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ABOUT COVER

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MINIREVIEWS

Isoperistaltic *vs* antiperistaltic anastomosis after right hemicolectomy: A comprehensive review

Dimitrios Symeonidis, Kostas-Sotirios Karakantas, Labrini Kissa, Athina A Samara, Effrosyni Bompou, Konstantinos Tepetes, Georgios Tzovaras

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Abstract

To optimize the efficiency of ileocolic anastomosis following right hemicolectomy, several variations of the surgical technique have been tested. These include performing the anastomosis intra- or extracorporeally or performing a stapled or hand-sewn anastomosis. Among the least studied is the configuration of the two stumps (*i.e.*, isoperistaltic or antiperistaltic) in the case of a side-to-side anastomosis. The purpose of the present study is to compare the isoperistaltic and antiperistaltic side-to-side anastomotic configuration after right hemicolectomy by reviewing the relevant literature. High-quality literature is scarce, with only three studies directly comparing the two alternatives, and no study has revealed any significant differences in the incidence of anastomosis-related complications such as leakage, stenosis, or bleeding. However, there may be a trend towards an earlier recovery of intestinal function following antiperistaltic anastomosis. Finally, existing data do not identify a certain anastomotic configuration (*i.e.*, isoperistaltic or antiperistaltic) as superior over the other. Thus, the most appropriate approach is to master both anastomotic techniques and select between the two configurations based on each individual case scenario.

Key Words: Isoperistaltic side-to-side anastomosis; Antiperistaltic side-to-side anastomosis; Ileocolic anastomosis; Right hemicolectomy; Scenario

Core Tip: This review assesses and compares two side-to-side anastomotic configurations (isoperistaltic and antiperistaltic) following right hemicolectomy. Current literature does not identify any anastomotic configuration as superior over the other. Thus, the most appropriate approach is to master both anastomotic techniques and select between the configurations based on each individual case scenario.

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INTRODUCTION

Colorectal cancer is one of the most common cancers globally, with an increasing incidence in developing countries and stabilizing trends in highly-developed countries[1]. For right-sided colon cancer, right hemicolectomy is the surgical treatment of choice[2]. Following resection, an anastomosis is performed between the terminal ileus and the transverse colon. For example, an ileocolic anastomosis may be performed to reestablish gastrointestinal tract continuity. Over the past decades, two major advances in the field of colon cancer surgery have been observed: The development of the laparoscopic approach and the concept of complete mesocolic excision (CME). Several studies have demonstrated superior short-term results and similar long-term oncological outcomes with the laparoscopic approach as compared to the traditional open approach[3,4]. Similar to the concept of total mesorectal excision for rectal tumors, Hohenberger *et al*[5] proposed CME for the surgical treatment of colon cancer. A recent meta-analysis has shown that a right hemicolectomy with CME is not inferior in terms of safety. Furthermore, this approach is associated with a greater lymph node yield, as well as better overall and disease-free survival as compared to traditional surgery[6]. Additionally, apart from colon cancer, terminal ileitis seen with Crohn's disease is a common indication for a more limited type of resection (*i.e.*, ileocecal resection) including the affected part of the small bowel, followed by an ileocolic anastomosis[7,8].

Following the resection, the efficiency and functionality of the ileocolic anastomosis influence operative outcomes and patient recovery. In the quest for optimal results, several variations of the surgical technique have been extensively tested, with studies often reporting conflicting results[9-11]. Some of the tested alternatives include conducting the anastomosis intra- or extracorporeally when the laparoscopic approach is followed, using a side-to-side or an end-to-end configuration and performing a stapled or hand-sewn anastomosis[9-11]. Parameters of success in the early postoperative period (*e.g.*, incidence of anastomosis-related complications, time to first flatus, time to recommencing oral feeding) as well as parameters reflecting long-term results (*e.g.*, functional recovery of the gastrointestinal tract, post-resection quality of life scores) have been commonly used as comparison end points. However, among the least-studied surgical technique aspects is the configuration of the stumps in the case of side-to-side anastomosis, (*i.e.*, isoperistaltic or antiperistaltic stump configurations). The purpose of the present article is to assess and compare the isoperistaltic *vs* antiperistaltic side-to-side anastomotic configurations following a right hemicolectomy by reviewing relevant literature.

