International Journal of Colorectal Disease (2024) 39:174
https://doi.org/10.1007/s00384-024-04746-0

REVIEW

Inferior mesenteric artery preservation techniques in the treatment of diverticular disease: a systematic review of the literature

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Accepted: 21 October 2024 / Published online: 28 October 2024

Abstract

Purpose The aim of this study is to analyze the impact of different surgical techniques used to preserve the inferior mesenteric artery on patient outcomes following left colonic resection.

Methods A search was conducted in PubMed, Embase and Web of Science, founding 4795 articles. The review was registered on PROSPERO (registration number: CRD42024572291).

Results Eleven articles published between 2001 and 2023, including 989 patients were the object of the present systematic review. Two hundred sixty-two patients (26.5%) underwent Valdoni's technique (Group A), which involves the skeletonization of the IMA, 272 (27.5%) underwent tubular resection (Group B), and 455 (46%) underwent peripheral dissection on sigmoid vessels (Group C). Laparoscopic surgery was predominant in Groups B (100%) and C (94.7%), while Group A had fewer laparoscopic procedures (44.6%). Patients in Group A experienced longer operative times (174.5 ± 27.4 min) and hospital stays (11.4 ± 3.6 days) compared to Groups B and C (165.9 min and 152.35 ± 46.9 min; 8.4 ± 5.7 days and 8.3 ± 3.6 days, respectively). Group A exhibited higher rates of anastomotic leakage (5%) compared to Group C (1.1%) and a higher incidence of bleeding (13%) compared to Group B (1.8%).

Conclusion Valdoni's technique is less favourable for IMA preservation in left colon resection for diverticular disease. Peripheral dissection of sigmoid vessels or tubular resection is recommended for IMA preservation in this context.

Keywords Inferior mesenteric artery · IMA preservation · IMA sparing · Valdoni technique · IMA peeling · IMA ligation

Introduction

Anastomotic leakage is a significant complication in colorectal surgery, influenced by various factors, with vascular supply playing a crucial role [1]. Several studies have investigated the impact of vascular supply on patient outcomes after left colonic resection, focusing on the ligation versus preservation of the inferior mesenteric artery (IMA) [2–12].

In a study conducted by Ren et al. [13], 207 patients who underwent sigmoidectomy for colon cancer with IMA preservation were compared with 123 patients who underwent high ligation of the IMA. The study reports similar overall survival (OS) rates and postoperative morbidity and mortality between the two groups. The authors suggested that IMA preservation may enhance bowel blood supply, leading to improvements in postoperative intestinal function recovery and reduction of anastomotic leakage. In the case of benign diseases such as diverticular disease, the rationale for IMA preservation becomes even more compelling, given the absence of concerns regarding oncologic radicality.

However, a systematic review on the level of IMA ligation in the treatment of diverticular disease conducted by Cirocchi et al. [14] revealed that the site of IMA ligation does not affect the incidence of functional complications, anastomotic leakage or bleeding. Moreover, preserving the IMA was associated with a higher conversion rate and longer operative durations.

It would be interesting to investigate whether these discrepancies regarding the benefits or potential risks of IMA preservation can be explained by the different surgical techniques used for preserving the IMA. To the best of our knowledge, no study has systematically compared various surgical techniques for IMA preservation. Existing

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literature outlines three distinct methods. The Valdoni technique, which involves the skeletonization of the IMA, requires accessing the adventitia of the artery from its posterior aspect, then the dissection progresses along this plane, with subsequent division of all branches directed towards the left and sigmoid colon [15]. Tubular resection technique, first described by Gall in 1982 [16], involves dividing the mesentery of the colon along the colonic wet, with vascular control achieved near the colonic wall [17]. The peripheral dissection technique on sigmoid vessels involves conducting vascular dissection and division at the intramesocolic level onto the distal branches of the sigmoid vessels [5] (Fig. 1). The current study aims to compare the results of the three surgical techniques used for IMA preservation in left colon resection for diverticular disease, focusing on perioperative surgical outcomes.

Table 1 Keywords used for research in the PubMed, EMBASE, and web of Science databases

IMA + preservation
inferior mesenteric artery + preservation
IMA + sparing
inferior mesenteric artery + sparing
SRA + preservation
superior rectal artery + preservation
SRA + sparing
superior rectal artery + sparing
IMA + peeling
inferior mesenteric artery + peeling
inferior mesenteric artery + lymph node dissection
IMA + lymph node dissection
IMA + lymphadenectomy

Materials and methods

Search strategy

We conducted a systematic review of published papers in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. The search was carried out in the PubMed, Embase and Web of Science databases, using the following keywords shown in Table 1. Each database was last consulted on January 18, 2024. The search revealed 4795 papers. The review was registered on PROSPERO (registration number: CRD42024572291).

Inclusion criteria

Inclusion criteria were (1) articles from any country written in English and (2) articles reporting postoperative outcomes after elective colonic resection with IMA preservation for diverticular disease.

