0)	9.0 (6.0–14.0)	0.588
Multiple laxative use (≥ 2 types), n (%)	26 (81.3)	20 (80.0)	0.905
120-h marker retention rate, %, mean ± SD	68.4 ± 12.6	70.2 ± 11.8	0.579
Whole-colon transit time, hours, mean ± SD	96.8 ± 18.4	98.2 ± 17.6	0.770
Anorectal manometry			
RAIR positivity, n (%)	32 (100)	25 (100)	–
RAP, mmHg, mean ± SD	69.1 ± 11.8	69.8 ± 12.1	0.815
MSP, mmHg, mean ± SD	142.36 ± 24.18	144.27 ± 23.65	0.765

SD standard deviation; IQR interquartile range; BMI body mass index; NRS-2002 Nutritional Risk Screening 2002; ASA American Society of Anesthesiologists; COPD chronic obstructive pulmonary disease; RAIR rectoanal inhibitory reflex; RAP resting anal pressure; MSP maximum squeeze pressure. P

values were calculated using χ^2 test for categorical variables, Student's t-test for normally distributed continuous variables, and Mann–Whitney U test for non-normally distributed continuous variables.

Preoperative medical therapy characteristics

All 57 patients had failed at least 6 months of supervised medical therapy before surgical referral. Median duration of conservative management was 14 months (IQR: 10–22). Osmotic laxatives were used in 54 patients (94.7%), most commonly polyethylene glycol and lactulose. Stimulant laxatives were used in 51 patients (89.5%), most commonly bisacodyl and senna. Among second-line agents, prucalopride was prescribed in 28 patients (49.1%), linaclotide in 5 patients (8.8%), and lubiprostone in 8 patients (14.0%). Inadequate symptom relief was the most common reason for treatment failure (47 patients, 82.5%), followed by adverse effects (18 patients, 31.6%), progressive symptom worsening (15 patients, 26.3%), and patient preference for surgery after prolonged symptoms (12 patients, 21.1%). Good medication adherence ($\geq 80\%$ of prescribed doses) was reported in 50 patients (87.7%). Biofeedback therapy was offered to 19 patients (33.3%) with borderline evacuation dysfunction; 14 (73.7%) completed at least 6 sessions. Detailed medical therapy characteristics are summarized in Table 2.

Table 2
Preoperative medical therapy characteristics

Variable	Short remnant (< 5 cm) (n = 32)	Long remnant (≥ 5 cm) (n = 25)	Total (N = 57)	P value
Duration of conservative management, months, median (IQR)	15 (11–23)	14 (10–21)	14 (10–22)	0.669
First-line agents, n (%)				
Osmotic laxatives	30 (93.8)	24 (96.0)	54 (94.7)	0.708
– Polyethylene glycol	23 (71.9)	19 (76.0)	42 (73.7)	0.721
– Lactulose	13 (40.6)	9 (36.0)	22 (38.6)	0.721
– Other osmotics*	8 (25.0)	6 (24.0)	14 (24.6)	0.929
Stimulant laxatives	28 (87.5)	23 (92.0)	51 (89.5)	0.575
– Bisacodyl	19 (59.4)	16 (64.0)	35 (61.4)	0.721
– Senna	16 (50.0)	12 (48.0)	28 (49.1)	0.879
– Other stimulants†	8 (25.0)	6 (24.0)	14 (24.6)	0.929
Second-line agents, n (%)				
Prokinetic agents	16 (50.0)	12 (48.0)	28 (49.1)	0.879
– Prucalopride (2 mg/day)	16 (50.0)	12 (48.0)	28 (49.1)	0.879
Prosecretory agents	8 (25.0)	5 (20.0)	13 (22.8)	0.650
– Linaclotide (145–290 µg/day)	3 (9.4)	2 (8.0)	5 (8.8)	0.854
– Lubiprostone (24 µg bid)	5 (15.6)	3 (12.0)	8 (14.0)	0.695
Total classes used, n (%)				0.735
– 1–2 classes	4 (12.5)	3 (12.0)	7 (12.3)	
– 3–4 classes	18 (56.3)	13 (52.0)	31 (54.4)	
– ≥5 classes	10 (31.3)	9 (36.0)	19 (33.3)	
Reasons for failure, n (%)				
Inadequate symptom relief	26 (81.3)	21 (84.0)	47 (82.5)	0.785
Adverse effects	11 (34.4)	7 (28.0)	18 (31.6)	0.606
Progressive worsening	9 (28.1)	6 (24.0)	15 (26.3)	0.723
Patient preference for surgery	7 (21.9)	5 (20.0)	12 (21.1)	0.862

Variable	Short remnant (< 5 cm) (n = 32)	Long remnant (≥ 5 cm) (n = 25)	Total (N = 57)	P value
Adherence, n (%)				0.955
Good (≥ 80% doses)	28 (87.5)	22 (88.0)	50 (87.7)	
Partial (50–79%)	4 (12.5)	3 (12.0)	7 (12.3)	
Poor (< 50%)	0	0	0	
Biofeedback, n (%)				
Offered	11 (34.4)	8 (32.0)	19 (33.3)	0.849
Completed ≥ 6 sessions	8 (25.0)	6 (24.0)	14 (24.6)	0.929
Proceeded to surgery despite biofeedback	11 (100)	8 (100)	19 (100)	—

Data are presented as n (%) unless otherwise indicated. IQR interquartile range. Other osmotics include magnesium hydroxide.† Other stimulants include sodium picosulfate. *P* values were calculated using χ^2 test for categorical variables and Mann–Whitney U test for continuous variables.

Factors influencing rectal transection level

Intraoperative decisions regarding rectal transection level were prospectively documented based on four prespecified domains: disease severity, pelvic dense adhesions, vascular supply, and rectal dilatation.

In the short-remnant group (n = 32), the primary decision factor was disease severity in 26 patients (81.3%), vascular supply concerns in 4 patients (12.5%), and pelvic dense adhesions in 1 patient (3.1%). Among patients with disease severity as the primary factor, specific indications included whole-colon transit time > 120 hours (n = 5), diffuse colonic dysmotility (n = 4), Wexner constipation score ≥ 20 (n = 4), and severe proximal rectal dilatation seen during surgery (n = 9).

In the long-remnant group (n = 25), pelvic dense adhesions were the primary decision factor in 5 patients (20.0%). Disease severity was not the primary factor in any patient in this group.

Comparison of rectal remnant length distribution between groups

Rectal remnant length distributions are shown in Fig. 3. In the short-remnant group (n = 32), the median remnant length was 3.4 cm (IQR: 3.3–3.6; range: 2.5–3.9). In the long-remnant group (n = 25), the median remnant length was 7.2 cm (IQR: 6.8–7.6; range: 5.5–8.0). The two distributions did not overlap. The difference in median remnant length was statistically significant (*P* < 0.01, Mann–Whitney U test).

Perioperative data

Operative time, blood loss, and hospital stay were similar between groups (Table 3). Time to first flatus was shorter in the long-remnant group (1.76 vs 2.01 days; $P = 0.007$; 95% CI: 0.07–0.43). Rectal remnant length differed significantly (3.22 ± 0.37 vs 6.80 ± 0.86 cm; $P < 0.01$). No anastomotic leakage, reoperation, or mortality occurred in either group. Readmission rates were comparable (short: 1 patient, 3.1%; long: 1 patient, 4.0%; $P = 0.854$). Reasons for readmission were prolonged ileus in the short-remnant group and wound infection in the long-remnant group (Table 4).