Factors influencing the healing of the anastomosis

Anastomotic leakage is a clinical manifestation of a failing anastomosis. With a reported prevalence ranging between 1% and 19%, it is considered the most dramatic complication following colorectal surgery[12]. Several factors negatively influencing the physiological healing of the anastomosis have been identified. For prevention and early detection, risk factors for anastomotic leakage have been classified into preoperative, tumor-related, and intraoperative risk factors[13]. Table 1 displays potentially modifiable risk factors for anastomotic leakage, which are of the utmost importance in the preoperative setting[12,13]. From a technical perspective, the three most important factors for mastering a bowel anastomosis include: (1) Meticulous surgical technique, taking extra care to prevent hematoma formation and to achieve optimal seromuscular apposition; and (2) Adequate blood supply of the two bowel stumps; and (3) Elimination of tension at the anastomosis[14-16].

TYPES OF ANASTOMOSES

After right hemicolectomy, a favorable operative outcome depends primarily on the efficiency of the ileocolic anastomosis. A functional, complication-free anastomosis can guarantee an uneventful

Table 1 Risk factors for anastomotic leakage

	Preoperative	Tumor related	Intraoperative
Non- modifiable	Male sex	Distal tumor site	Excessive blood loss
	ASA score > II	Tumor size > 3 cm	Need for transfusion
	Chronic renal disease	Advanced stage disease	Duration > 4 hours
	History of radiotherapy	Non-elective surgery	
		Metastatic disease	
Modifiable	Smoking		
	Obesity		
	Poor nutrition		
	Alcohol abuse		
	Immunosuppressant use		

ASA: American Society of Anesthesiology.

postoperative course and improved quality of life in the long-term. To identify the optimal approach, various anastomotic techniques altering several technical parameters have been proposed. In general, anastomosis can be performed either by the use of sutures (*i.e.*, hand-sewn anastomosis) or by the use of stapling devices (*i.e.*, stapled anastomosis).

Hand-sewn anastomosis can be performed with the use of various suture materials. Materials such as silk, linen, catgut, and nylon were traditionally utilized for colorectal anastomosis. Generally, the use of absorbable or multi-filament sutures can increase tissue reaction and damage, without the guarantee of uneventful anastomosis healing[17]. Today, most gastrointestinal anastomoses are performed using slowly absorbable monofilament polydioxanone sutures[17]. In earlier decades, a double-layer inverting anastomotic technique was the standard for gastrointestinal anastomosis[18]. However, single-layer anastomosis became popular following favorable results reported by various studies[18,19]. More recent studies have failed to demonstrate a difference between the double- and single-layer techniques[20,21]. However, a single-layer continuous anastomosis costs less and can be constructed in significantly less time, with a similar complication rate as compared to the two-layer technique[22]. The dilemma in choosing between interrupted or continuous sutures arose when single-layer anastomoses became the standard of practice. As existing literature on the subject is limited and does not show obvious trends, a continuous suture may be preferable to interrupted sutures for creating intestinal anastomosis, since it is less time-consuming and technically simpler[23,24].

Conversely, stapled anastomosis can include the use of different types of stapling devices. These include linear, transverse, and circular staplers with two- or three-row stapling line systems. Following the introduction of stapled colorectal anastomosis in the 1980s, both techniques (hand sewn and stapled anastomosis) have become available for the majority of surgeons. Several studies have compared these techniques[25]. A Cochrane review conducted by Choy *et al*[11] concluded that stapled functional end-to-end ileocolic anastomosis after right hemicolectomy is associated with fewer leaks as compared to hand-sewn anastomosis. However, the difference was not considered statistically significant when the clinically significant anastomotic leaks were used as the comparison endpoint[11]. In general, superiority of the stapled over the hand-sewn anastomosis has not been documented in the available literature[26].

