Superior Rectal Artery Preservation in Laparoscopic-Assisted Subtotal Colectomy and Ileorectal Anastomosis for Slow-Transit Constipation

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Article

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Abstract: Our previous retrospective observational study demonstrated the safety of laparoscopically assisted subtotal colectomy with ileorectal anastomosis and preservation of the superior rectal artery (SRA), without instances of leakage, in patients with slow-transit constipation (STC). Thus, we extended the enrollment period and enlarged the sample size to detect the differences in the post-operative complications, and surgical and functional outcomes between patients who underwent laparoscopically assisted subtotal colectomy with and without SRA preservation. We conducted a retrospective single-center analysis of patients with STC who underwent laparoscopically assisted subtotal colectomy between 2016 and 2020. The diagnosis of STC was based on the colonic transit and anal functional tests, and barium enema to exclude secondary causes. Patients were divided into group A that underwent surgery with SRA preservation, and group B that underwent ligation of the SRA during surgery. Outcome assessments for both groups included the incidence of anastomotic breakdown, intraoperative complications, length of hospital stay, estimated blood loss, time to first flatus, and complications. Propensity-score matching allocated 34 patients to groups A and B each. Postoperative bowel function, including time to first flatus, stool, and oral intake, recovered better in group A than that in group B. Anastomotic leakage, a significant postoperative complication, was less frequent in patients with SRA preservation. Preservation of the SRA in patients undergoing laparoscopically assisted subtotal colectomy with ileorectal anastomosis for STC is associated with favorable postoperative bowel function recovery and lower anastomotic leakage rates.

Keywords: slow-transit constipation; superior rectal artery; anastomosis leakage

1. Introduction

Constipation is a condition characterized by infrequent bowel movements, difficulty in passing stool, or a feeling of incomplete bowel movements. It can be caused by a variety of factors such as a low-fiber diet, dehydration, lack of physical activity, certain medications, and medical conditions such as irritable bowel syndrome or hypothyroidism. It is important to treat constipation as it can lead to discomfort, pain, and complications such as hemorrhoids or fecal impaction in some cases. The treatment for constipation entails lifestyle modifications such as increasing fiber intake and exercise, medications that stimulate bowel movements, or, in severe cases, surgical intervention [1–4].

Although slow-transit constipation (STC) has traditionally been classified as a functional disorder, recent clinical and manometric evidence suggests that most motility alterations in STC may be neuropathic in origin. This indicates that STC may be caused by impairment of the nerves that control the muscles involved in bowel movements, rather than simply being a result of decreased motility of the digestive system. This new understanding of the mechanisms underlying STC may

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lead to the formulation of more targeted and effective treatment options.[5] Infrequent bowel movements, typically one or fewer per week, are among the hallmark symptoms of STC. The diagnosis of STC often requires a colonic transit test that uses radiopaque markers to track the movement of fecal matter through the colon. Delay in emptying of these markers can indicate a problem with digestive system motility, which is characteristic of STC. Other symptoms may include bloating, abdominal discomfort, and a feeling of incomplete evacuation after bowel movements [2,3,6]. Surgical intervention may be necessary for STC without pelvic outlet obstruction that does not respond well to conservative treatment with laxatives. Subtotal colectomy, which entails removal of a significant portion of the colon, is an effective surgical option for STC. This procedure can help improve motility and reduce the symptoms of constipation. However, as with any surgery, the risks and potential complications must be carefully considered before selecting this treatment option. It is important for patients to discuss the risks and benefits of surgery with their healthcare provider to facilitate informed decision-making.[7] Anastomotic leakage is a potentially serious and most undesirable complication of colorectal surgery. It is defined as leakage of intraluminal contents from a surgical connection between the two intestines that occurs when the connection or anastomosis between two sections of the colon or rectum does not heal properly after surgery.[8] It is reportedly responsible for a postoperative mortality rate as high as 40%, prolonged hospitalization, and an increase in the overall healthcare costs due to the requirement of sepsis treatment and additional surgical intervention to repair the leak. In addition to the physical and financial burden on patients and healthcare systems, anastomotic leakage can also have a significant effect on the quality of life, as patients may experience persistent symptoms that require continuous medical care.[9] Therefore, the objective of this study was to investigate the feasibility, utility, and outcomes of patients with STC who underwent superior rectal artery (SRA) preserved laparoscopically assisted subtotal colectomy.