Table 3
Perioperative outcomes

Parameter	Short remnant (< 5 cm) (n = 32)	Long remnant ($\geq$ 5 cm) (n = 25)	P value
Rectal remnant length, cm, mean $\pm$ SD	3.22 ± 0.37	6.80 ± 0.86	< 0.01
Operative time, min, mean $\pm$ SD	199.6 ± 18.7	201.8 ± 17.5	0.649
Blood loss, mL, median (IQR)	50 (40–60)	50 (30–50)	0.471
Time to first flatus, days, mean $\pm$ SD	2.01 ± 0.35	1.76 ± 0.32	0.007
Postoperative hospital stay, days, mean $\pm$ SD	9.61 ± 1.52	9.87 ± 1.44	0.512
Readmission within 30 days, n (%)	1 (3.1)	1 (4.0)	0.854

SD standard deviation; IQR interquartile range. P values were calculated using Student's t-test for normally distributed variables, Mann–Whitney U test for non-normally distributed variables, and χ^2 test or Fisher's exact test for categorical variables.

Table 4
Postoperative complications according to Clavien–Dindo classification

Grade	Short remnant (< 5 cm) (n = 32)	Long remnant ($\geq$ 5 cm) (n = 25)	Total (N = 57)
I	4 (12.5)	3 (12.0)	7 (12.3)
II	3 (9.4)	3 (12.0)	6 (10.5)
IIIa	1 (3.1)	1 (4.0)	2 (3.5)
IIIb	0	0	0
IV	0	0	0
V	0	0	0
Total	8 (25.0)	7 (28.0)	15 (26.3)

Data are presented as n (%). Specific complications included infection (wound or respiratory requiring antibiotics): n = 3 vs. n = 2; urinary retention: n = 1 vs. n = 1; ileus: n = 1 vs. n = 1; diarrhea requiring

medication: $n = 1$ vs. $n = 0$; effusion (symptomatic fluid collection confirmed by imaging): $n = 2$ vs. $n = 1$ (one Grade IIIa requiring drainage); respiratory dysfunction ($\text{SpO}_2 < 90\%$ requiring supplemental oxygen): $n = 0$ vs. $n = 1$.

Overall outcomes in the full cohort

In the whole cohort, Wexner constipation scores dropped from 16.4 before surgery to 6.2 at 3 months, 3.8 at 6 months, and 2.4 at one year (all $P < 0.001$). GIQLI scores improved from 63 to 93, 104, and 111 over the same intervals (all $P < 0.001$). Bowel frequency climbed from almost nothing to 3.0, 2.8, and 2.4 times/day (all $P < 0.001$). The mean Wexner incontinence score—zero before surgery—rose to 7.9 at 3 months, then settled to 5.3 at 6 months and 2.8 at one year. At 12 months, 12 patients (21.1%) had a score of 0, 38 (66.7%) had mild incontinence (1–5), and 7 (12.3%) had moderate incontinence (6–10). No one had severe incontinence (> 10). Stool was watery in 11 patients (19.3%), soft in 41 (71.9%), and hard in 5 (8.8%). Antidiarrheal use dropped from 14% at 3 months to 5% at one year. All patients had stopped laxatives by 6 months. Satisfaction was high: 49 patients (86.0%) said they were satisfied or very satisfied, and 51 (89.5%) said they would have the operation again.

Postoperative functional outcomes over time

Preoperative scores were similar between groups (all $P > 0.05$). After surgery, the short-remnant group consistently outperformed the long-remnant group on constipation-related measures—Wexner constipation, GIQLI, abdominal pain, bloating, and bowel frequency—at every time point (all $P < 0.05$). The long-remnant group had better incontinence scores at 3 and 6 months ($P < 0.05$), but by 12 months the difference was gone ($P = 0.143$). The time-by-group interaction was significant for all constipation outcomes and for incontinence ($F = 4.263$, $P = 0.022$).

At 12 months, the components of the incontinence score were similar between groups: liquid-stool incontinence (short: 1.12 ± 0.76 ; long: 0.84 ± 0.62 ; $P = 0.134$), solid-stool (short: 0.24 ± 0.43 ; long: 0.16 ± 0.37 ; $P = 0.452$), flatus (short: 0.68 ± 0.58 ; long: 0.56 ± 0.51 ; $P = 0.392$), pad use (short: 0.44 ± 0.61 ; long: 0.32 ± 0.52 ; $P = 0.418$), and lifestyle alteration (short: 0.54 ± 0.64 ; long: 0.48 ± 0.58 ; $P = 0.706$). Zero incontinence at 12 months was seen in 7 short-remnant patients (21.9%) and 5 long-remnant patients (20.0%) ($P = 0.862$). Persistent new-onset incontinence (score ≥ 1 at 12 months) was present in 78.1% of the short group and 80.0% of the long group ($P = 0.862$). No patient needed pelvic-floor therapy or surgical intervention for incontinence during follow-up. Details are in Table 5.

Table 5
Functional outcomes over 12-month follow-up

Parameter	Group	Preoperative	3 months	6 months	12 months	Interaction P value*
Wexner Constipation Score	Short	16.41 ± 1.12	5.42 ± 1.86	3.08 ± 1.41	1.84 ± 1.22	0.017
	Long	16.28 ± 1.06	7.18 ± 2.04	4.67 ± 1.63	3.21 ± 1.46	
	<i>P</i> (between groups)	0.656	0.003	0.001	0.002	
GIQLI score	Short	63.12 ± 4.18	96.84 ± 10.26	108.62 ± 11.85	116.28 ± 13.42	0.024
	Long	63.34 ± 4.26	88.17 ± 9.64	98.54 ± 10.73	104.36 ± 12.85	
	<i>P</i> (between groups)	0.846	0.004	0.002	0.001	
Bowel frequency (times/day)	Short	0.17 ± 0.09	3.42 ± 0.81	3.05 ± 0.72	2.63 ± 0.64	0.013
	Long	0.18 ± 0.08	2.56 ± 0.68	2.37 ± 0.61	2.08 ± 0.52	
	<i>P</i> (between groups)	0.667	0.001	0.002	0.004	
Wexner Incontinence Score	Short	0	8.84 ± 2.52	6.12 ± 2.17	3.02 ± 1.41	0.022
	Long	0	6.74 ± 2.41	4.18 ± 1.82	2.47 ± 1.28	
	<i>P</i> (between groups)	—	0.002	0.001	0.143	
Abdominal pain frequency	Short	2.18 ± 0.63	0.94 ± 0.46	0.58 ± 0.31	0.28 ± 0.21	0.031
	Long	2.22 ± 0.61	1.36 ± 0.58	0.92 ± 0.42	0.63 ± 0.36	
	<i>P</i> (between groups)	0.806	0.006	0.003	0.001	
Abdominal bloating frequency	Short	2.63 ± 0.68	1.03 ± 0.47	0.69 ± 0.35	0.36 ± 0.24	0.021
	Long	2.59 ± 0.71	1.58 ± 0.62	1.12 ± 0.46	0.82 ± 0.39	

Parameter	Group	Preoperative	3 months	6 months	12 months	Interaction P value*
	<i>P</i> (between groups)	0.829	0.002	0.001	< 0.001	

*Data are presented as mean $\pm$ SD. Wexner Constipation Score ranges from 0 to 30 (higher = more severe). GIQLI ranges from 0 to 144 (higher = better quality of life). Wexner Incontinence Score ranges from 0 to 20 (higher = worse continence). Abdominal pain and bloating frequency scored 0–4 (higher = more frequent). *P* values for between-group comparisons were calculated using Student's *t*-test. Time $\times$ group interaction from repeated-measures ANOVA.