Irrespective of the use of sutures or stapling devices, anastomoses can be further classified based on the configuration of the two stumps, (*i.e.*, end-to-end, end-to-side and side-to-side)[15] (Figure 1). Specifically for the side-to-side configuration, an additional distinction is made between isoperistaltic and antiperistaltic anastomoses, depending on the configuration and orientation of the two stumps. In the isoperistaltic variant, the peristaltic flow in both parts is towards the same normal, aboral direction (Figure 1).

DISCUSSION

Several technical parameters influence the final form of an intestinal anastomosis. In the case of a side-to-side anastomosis, one of these parameters is the configuration of the two bowel stumps as isoperistaltic or antiperistaltic. In attempt to identify the optimal configuration, interpretation of the reviewed studies is muddied by the modification of additional technical parameters in addition to the selection of an anastomotic configuration alone. The field becomes even more unclear with increased prevalence of

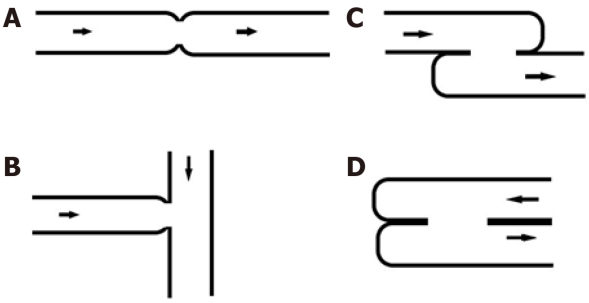

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Figure 1 Possible anastomotic configurations. A: End-to-end anastomosis; B: End-to-side anastomosis; C: Isoperistaltic side-to-side anastomosis; D: Antiperistaltic side-to-side anastomosis.

laparoscopic surgery and incorporation of CME principles in colorectal cancer surgery, which have notably increased heterogeneity of the comparison groups[3,4,6]. Moreover, the endpoint of functional recovery following colonic resections, time to first flatus, which has been used to compare the two configurations, seems to be influenced by the presence of other confounding factors.

Pros and cons of the different anastomotic configurations

Generally, the ideal intestinal anastomosis is one that can be easily performed from a technical perspective, can be reproduced by surgeons without advanced surgical skills, is associated with low or no rate of complication due to leakage or stenosis, and is aligned with the physiological function of the gastrointestinal tract. To date, no single technique or anastomotic form can guarantee success with respect to these desired characteristics. Traditionally, a hand-sewn end-to-end anastomosis has been considered the standard approach for reestablishing gastrointestinal tract continuity after colonic resection[27]. However, this approach was associated with an increased incidence of anastomosis-related complications, mainly stenosis, particularly if a notable discrepancy occurred in the luminal diameter of the two stumps and in the setting of significant prolongation of operative time[27,28].

After the introduction of stapling devices, a shift in surgical trends was seen from the use of hand-sewn towards stapled anastomosis[29]. A side-to-side stapled anastomosis became the new standard as a rapid and easier alternative, and it allowed surgeons to overcome technical difficulties posed when a significant discrepancy in the luminal diameter of the two stumps was present[30]. Increased safety due to lower anastomotic failure rates was attributed to the stapled approach, at least in early comparative studies[28,29,31-35]. As more colorectal cancer resections are performed laparoscopically, another surgical dilemma has emerged; namely, whether to perform the anastomosis intra- or extracorporeally. In 2003, Casciola *et al*[36] reported the first intracorporeal ileocolic anastomosis after a laparoscopic right hemicolectomy. Generally, performing an intracorporeal anastomosis following laparoscopic right hemicolectomy appears to be associated with quicker recovery of postoperative bowel function, decreased infection rates, and overall postoperative complications when compared to the extracorporeal anastomotic approach[36-38].