2. Materials and Methods

This study incorporated a retrospective single-center design. The decision to preserve the SRA during laparoscopic-assisted subtotal colectomy for STC was left to the surgeon's discretion. Patients who were treated at the Division of Colon and Rectal Surgery at the Taiwan Adventist Hospital and diagnosed with constipation (according to Rome II criteria) between January 2016 and January 2020 were evaluated using laboratory tests including thyroid function tests, serum calcium, serum glucose, and complete blood counts. All patients underwent clinical evaluation, including digital rectal examination and psychological consultation. Patients with other conditions such as colonic obstruction and drug-induced constipation were excluded. The diagnosis of STC was based on a series of diagnostic tests, including the colonic transit test, anorectal manometry, balloon expulsion test, and barium enema. A positive colonic transit test was defined as radiopaque marker stasis in the colorectum exceeding 20% after 96 h. Anorectal manometry and balloon expulsion tests were performed to ensure that there was no outlet-obstructed defecation and rule out pelvic floor dysfunction. This thorough diagnostic work-up facilitated accurate diagnosis of STC and the exclusion of other potential causes of constipation, which helped in the implementation of more effective and targeted treatment approaches. Patients underwent a barium enema to ensure that there were no mechanical obstruction problems, and all cases showed a redundant colon. Colonoscopy findings were normal in all patients, and anal ultrasonography did not reveal disruption of the external anal sphincter. Patients with a colonic transit test time greater than 96 h but whose barium enema, balloon expulsion test, anal manometry, colonoscopy, and anal ultrasonography results were normal were deemed suitable for inclusion in this analysis. Informed consent was obtained from all patients prior to examination. Since January 2016, the surgical team has attempted to preserve the SRA in every patient with STC. All surgeries were performed by the same team. This consistent approach helped ensure uniformity and minimize variations in surgical techniques or patient selection, which could affect the study results.

A total of 100 patients diagnosed with STC underwent laparoscopic-assisted subtotal colectomy between January 2016 and January 2020. The SRA in the ileorectal anastomosis (IRA) was spared in patients treated between January 2016 and January 2018. Data on various factors were recorded,

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including age, body mass index, preoperative laxative dependence, preoperative defecation duration, colonic transit time, operative time, largest incision length, volume of blood loss, operative complications, postoperative bowel movements, length of hospital stay, and functional outcomes. These data were used to analyze the feasibility, utility, and outcomes of patients with STC who underwent SRA-preserved laparoscopic-assisted subtotal colectomy.

This study was conducted in accordance with the Declaration of Helsinki and approved by the Institutional Review Board of Taiwan Adventist Hospital (TAHIRB No.105-E-10). Written informed consent was obtained from all patients for inclusion in the study, and their personal information was de-identified prior to analysis. Patient characteristics were presented using percentages and mean ± standard deviation. Propensity-score matching (PSM) analysis was performed by matching age, sex, and body mass index and establishing a tolerance level of 0.05 to reduce the effects of confounding variables. An omnibus test was conducted and statistical analyses were performed using IBM SPSS statistical software version 22 for Windows (IBM Corp., Armonk, NY, USA).

Surgical technique

Two highly experienced colorectal surgeons, who perform over 100 laparoscopic and open colorectal cancer procedures annually, conducted laparoscopic surgeries entailing preservation of the SRA in patients with STC. The planned procedure for all cases was laparoscopic subtotal colectomy with IRA under general anesthesia, with the patients placed in the modified lithotomy position. The laparoscopic procedure involved the use of five trocars: the primary trocar was a 10-mm port inserted above the umbilicus to establish a pneumoperitoneum for the laparoscope. Four working ports of different sizes were established as follows: a 12-mm port at the right iliac fossa, a 10-mm port at the left iliac fossa, and two 5-mm ports in the right and left upper quadrants of the abdomen. Mobilization of the colon segments was initiated from the right colon using the LigaSure device.

All patients in group A underwent laparoscopic subtotal colectomy with preservation of the SRA, which was performed by two experienced colorectal surgeons. The surgical procedure involved mobilization of the colon segments, resection of the rectosigmoid colon with a laparoscopic linear stapler, and mobilization of the rectal stump for transanal insertion of a circular stapler or Hegar dilator.

A 4-5-cm long surgical incision was made in the Pfannenstiel area and the mobilized bowel section was brought out. The end of the ileum was separated a few centimeters before the ileocecal valve, and the anvil of a circular stapling device was inserted into its lumen. The anvil-secured ileum was placed back into the abdominal cavity, and a circular stapling device was used to perform a transanal end-to-end anastomosis. A Jackson Pratt drain was placed in the pelvis, followed by layer-by-layer wound closure.