Anorectal manometry

Preoperative RAIR was positive in all patients. At 3 months, RAIR was negative in 7 short-remnant patients (21.9%) and 4 long-remnant patients (16.0%) (*P* = 0.578). By 6 months, positivity was 87.5% vs 92.0%; by 12 months, 90.6% vs 96.0%. No significant between-group differences emerged at any time point (all *P* > 0.05). RAP and MSP were lower in the short-remnant group at 3 and 6 months (*P* < 0.05), but by 12 months the differences had disappeared (*P* > 0.05). Time–group interaction was significant for both RAP (*F* = 4.871, *P* = 0.018) and MSP (*F* = 3.109, *P* = 0.047) (Table 6).

Table 6
Anorectal manometry parameters over 12-month follow-up

Parameter	Group	Preoperative	3 months	6 months	12 months	Interaction <i>P</i> value*
RAIR positivity, n (%)	Short	32 (100)	25 (78.1)	28 (87.5)	29 (90.6)	0.578
	Long	25 (100)	21 (84.0)	23 (92.0)	24 (96.0)	
	<i>P</i> (between groups)	—	0.578	0.578	0.578	
RAP, mmHg, mean $\pm$ SD	Short	69.1 $\pm$ 11.8	47.8 $\pm$ 9.6	54.9 $\pm$ 9.2	63.5 $\pm$ 8.9	0.018
	Long	69.8 $\pm$ 12.1	56.3 $\pm$ 10.1	62.7 $\pm$ 9.8	66.2 $\pm$ 9.1	
	<i>P</i> (between groups)	0.815	0.002	0.003	0.229	
MSP, mmHg, mean $\pm$ SD	Short	142.36 $\pm$ 24.18	123.52 $\pm$ 20.31	129.84 $\pm$ 19.45	137.24 $\pm$ 18.52	0.047
	Long	144.27 $\pm$ 23.65	136.88 $\pm$ 20.76	140.35 $\pm$ 19.12	141.03 $\pm$ 18.24	
	<i>P</i> (between groups)	0.765	0.011	0.041	0.426	

*RAIR rectoanal inhibitory reflex; RAP resting anal pressure; MSP maximum squeeze pressure; SD standard deviation. *P* values for between-group comparisons were calculated using Student's *t*-test for continuous variables and χ^2 test for categorical variables. Time $\times$ group interaction from repeated-measures ANOVA.

Adjusted and sensitivity analyses

Continuous analysis of remnant length

Treating remnant length as a continuous variable (range 2.5–8.0 cm), we found significant correlations with 12-month outcomes: Wexner constipation ($r^* = 0.482$, 95% CI: 0.256–0.663, $P < 0.001$), GIQLI ($r^* = -0.451$, 95% CI: -0.638 to -0.221, $P < 0.001$), and bowel frequency ($r^* = -0.398$, 95% CI: -0.591 to -0.169, $P = 0.002$). Incontinence showed a weaker, non-significant correlation ($r^* = 0.218$, 95% CI: -0.044 to 0.453, $P = 0.102$). The scatter plots (Fig. 4) illustrate these relationships.

Multivariable adjusted analysis

We built multivariable linear regression models adjusting for age, sex, BMI, baseline whole-colon transit time, constipation duration, and the primary decision factor (disease severity vs pelvic adhesions vs vascular concerns). We checked the usual assumptions: linearity looked fine on partial residual plots; residuals were roughly normal (Shapiro–Wilk $P > 0.05$ for all outcomes); homoscedasticity was acceptable; and variance inflation factors were all below 2.0.

After adjustment, the short remnant remained independently associated with better Wexner constipation scores ($\beta = -2.14$, 95% CI: -3.42 to -0.86, $P = 0.002$), GIQLI ($\beta = 8.76$, 95% CI: 3.24 to 14.28, $P = 0.003$), and bowel frequency ($\beta = 0.52$, 95% CI: 0.18 to 0.86, $P = 0.004$). The incontinence difference at 12 months was not significant ($\beta = -0.38$, 95% CI: -1.24 to 0.48, $P = 0.382$). R^2 values were modest: 0.31 for Wexner constipation, 0.28 for GIQLI, 0.24 for bowel frequency, and 0.11 for incontinence. Full details are in Table 7 and Fig. 5.

Table 7
Multivariable linear regression models for 12-month functional outcomes

Outcome	Predictor	β coefficient	95% CI	P value
Wexner Constipation Score ($R^2 = 0.31$)	Remnant group (short vs. long)	-2.14	-3.42 to -0.86	0.002
	Age (per year)	0.02	-0.01 to 0.05	0.124
	Sex (male vs. female)	-0.28	-0.96 to 0.40	0.417
	BMI (per kg/m ²)	-0.04	-0.14 to 0.06	0.462
	Baseline WCTT (per hour)	0.01	-0.01 to 0.03	0.308
	Constipation duration (per year)	0.03	-0.02 to 0.08	0.219
	Decision factor (disease severity vs. adhesions)	-1.56	-3.12 to 0.00	0.050
	Decision factor (vascular concerns vs. adhesions)	-0.92	-2.48 to 0.64	0.247
GIQLI score ($R^2 = 0.28$)	Remnant group (short vs. long)	8.76	3.24 to 14.28	0.003
	Age (per year)	-0.12	-0.34 to 0.10	0.278
	Sex (male vs. female)	1.24	-3.04 to 5.52	0.569
	BMI (per kg/m ²)	0.18	-0.38 to 0.74	0.528
	Baseline WCTT (per hour)	-0.04	-0.16 to 0.08	0.508
	Constipation duration (per year)	-0.14	-0.42 to 0.14	0.323
	Decision factor (disease severity vs. adhesions)	6.82	-1.56 to 15.20	0.110
	Decision factor (vascular concerns vs. adhesions)	4.16	-4.22 to 12.54	0.331

Outcome	Predictor	β coefficient	95% CI	P value
Bowel frequency ($R^2 = 0.24$)	Remnant group (short vs. long)	0.52	0.18 to 0.86	0.004
	Age (per year)	-0.01	-0.02 to 0.00	0.162
	Sex (male vs. female)	0.06	-0.18 to 0.30	0.626
	BMI (per kg/m ²)	0.01	-0.03 to 0.05	0.634
	Baseline WCTT (per hour)	0.00	-0.01 to 0.01	0.778
	Constipation duration (per year)	-0.01	-0.03 to 0.01	0.206
	Decision factor (disease severity vs. adhesions)	0.28	-0.12 to 0.68	0.171
	Decision factor (vascular concerns vs. adhesions)	0.20	-0.20 to 0.60	0.324
Wexner Incontinence Score ($R^2 = 0.11$)	Remnant group (short vs. long)	-0.38	-1.24 to 0.48	0.382
	Age (per year)	0.02	-0.01 to 0.05	0.192
	Sex (male vs. female)	-0.14	-0.82 to 0.54	0.684
	BMI (per kg/m ²)	-0.02	-0.12 to 0.08	0.673
	Baseline WCTT (per hour)	0.00	-0.02 to 0.02	0.878
	Constipation duration (per year)	0.01	-0.04 to 0.06	0.716
	Decision factor (disease severity vs. adhesions)	0.48	-0.62 to 1.58	0.391
	Decision factor (vascular concerns vs. adhesions)	0.32	-0.78 to 1.42	0.567