Side-to-side anastomoses are considered to have certain advantages over end-to-end anastomoses, including better blood supply and wider diameter. In addition, the detrimental effect of increased intraluminal pressure on the healing process of an anastomosis seems to be more efficiently addressed by the side-to-side configuration[39,40]. A side-to-side ileocolic anastomosis appears to be the preferred anastomotic configuration by the majority of colorectal surgeons[41]. The end-to-side ileocolic configuration following right hemicolectomy has recently gained popularity due to the favorable results reported from retrospective cohort studies comparing end-to-side with side-to-side anastomosis[42-44]. Lower leakage rates and faster recovery at the expense of increased technical difficulty were reported after end-to-side anastomosis as compared to side-to-side anastomosis[42-44]. Several theoretical advantages have been attributed to the end-to-side configuration. This configuration resembles the physiological entry point of the ileum into the cecum lumen, results in less damage to luminal muscle fibers, and has been shown to withstand higher intraluminal pressures than end-to-end anastomosis[45,6]. However, these results were not confirmed in a study by Kim *et al*[47] which is the only available prospective randomized trial in the field, nor by any large retrospective cohort studies.

A side-to-side anastomosis can be performed either with an isoperistaltic or antiperistaltic orientation of the two stumps[48] (Figure 1). In 2005, Tewari *et al*[49] proposed the isoperistaltic, stapled, side-to-side ileocolic anastomosis after right hemicolectomy, rather than the antiperistaltic side-to-side anastomosis which was most common at the time. Despite being the most anatomical anastomotic configuration (as it is consistent with the physiological flow of the intestinal contents), a theoretical limitation of the isoperistaltic side-to-side configuration is that it requires additional mobilization to achieve adequate overlap of the two stumps. Therefore, challenges may arise in cases where the location of the anastomosis precludes such maneuvers, such as in low rectal anastomosis. However, as the

isoperistaltic orientation has already proven valid in other anatomical locations such as the biliary tree, esophagus, and stomach, it could represent the optimal approach to reestablish gastrointestinal tract continuity following colonic resection[48].

Conversely, it has been postulated that the antiperistaltic orientation could reduce the incidence of postoperative ileus, since an ileocolic anastomosis could prevent the mesentery twist seen with the isoperistaltic variant[49]. After the resection of the ileocecal valve in right hemicolectomy, reflux of colonic contents in the terminal ileus may occur. The disruption of the physiological direction of colonic content flow may be associated with secondary bacterial overgrowth in the small bowel lumen[50]. The prolonged small bowel transit times attributable to this increasingly recognized syndrome appear to be more adequately prevented with antiperistaltic anastomosis[50]. This certain anastomotic orientation likely acts through a functional pseudovalvular mechanism, diminishing ileocecal reflux and postoperative ileus[49].

Comparison of isoperistaltic vs antiperistaltic side-to-side ileocolic anastomosis

Few studies have directly compared the two anastomotic orientations. In 2003, Ibáñez *et al*[51] published a narrative review on intracorporeal anastomosis and analyzed the configuration as a possible risk factor for leakage. The authors concluded that there was no difference in anastomotic breakdown when isoperistaltic and antiperistaltic anastomoses were compared. Nevertheless, various studies have utilized different surgical techniques depending on the configuration type (*i.e.*, the isoperistaltic orientation was achieved with stapled and hand-sewn intracorporeal anastomoses, while the antiperistaltic anastomoses were all stapled).