3. Results

A total of 100 patients diagnosed with STC underwent laparoscopic-assisted subtotal colectomy with IRA between January 2016 and January 2020. Table 1 displays the participants' preoperative characteristics. The SRA was preserved in 59 patients (group A) and sacrificed in 41 patients (group B). All patients had been diagnosed with STC prior to the procedure, and each patient had severe constipation with an average defecation duration of 7.9 and 9.3 days, respectively. Before surgery, almost all patients reported intermittent abdominal pain (55 and 36 patients in groups A and B, respectively). Except for the colonic transit time, which was 148.2 and 141 h in groups A and B, respectively, the preoperative characteristics did not differ significantly between the two groups.

PSM analysis was performed with age-, sex-, and body mass index-matched patients, with 34 patients allocated to each group (Table 2). The significant difference in the preoperative colonic transit time between the two groups (148.4 and 138.2 h) was retained even after PSM analysis.

Table 3 outlines the intra- and postoperative characteristics of the patients. The surgical time with preservation of the SRA was 142.8±28.8 min, while surgery with ligation required 148.7±33.6 min ($p = 0.439$). The average length of hospitalization did not differ significantly between group A (9.9±3.2 days) and group B (10.1±2.6 days) ($p = 0.806$). However, the average time of first flatus was

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significantly shorter in group A (2.8±0.9 days) than in group B (4.2±1.5 days) ($p < 0.001$). Similarly , the average time of oral intake was significantly shorter in group A (2.9±0.8 days) than in group B (4.3±1.1 days) ($p < 0.001$).

No intra-operative complications were observed (Table 4). Anastomotic breakdown did not occur in group A, whereas it occurred in four patients (11.8%) in group B ($p = 0.039$). The incidence of postoperative ileus or urinary tract infections did not differ significantly between the two groups. Postoperative complications such as incisional hernia developed in only one patient (1.5%) in group A, and no wound infections were observed in either group. The Jackson–Pratt drain was removed on the day of discharge, and there were no surgery-related mortalities. No patient required conversion to exploratory laparotomy.

Table 1. Preoperative variables before propensity-score matching.

Variables	Group A (n=59)	Group B (n=41)	P-value
Age (years)	39.4±10.7	42.9±11.0	0.120
Body mass index (kg/m²)	24.6±3.7	25.8±3.1	0.100
Female (%)	44 (74.6)	33 (80.5)	0.490
Preoperative laxatives dependent (years)	13.9±5.9	14.1±5.8	0.846
Preoperative defecation duration (days)	7.9±3.7	9.3±3.9	0.083
Colonic transit time (h)	148.2±16.8	141±21.6	0.065
Previous abdominal surgery	13 (22)	5 (12.2)	0.208
Preoperative abdominal pain	55 (93.2)	36 (87.8)	0.352

[1] Values with mean (SD) or total number (percentage).

Table 2. Preoperative variables after propensity-score matching.

Variables	Group A (n=34)	Group B (n=34)	P-value
Age (years)	42.3±11.0	41.7±11.1	0.827
Body mass index (kg/m²)	25.8±3.7	25.9±3.2	0.902
Female (%)	24 (70.6)	28 (82.4)	0.253
Preoperative laxatives dependent (years)	14.3±5.6	14.2±5.2	0.929
Preoperative defecation duration (days)	8.0±3.6	9.5±3.8	0.100
Colonic transit time (h)	148.4±17.4	138.2±19.5	0.025
Previous abdominal surgery	7 (20.6)	2 (5.9)	0.074
Preoperative abdominal pain	32 (94.1)	30 (88.2)	0.393

Values with mean (SD) or total number (percentage).

Table 3. Surgical and postoperative variables.

Variables	Group A (n=34)	Group B (n=34)	P-value
Operative time (min)	142.8±28.8	148.7±33.6	0.439
Estimated blood loss (mL)	104.3±46.1	133.5±43.3	0.009
Time to first flatus (days)	2.8±0.9	4.2±1.5	<0.001
Time to first stool passage (days)	2.7±0.6	2.4±0.5	0.037
Time to oral intake (days)	2.9±0.8	4.3±1.1	<0.001
Dose of demerol administered (mg)	100±35	110±40	0.359
Duration of hospital stay (days)	9.9±3.2	10.1±2.6	0.806
Postoperative bowel frequency (per day)	2.2±1.0	2.3±1.0	0.597

Values with mean (SD) or total number (percentage).

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Table 4. Intraoperative and postoperative complications.