WCTT, whole-colon transit time; GIQLI, Gastrointestinal Quality of Life Index; CI, confidence interval. Remnant group: short (< 5 cm) vs. long ($\geq$ 5 cm). Decision factor categories: disease severity (whole-

colon transit time > 120 hours, diffuse colonic dysmotility, Wexner constipation score ≥ 20 , or severe proximal rectal dilatation); pelvic dense adhesions (history of prior pelvic surgery or chronic fibrotic changes); vascular concerns (poor perfusion of the rectal stump requiring more proximal transection). Reference category for decision factor: pelvic dense adhesions. Model assumptions: linearity verified by partial residual plots; residuals approximately normal (Shapiro–Wilk test $P > 0.05$); homoscedasticity confirmed; VIF < 2.0 for all predictors.

Sensitivity analysis around alternative cutoffs

We also checked whether the results held up with different cutoffs—4 cm and 6 cm instead of 5 cm. The 4-cm cutoff (short < 4 cm, $n = 21$; long ≥ 4 cm, $n = 36$) gave larger effect sizes (Wexner Constipation: $\beta = -2.31$, 95% CI: -3.68 to -0.94; GIQLI: $\beta = 9.52$, 95% CI: 3.58 to 15.46; Bowel Frequency: $\beta = 0.58$, 95% CI: 0.22 to 0.94), which makes sense—the contrast between short and long was more extreme. The 6-cm cutoff (short < 6 cm, $n = 41$; long ≥ 6 cm, $n = 16$) gave attenuated but directionally consistent effects (Wexner Constipation: $\beta = -1.62$, 95% CI: -2.98 to -0.26; GIQLI: $\beta = 6.48$, 95% CI: 1.92 to 11.04; Bowel Frequency: $\beta = 0.38$, 95% CI: 0.10 to 0.66). For incontinence, none of the cutoffs showed a significant difference ($P > 0.05$ for all). These sensitivity analyses support the overall association between shorter remnants and better constipation relief, though the optimal threshold likely varies among individuals. Results are presented in Fig. 6.

Discussion

Several guidelines have helped standardize the evaluation and surgical selection of patients with chronic constipation [16–18], but they offer little guidance on the technical details of rectal transection. A network meta-analysis suggested that subtotal colectomy with cecorectal anastomosis may improve quality of life, though the evidence came mostly from nonrandomized studies, East Asian cohorts, and a mix of operations [19]. What works for antiperistaltic cecorectal reconstruction may not apply to our isoperistaltic approach. Most studies have focused on ileocecal preservation and anastomotic configuration [5], leaving the rectal remnant length question largely unanswered. This gap is clinically relevant because the retained rectum serves as a reservoir—its length directly affects stool storage capacity, sensory feedback, and the coordination of defecation. The 5-cm cutoff we used came from Elton et al. [10], who found that leaving ≥ 5 cm above the peritoneal reflection reduced incontinence after ileorectal anastomosis. Whether that threshold applies to cecorectal anastomosis—where the reservoir dynamics differ due to the preserved cecum—is uncertain and deserves scrutiny.

A major limitation is that allocation was not random. The surgeon chose the transection level based on disease severity, adhesions, and vascular concerns—all of which are prognostic factors. That introduces confounding by indication and limits causal inference. The decision-factor data tell the story clearly: short remnants went almost exclusively to patients with severe disease (81.3%), while long remnants went to patients with adhesions (20.0%). This imbalance alone precludes causal attribution. It is worth emphasizing that this is not a minor technical detail—confounding by indication is arguably the most

serious threat to validity in surgical observational studies. When the exposure (remnant length) is determined by the same factors that influence the outcome (disease severity), the observed association may be driven entirely by the indication rather than the exposure itself. Even after multivariable adjustment, residual confounding from unmeasured variables—such as the surgeon's intraoperative assessment of bowel quality, which was not quantified—cannot be ruled out.

The procedure was safe in this cohort—no leaks, reoperations, or deaths. Complication rates (25.0% vs 28.0%) matched earlier reports [20, 21]. A systematic review of 2045 patients found a similar complication rate of about 24%, with a 30-day mortality of 0.4% and small bowel obstruction recurrence of about 15% [22]. These figures underscore that while colectomy for STC is generally safe, it is not without risk, and patients should be counseled accordingly. Both groups improved significantly in constipation, quality of life, and bowel frequency, consistent with larger cohorts [23]. The improvements were substantial—Wexner scores dropped by approximately 85% from baseline, and GIQLI scores nearly doubled—suggesting that SC-CRA, regardless of remnant length, achieves the primary goal of symptom relief in the majority of patients. The long-remnant group had faster time to first flatus ($P = 0.007$), but the clinical significance of that difference—about 6 hours—is debatable. This minor advantage may reflect the larger reservoir facilitating gas passage, but whether it translates into meaningful patient benefit is unclear.

Several studies have compared anastomotic configurations. A meta-analysis of five studies (291 patients) found that cecorectal anastomosis was associated with shorter operative time, shorter hospital stay, and lower long-term Wexner scores than ileorectal anastomosis, with no difference in complications [24]. Another study comparing SC-CRA with ileosigmoidal anastomosis found higher satisfaction and greater bowel frequency with ISA [25]. These findings suggest that anastomotic configuration matters, and it should be considered alongside remnant length in surgical planning. However, the interpretation of these comparisons is complicated by heterogeneous patient populations, varying surgical techniques, and differences in outcome definitions across studies. Notably, most of these studies did not systematically measure rectal remnant length, making it difficult to disentangle the effect of anastomotic configuration from that of residual rectal length. Future studies should aim to standardize the measurement of both variables to clarify their independent and interactive effects on functional outcomes.

Shorter remnants were associated with better constipation relief and quality of life. Longer remnants offered transient continence benefits that faded by 12 months. But again, these are associations, not causes. The sicker patients got the shorter remnants; the ones with adhesions got the longer ones. The observed constipation benefit could simply reflect more aggressive resection in more severe disease—a classic example of confounding by indication. If we had randomized patients to short versus long remnants, the effect sizes might have been different. The 5-cm cutoff held up reasonably well in sensitivity analyses—the 4-cm cutoff gave stronger effects, the 6-cm cutoff weaker but still consistent. So 5 cm seems a reasonable pragmatic choice, but it is not a biological boundary; the optimal length probably differs from patient to patient based on their baseline anorectal function, symptom severity,

and lifestyle priorities. For instance, a patient with severe preoperative incontinence or weak sphincter function might benefit from a longer remnant, whereas a patient with refractory constipation and preserved sphincter function might tolerate a shorter remnant better.