To our knowledge, only three studies have directly compared the isoperistaltic and antiperistaltic orientations for ileocolic anastomoses. The first was a study by Chander Roland *et al*[52] in which the authors conducted a randomized controlled trial comparing isoperistaltic *vs* antiperistaltic stapled side-to-side ileocolic and colocolic anastomoses in colon cancer patients. There were 20 elective resection patients in each study arm. While the antiperistaltic anastomoses were all stapled, the authors used a running suture to close the stapling device entry hole in the isoperistaltic anastomoses to prevent iatrogenic stenosis of the ileum stump. The primary endpoints were rates of anastomotic leakage, hemorrhage, and stenosis. Across all endpoints, no significant differences were observed between the two groups. Specifically, anastomotic leakage was seen in 2 patients from the isoperistaltic group, compared to none from the antiperistaltic group (P = 0.487). One patient from the antiperistaltic group had anastomotic stenosis, while there was no stenosis in the isoperistaltic group (P = 1.000). Median postoperative length of hospital stay was similar between the two groups (P = 0.313). However, the study was suspended due to excess morbidity detected in the isoperistaltic group. While the study did not show any short-term differences between the isoperistaltic and antiperistaltic side-to-side anastomoses, considering that anastomotic leakage occurred only in the isoperistaltic group, study authors suggested that additional modifications to the isoperistaltic technique may be justified. This study had several limitations that must be considered, including small sample size, the different anastomotic types included in the analysis (both ileocolic and colocolic anastomoses), the use of both open and laparoscopic approaches, and the dissimilar technical parameters used between the groups (*i.e.*, the author used additional sutures to reinforce the antiperistaltic anastomosis).

The second study was the ISOVANTI trial published by Tewari *et al*[49]. This was a double-blind, randomized, prospective trial in colon cancer patients undergoing laparoscopic right hemicolectomy and isoperistaltic or antiperistaltic ileocolic anastomosis. A total of 108 patients were randomized either to isoperistaltic or antiperistaltic configuration groups. No differences in surgical time, anastomotic time, or postoperative complication rates (37.0% isoperistaltic *vs* 40.7% antiperistaltic, P = 0.693) were identified. In addition, there were no differences in postoperative ileus or anastomotic leakage rates (3.7% *vs* 5.56%, P = 1.00). However, the antiperistaltic configuration was associated with decreased "time to first flatus" and "time to first deposition" (P = 0.004 and P = 0.017, respectively). In the long-term, there were no differences between the groups at 1, 6 or 12 mo. There was also no difference in the rate of chronic diarrhea rate. The authors concluded that the isoperistaltic and antiperistaltic ileocolic anastomosis configurations present similar results in terms of performance, safety, and functionality.

The third study by Tarta *et al*[53] retrospectively reviewed 214 consecutive patients who underwent laparoscopic right colectomy with gastrointestinal tract continuity reestablished either by an isoperistaltic side-to-side anastomosis or an antiperistaltic side-to-side anastomosis. These anastomotic configurations proved similar in all short-term comparison categories, including operating time, intraoperative bleeding, length of resected intestine, number of harvested lymph nodes, length of incision, time to first flatus, time to first defecation, postoperative complications, and length of hospital stay. Similarly, at a median follow-up time of 35.6 mo, there were no differences in the long-term outcomes. The authors concluded that both configurations are safe, and are associated with similar short- and long-term outcomes. Despite the fact that this study has the larger sample size than the studies discussed above, it is limited by its retrospective nature. However, it is the only study that assessed oncological outcomes following the use of different anastomotic orientations.

Relevant, high-quality data are scarce, making it difficult to draw definite conclusions regarding optimal anastomotic configuration. None of the three aforementioned studies reported any significant differences between the configurations, including no differences in the incidences of anastomosis-

related complications such as leakage, stenosis, and bleeding[49,52-55]. There may be a trend towards shorter intestinal function recovery time following antiperistaltic anastomosis; however, the small sample size and associated lack of statistical significance render any such conclusion unclear. High-quality, prospective randomized trials are needed to fully elucidate the optimal anastomotic configuration after a right hemicolectomy.

CONCLUSION

In conclusion, existing data are insufficient to favor either isoperistaltic or antiperistaltic anastomotic configuration. Thus, the most appropriate approach is to master both anastomotic techniques and select the appropriate configuration based on each individual case scenario.

FOOTNOTES

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