Characteristics	Group A (n=34)	Group B (n=34)	P-value
Intraoperative complication			
none	34 (100%)	34 (100%)	
Postoperative complications			
Urinary tract infection	3 (8.8%)	3 (8.8%)	1
Ileus (over 5 days)	4 (11.8%)	2 (5.9%)	0.393
Incisional hernia	1 (1.5%)	0 (0%)	0.314
Wound infection	0 (0%)	0 (0%)	1
Anastomosis leakage	0 (0%)	4 (11.8%)	0.039

Values with mean (SD) or total number (percentage).

4. Discussion

Constipation is common among adults, with an estimated prevalence of 16%. The primary treatment for constipation typically involves dietary modification and laxative administration. However, if these interventions are ineffective, it is crucial to rule out other causes, such as metabolic, organic, or pharmacological factors. STC is a subtype of constipation characterized by delayed transit of feces through the colon, in the absence of secondary causes. The mechanisms underlying STC include reduced colonic contractility in response to a meal or fewer high-amplitude-propagated contractions. However, the precise etiology of STC remains unclear.

A comprehensive set of physiological examinations, including colonic transit studies with radiopaque markers, balloon expulsion tests, anorectal manometry, and defecography,[10]are necessary for the accurate diagnosis of constipation. A colonic transit study is a crucial initial examination for patients with STC, as it provides important information about the transit time of stool through the colon. The radiopaque marker test is a simple, easy, and informative method. Additionally, anorectal manometry should be included in physiological examinations to eliminate the possibility of pelvic floor dysfunction. Anorectal manometry was performed in our study, and no abnormal anorectal inhibitory reflexes were observed in the patient population. Furthermore, colonoscopy or barium enema may be used to identify pathological entities or structural lesions.[11] Currently, total colectomy followed by IRA is considered the standard of care for patients with STC who are refractory to conservative treatment.[12]

We performed a case-control study[13] on the basis of the results of our previous single-center, observational study that included 32 patients. The cross-matched case-control study enrolled 34 patients with SRA preservation were in the preservation group. The incidence of anastomotic leakage after gastrointestinal surgery varies according to the localization of the anastomosis (all resections: 4.3%-13%).[14] Ischemia of the anastomotic region is one of the most important factors leading to anastomotic leakage. Given the devastating consequences of anastomotic leakage in colorectal surgery, numerous studies have explored the impact of rectal blood supply on anastomotic healing, with special emphasis on the preservation of the inferior mesenteric artery. However, research on the effects of SRA on anastomotic healing and postoperative complications is limited, particularly in patients with STC. In addition to reducing the risk of anastomotic leakage, the SRA-sparing technique may also preserve the hypogastric nerve, which can potentially improve functional outcomes.[15]

Bergamaschi et al. investigated 30 patients who underwent laparoscopic SRA-preserving sigmoidectomy for complete rectal prolapse and found no anastomotic leakage.[16] A similar result was reported by Tocchi et al., who conducted a randomized controlled trial and found prominent lower anastomotic leakage rate in the SRA-preserving group among patients undergoing left colectomy for diverticular disease.[17] Sohn et al. have also demonstrated that preserving the SRA may be associated with a reduced rate of anastomotic leakage in patients undergoing laparoscopic sigmoid resection for diverticular disease.[15] In our study, no anastomotic leakage and faster post-operative bowel function recovery was noted in the SRA-preserving group.

The application of laparoscopic techniques to colon surgery has been successful in reducing morbidity, mortality, and length of hospital stay.[18,19] The length of hospital stay typically ranges from 7 to 13 days in patients with STC.[20–22] However, postoperative ileus can complicate the treatment course for many patients following surgery.[7] Although we did not find a lower postoperative ileus rate in our study, earlier first flatus after the operation in the SRA-reserving group enabled early oral intake after surgery.

The key limitation of our study was its retrospective design and small sample size. Moreover, tissue-sealing devices have improved over the years. At present, sparing of the mesosigmoid and mesorectum can be achieved much more easily during surgery owing to improvements in devices and their impact on the quality of dissection. Despite these limitations, we report a pilot study comparing the benefits of SRA preservation in subtotal colectomy with ileorectal anastomosis for STC.Authors should discuss the results and how they can be interpreted from the perspective of previous studies and of the working hypotheses. The findings and their implications should be discussed in the broadest context possible. Future research directions may also be highlighted.

5. Conclusions

Preservation of the SRA in patients with STC undergoing laparoscopically assisted subtotal colectomy with ileorectal anastomosis appears to be associated with more favorable post-operative bowel function recovery outcomes and a lower risk of anastomotic leakage. which with better recovery during hospital course.

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