On the continence side, the long-remnant group had better Wexner incontinence scores and manometry readings at 3 and 6 months, but those differences were gone by 12 months. The scores were not trivial—8.84 vs 6.74 at 3 months, 6.12 vs 4.18 at 6 months, and 3.02 vs 2.47 at 12 months. These numbers translate to real-world symptoms: at 3 months, patients in the short-remnant group were experiencing, on average, frequent episodes of liquid stool incontinence that would be distressing for many individuals, even if they had been severely constipated before surgery. At 12 months, 78.1% of the short group and 80.0% of the long group still had some new-onset incontinence, though mostly mild. No one needed surgery for incontinence, and antidiarrheal use dropped from 14% at 3 months to 5% at one year—suggesting that most patients adapted or that the frequency of episodes decreased over time. We should be cautious about saying the continence differences "resolved" by 12 months. A non-significant P value does not prove equivalence. Both groups still had nonzero mean incontinence scores at 12 months. The significant time-by-group interaction ($F = 4.263$, $P = 0.022$) shows that the between-group difference changed over time, but it does not demonstrate equivalence at 12 months. The lack of significance could reflect diminishing effect size or insufficient power—the study was not designed to detect small differences in continence. It is also possible that true differences do persist beyond 12 months but are too small to be clinically meaningful. Longer follow-up with larger sample sizes is needed to resolve this uncertainty.

Long-term durability is another open question. A 15-year follow-up study found that 26% of patients required additional surgery after subtotal colectomy with ileorectal anastomosis [27]. A systematic review made the same point: 12-month outcomes are not necessarily predictive of long-term results [20]. In a cohort with a median follow-up of 19.8 years, 26% (13 of 50) underwent salvage surgery, though bowel frequency improved from once a week to five times a week ($P = 0.001$) [26]. These findings raise an important concern: even when initial symptom relief is excellent, the functional gains may erode over time, and a subset of patients will require revisional surgery. The reasons for late failure likely include progressive dysmotility in the retained segment, development of small bowel dysmotility, or the emergence of pelvic floor dysfunction that was subclinical at the time of colectomy. Whether the short-remnant advantage observed at 12 months persists beyond the first year is unknown. If the retained longer segment is indeed intrinsically dysmotile, one might expect the constipation benefit of a shorter remnant to be sustained or even amplified over time. Conversely, if the short remnant leads to chronic diarrhea or adaptation problems, the early advantage might diminish. Extended follow-up of this cohort will be essential to answer these questions.

What explains these findings? Aranha and colleagues showed years ago that rectal stump length predicted postoperative bowel frequency after total colectomy [28]. Our data point to a "reservoir-propulsion trade-off." A longer remnant gives more storage capacity—which helps continence early on—but the sluggish distal segment does not empty well, so stool accumulates and constipation returns. A

shorter remnant empties efficiently, but without the reservoir, patients struggle with frequency and incontinence in the short term. Over 12 months, both groups recovered some resting and squeeze pressures, suggesting that the retained rectum adapts. How exactly that happens is unclear and needs human studies, but possible mechanisms include neural regeneration, remodeling of the extracellular matrix, and changes in smooth muscle tone. The RAIR data add a small piece: about 20% of patients lost the reflex at 3 months, but most regained it by 12 months, mirroring the recovery of resting and squeeze pressures. This pattern suggests that the neural circuits subserving the RAIR may be temporarily disrupted during rectal transection but can recover over time, supporting the concept of functional adaptation. The clinical implication is that early postoperative incontinence may be, at least in part, a transient phenomenon related to neural stunning rather than permanent structural damage. This is reassuring for patients experiencing early symptoms and suggests that conservative management and pelvic floor rehabilitation should be offered before considering further interventions for incontinence.

Limitations

Several limitations deserve mention. The single-center observational design and non-randomized allocation introduced confounding by indication, as transection level was driven by disease severity and adhesions—factors directly tied to prognosis. Despite multivariable adjustment, residual confounding cannot be ruled out. The preoperative workup was not fully uniform—defecography was used selectively, and psychological and upper GI motility assessments were not routine. The sample size ($n = 57$) limited power, especially for continence outcomes, and we did not adjust for multiple comparisons; findings with P values between 0.01 and 0.05 should be viewed as exploratory. The 5-cm cutoff was borrowed from ileorectal anastomosis literature [10] and may not be biologically optimal for cecorectal anastomosis, though sensitivity analyses with 4-cm and 6-cm cutoffs gave consistent results. Our patients were older than most STC series, limiting generalizability, and one year of follow-up is insufficient for long-term assessment. Remnant length measurement was done intraoperatively without formal reproducibility validation, and the peritoneal reflection can be difficult to identify consistently. Dietary and quality-of-life data after discharge were not systematically collected. Multi-center prospective studies with longer follow-up and rigorous confounding control are needed.

Conclusions

In this cohort, shorter rectal remnants correlated with better constipation relief and quality of life. Longer remnants offered some early protection against incontinence, but that advantage faded by one year. However, because the sicker patients got the shorter remnants, we cannot be sure that remnant length itself caused the difference. The association is real in this dataset, but causality is unproven. Until a randomized trial settles the question, surgeons should choose the transection level case by case, weighing these functional trade-offs against each patient's anatomy and priorities.

Abbreviations

STC

Slow-transit constipation

SC-CRA

Subtotal colectomy with cecorectal anastomosis

TC-IRA

Total colectomy with ileorectal anastomosis

ASCRS

American Society of Colon and Rectal Surgeons

RAIR

Rectoanal inhibitory reflex

RAP

Resting anal pressure

MSP

Maximum squeeze pressure

WCTT

Whole-colon transit time

GIQLI

Gastrointestinal Quality of Life Index

ODS

Obstructed defecation syndrome

ASA

American Society of Anesthesiologists

BMI

Body mass index

IQR

Interquartile range

SD

Standard deviation

CI

Confidence interval

Declarations

Ethics approval and consent to participate

The study protocol was approved by the Ethics Committee of Affiliated Hangzhou First People's Hospital, School of Medicine, Westlake University. All procedures performed in this study conformed to the provisions of the Declaration of Helsinki. Written informed consent was obtained from all eligible patients prior to enrollment.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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Author Contribution

Authors' contributions KC (Kangwen Cheng): conceptualization (study design and research framework development), project administration (overall coordination of the research team and project execution), supervision (oversight of clinical operations and surgical quality control), writing—review & editing (critical revision of the manuscript for important intellectual content). JH (Jemin Huang): conceptualization (contribution to study design and hypothesis formulation), investigation (patient enrollment, data collection, and clinical assessment), writing—original draft (drafting of the initial manuscript). LL (Liangliang Li): formal analysis (performed the statistical analyses and interpreted the results), methodology (developed the analytical strategies and contributed to study protocol design). QC (Qiang Chen): data curation (organized and maintained the research database), validation (verified the accuracy and completeness of the data), visualization (prepared the figures, tables, and graphical presentations). SZ (Sixin Zheng): formal analysis (assisted with statistical modeling and data interpretation), software (managed the statistical software and analytical tools), validation (participated in data quality checks and verification). JC (Junyi Chen): investigation (performed patient assessments and collected clinical data), data curation (assisted in database management and data entry). ZW (Zhiqiang Wu): investigation (contributed to patient recruitment and clinical evaluations), project administration (assisted in study logistics and coordination of follow-up assessments). YZ (Yixin Zheng): data curation (supported data collection, entry, and database maintenance). LW (Liang Wang): methodology (provided methodological guidance and quality assurance), supervision (clinical supervision and oversight of surgical procedures). KL (Kai Lin): formal analysis (oversaw statistical analysis and data interpretation), methodology (guided the study methodology and analytical framework), resources (provided institutional support and research infrastructure). YS (Yuqiang Shan): conceptualization (led study design and hypothesis generation), funding acquisition (secured financial support for the research), supervision (overall study oversight, final responsibility for the research integrity and clinical governance). KC, JH, and LL contributed equally to this work and share first

authorship. All authors reviewed and approved the final manuscript and agree to be accountable for all aspects of the work.

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Not applicable.

Data Availability

The datasets generated and/or analyzed during the current study are available from the corresponding author upon reasonable request, but restrictions apply to the availability of these data, which were used under institutional ethics approval for the current study and so are not publicly available. The data are, however, available upon request and with the permission of the Ethics Committee of Affiliated Hangzhou First People's Hospital, School of Medicine, Westlake University, and subject to institutional privacy policies.

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Figures

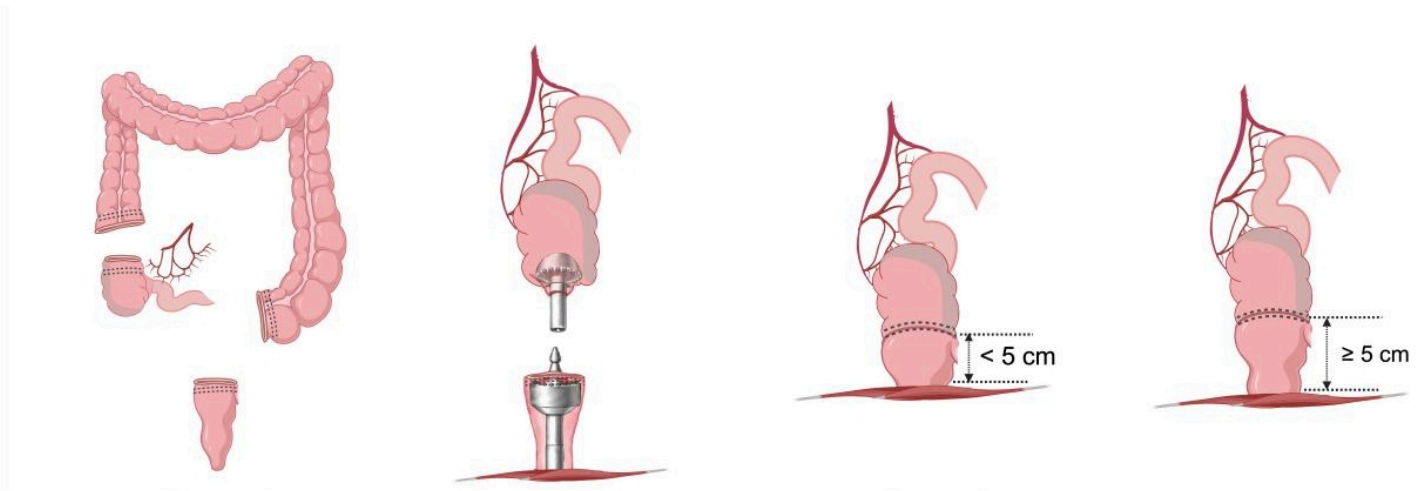


Figure 1

Schematic illustration of laparoscopic subtotal colectomy with antegrade cecorectal anastomosis. (a) Extent of colonic resection during laparoscopic subtotal colectomy, including appendectomy, with preservation of the ileocecal junction and a portion of the rectal remnant. (b) Mechanical end-to-end antegrade cecorectal anastomosis. (c) Short-remnant anastomosis, defined as a rectal remnant length of <5 cm above the peritoneal reflection. (d) Long-remnant anastomosis, defined as a rectal remnant length of ≥ 5 cm above the peritoneal reflection.

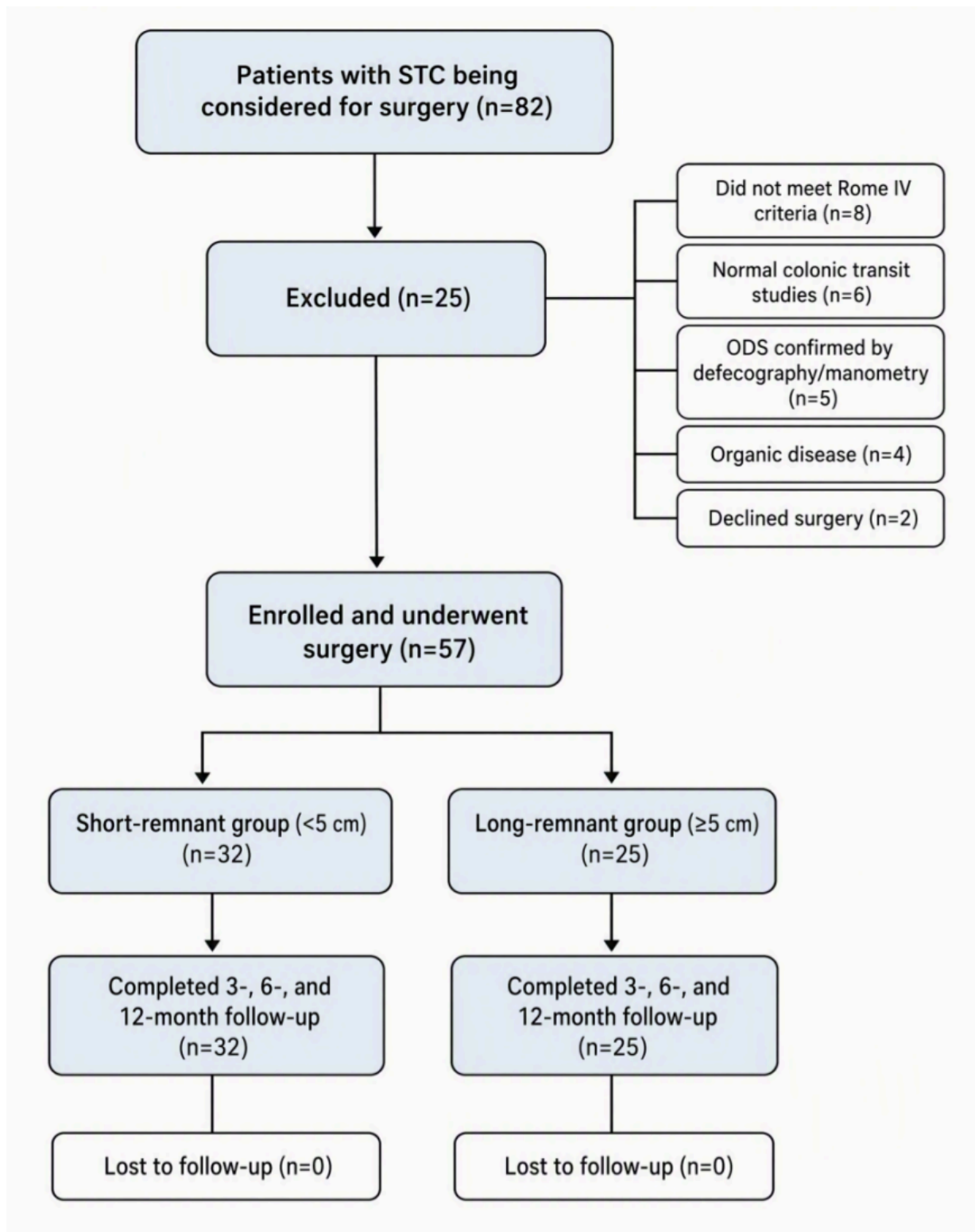


Figure 2

Patient flow diagram. STC: slow-transit constipation; ODS: obstructed defecation syndrome; Rome IV: Rome IV criteria for functional constipation.

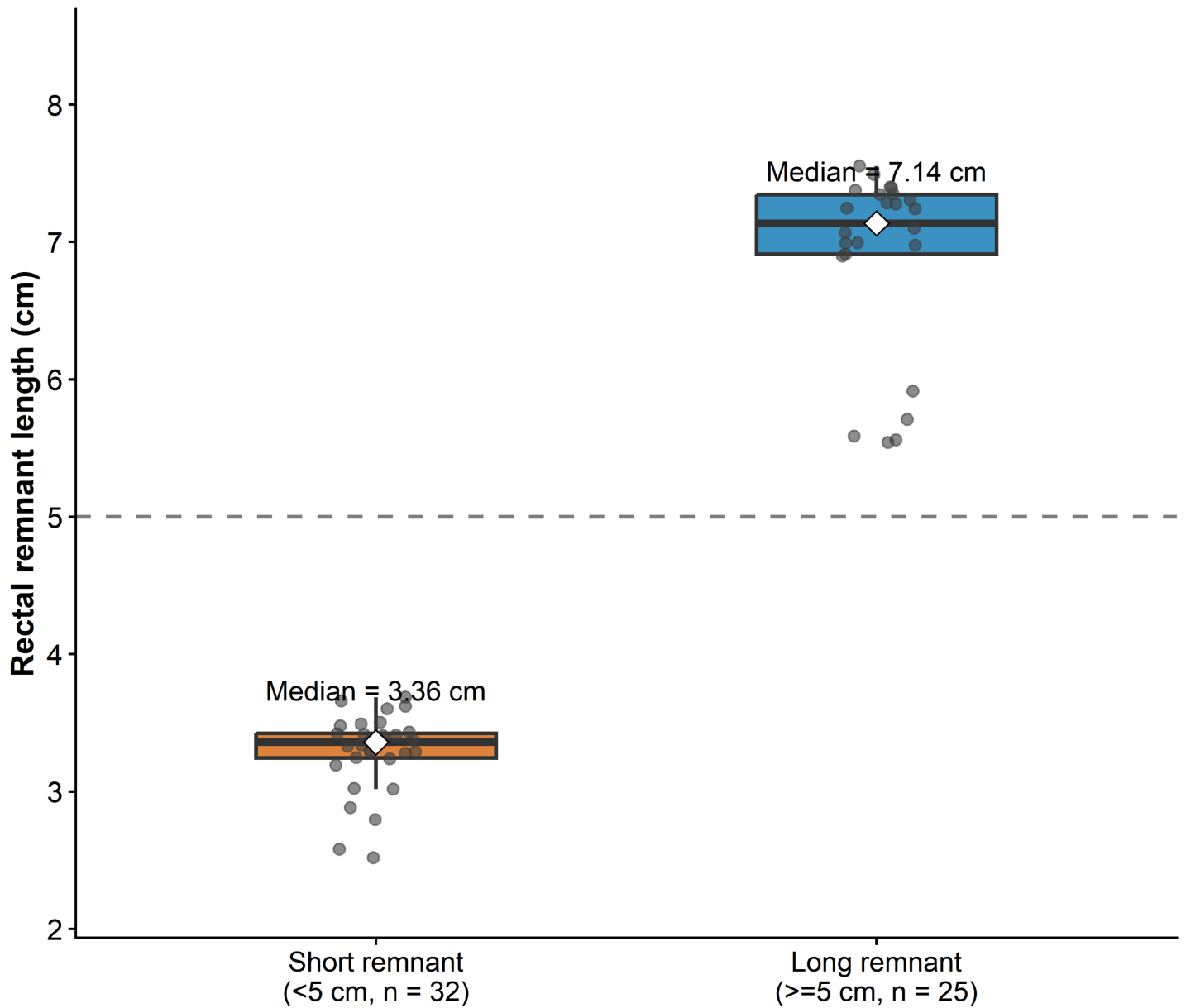


Figure 3

Box plot showing the distribution of rectal remnant lengths in the short-remnant group (<5 cm, n=32) and long-remnant group (≥5 cm, n=25). Boxes represent the interquartile range (IQR), horizontal lines indicate the median, and whiskers represent the range (minimum to maximum). Short-remnant group: median 3.4 cm (IQR: 3.3–3.6 cm; range: 2.5–3.9 cm); Long-remnant group: median 7.2 cm (IQR: 6.8–7.6 cm; range: 5.5–8.0 cm). $P < 0.01$ (Mann–Whitney U test).

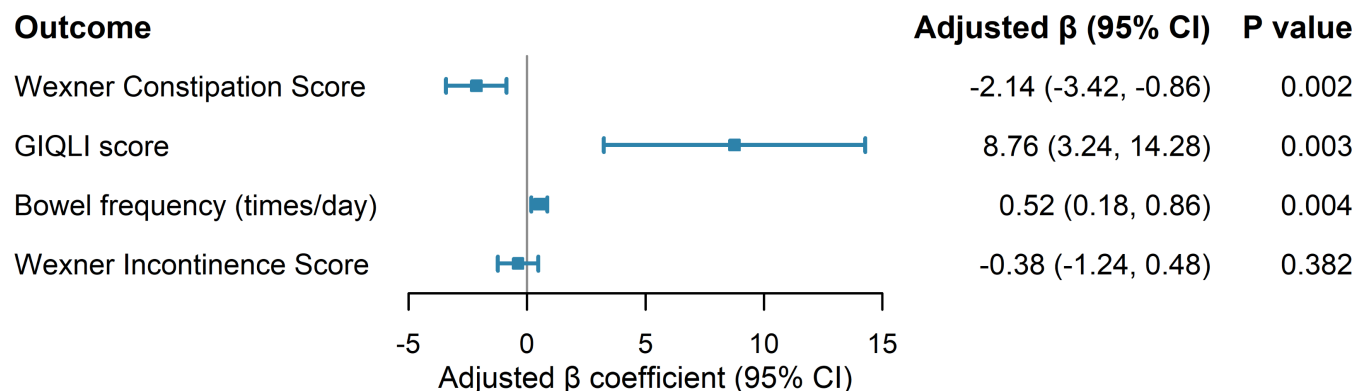


Figure 4

Correlation between rectal remnant length and 12-month functional outcomes. Scatter plots illustrating the relationship between rectal remnant length (cm) and four 12-month outcomes: (A) Wexner Constipation Score, (B) GIQLI score, (C) bowel frequency (times/day), and (D) Wexner Incontinence Score. Orange circles represent patients with short remnant (<5 cm); blue triangles represent patients with long remnant (≥ 5 cm). The solid line represents the Loess regression curve with 95% confidence band (gray shading). Spearman correlation coefficients (r^*) and P values are shown in each panel. GIQLI, Gastrointestinal Quality of Life Index.

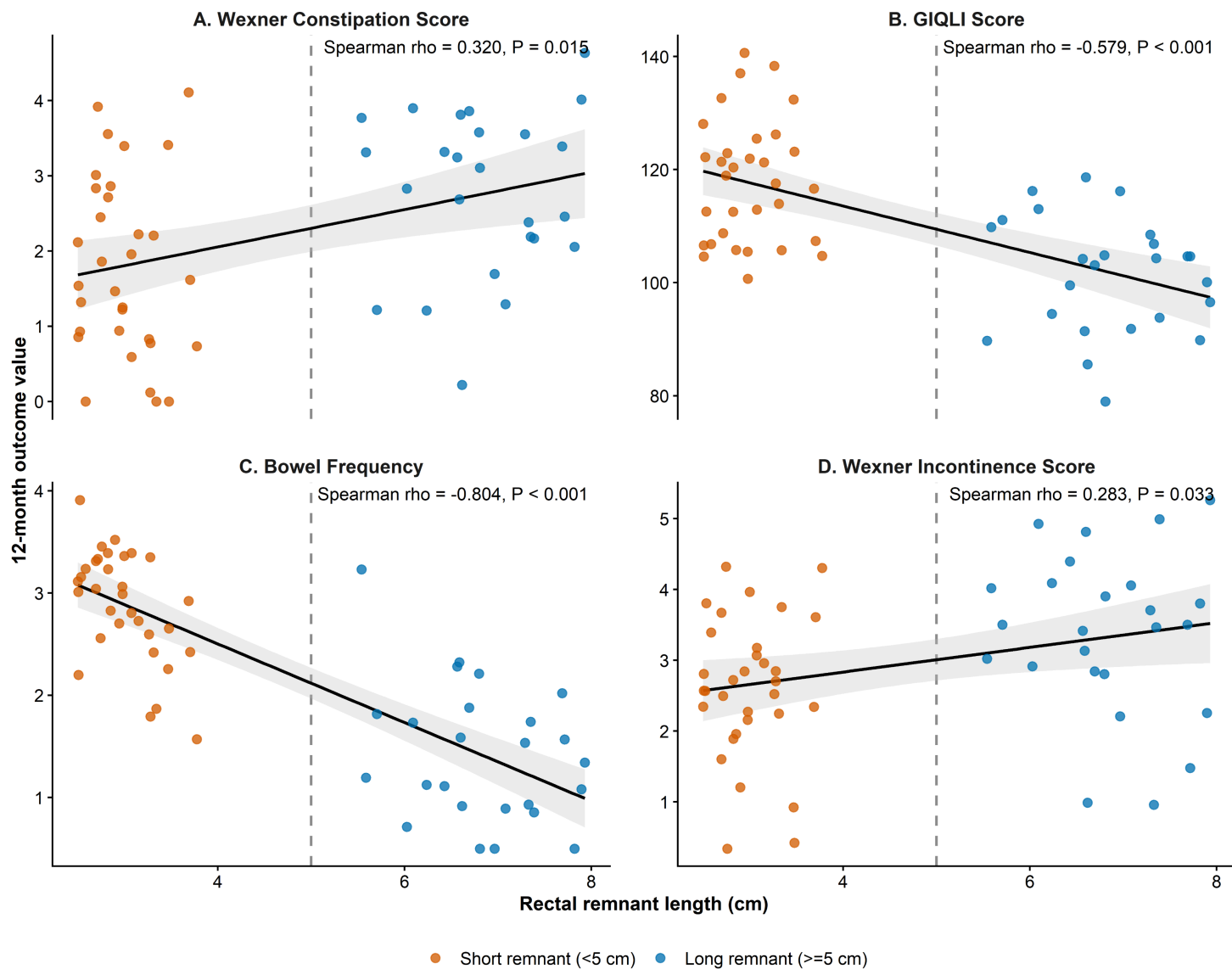


Figure 5

Forest plot of multivariable linear regression analyses for 12-month functional outcomes. The forest plot displays adjusted β coefficients and 95% confidence intervals for the independent association between remnant group (short vs. long) and each outcome, controlling for age, sex, BMI, baseline WCTT, constipation duration, and decision factor. Squares represent point estimates; horizontal lines represent 95% confidence intervals. GIQLI, Gastrointestinal Quality of Life Index.

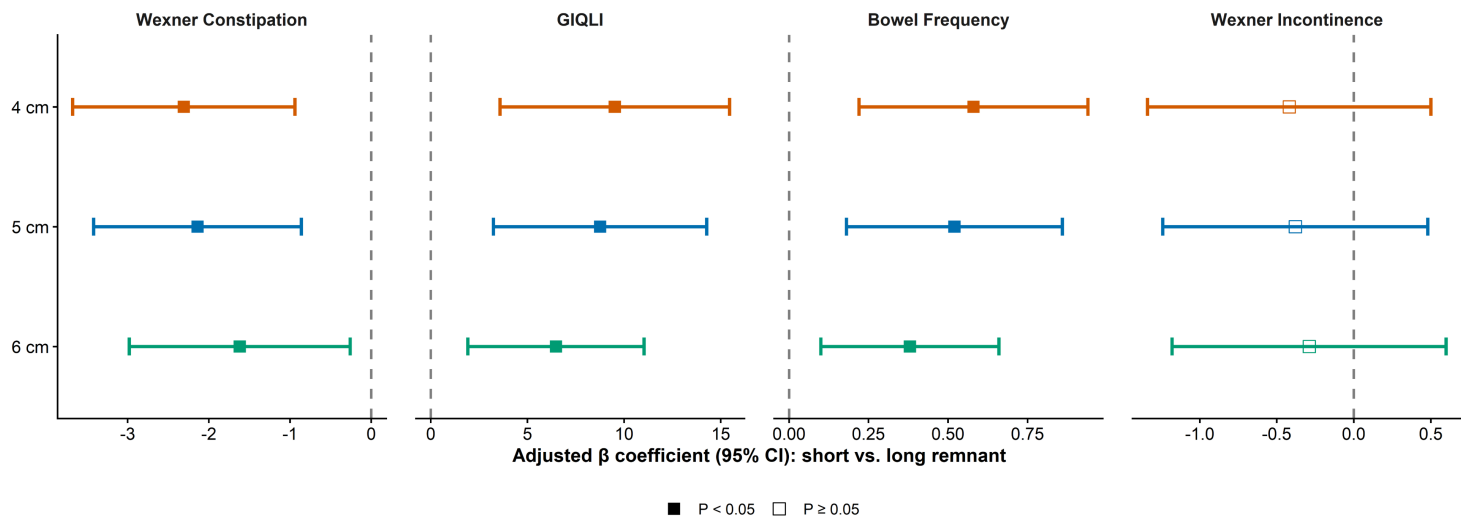


Figure 6

Sensitivity analysis around alternative cutoffs. Forest plot comparing the effect of short versus long rectal remnant on 12-month outcomes across three cutoff thresholds: 4 cm (short <4 cm, n=21; long $\geq$ 4 cm, n=36), 5 cm (short <5 cm, n=32; long $\geq$ 5 cm, n=25), and 6 cm (short <6 cm, n=41; long $\geq$ 6 cm, n=16). Squares represent point estimates (β coefficients); horizontal lines represent 95% confidence intervals. The vertical line at 0 indicates no effect. Positive β values indicate worse outcomes for the short-remnant group; negative β values indicate better outcomes. GIQLI, Gastrointestinal Quality of Life Index.