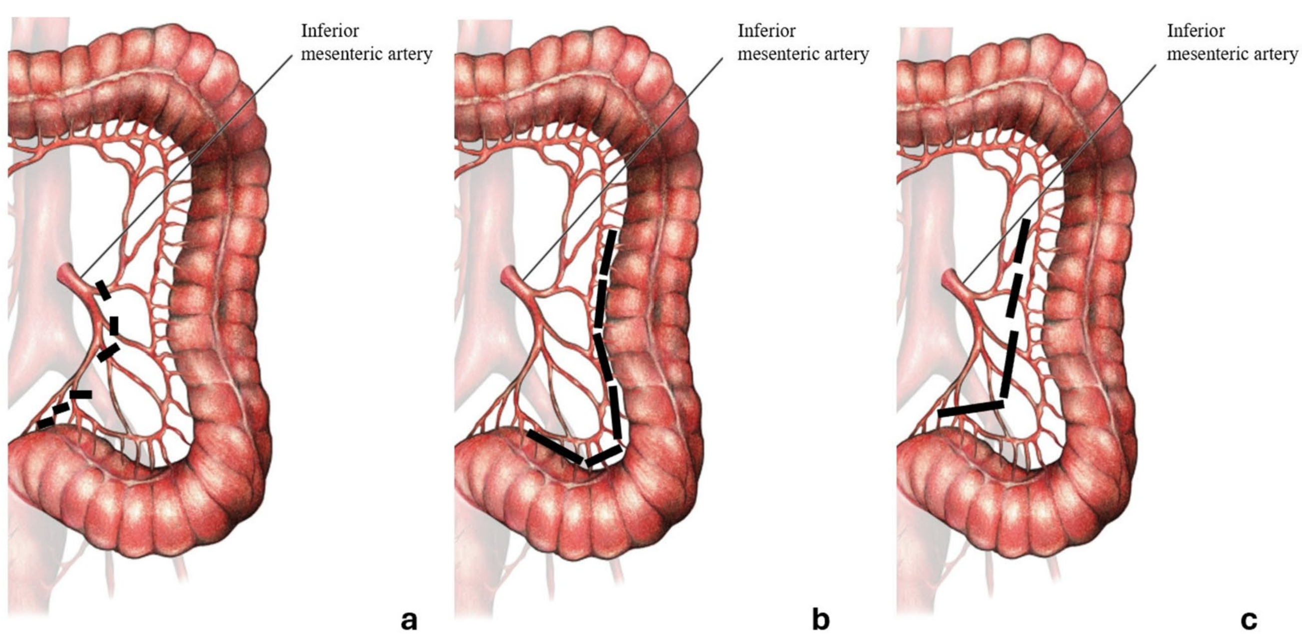

Fig. 1 Surgical techniques used for IMA preservation in left colon resection. Black bracket lines indicate the level of vascular ligation. Image a: Valdoni technique; image b: tubular resection technique; image c: peripheral dissection technique

Exclusion criteria

Exclusion criteria were (1) articles in languages other than English; (2) articles that do not describe the surgical technique used to preserve the IMA; (3) articles reporting more than one technique of IMA preservation in which was not possible to extract only data regarding one particular technique (4) articles about other diagnosis; (5) reviews, systematic reviews, meta-analysis, case reports, correspondence and letters to authors or editors, editorials and video-vignette; and (6) articles involving animals.

Outcome of interest

Data extracted from each paper were number of patients, age, gender, Body Mass Index (BMI), American Society of Anesthesiologists (ASA) score, Hinchey classification, surgical approach, operative time, creation of colostomy/ileostomy, intra and postoperative complications, hospital stay, reoperation and mortality. After screening the titles and abstracts, we identified articles that fulfilled the eligibility criteria and reviewed their full text. Data were extracted by two surgeons (S.A. and F.V.). Then data were checked by a third surgeon (A.B.) and stored in the Microsoft Excel program (Microsoft Corporation, Redmond, WA, USA).

Assessment of the studies quality

The study quality and risk of bias assessment were performed by two authors (S.A. and A.B.) for 8 non-randomized controlled trials using the Cochrane Risk of Bias Tools for Nonrandomized Clinical Studies (ROBINS-I) [18]. The ROBINS-I tool regards each study as an attempt to simulate a hypothetical pragmatic randomized trial. It evaluates seven domains to identify potential biases: bias due to confounding, bias in the selection of participants into the study, bias in classification of interventions, bias due to deviations from intended interventions, bias due to missing data, bias in the measurement of outcomes, and bias in the selection of the reported result. The assessments within each domain contribute to an overall risk of bias categorization: “Low risk of bias,” “Moderate risk of bias,” “Serious risk of bias,” “Critical risk of bias,” or “No information” (See Table 2). The remaining 3 randomized controlled trials were assessed using the Risk of Bias 2 (RoB2) tool [19], which encompasses five key domains: randomization, deviations from intended interventions, missing outcome data, measurement of the outcome, and selection of the reported results. Each domain was evaluated for its risk level: low, some concerns, or high. In our assessment, if a study demonstrated low risk across all domains, it was categorized as having a low risk of bias. Conversely, if a study exhibited some concerns in at least one domain but did not show any high-risk items, it was classified as having some concerns. Finally, if a study displayed high risk of bias in one or more domains, it was deemed to be at high risk of bias (See Table 3).

Statistical analysis

The data were expressed in frequencies and percentages. Mean and standard deviation (SD) were calculated following the method outlined by Hozo et al. [20]. For comparing groups, statistical analysis utilized either the t-test or Fisher’s exact test. Data were analyzed using SPSS version 26 (IBM Corp. SPSS Inc. Armonk, NY, USA). A probability (p) value below 0.05 was deemed statistically significant.

Results

Out of the 4795 articles identified in the initial search, 2525 duplicates were removed. Among the remaining 2270 articles, 2252 were further excluded after screening the title and abstract. The analysis continued with the remaining 18 articles, from which 7 additional studies were excluded (Fig. 2). Finally, 11 articles published between April 2001 and July 2023 were included in the present systematic review, as shown in the PRISMA [21] flow diagram (Fig. 2).

Six studies were retrospective in nature, 2 were prospective, and 3 were randomized control trials (RCTs) (Tables 2 and 3) [2–12]. It should be noted that the three RCTs included in the analysis compare IMA ligation versus preservation, rather than different techniques of IMA preservation. Overall, data from a total of 989 patients were included. Patients were categorized into three groups based on the surgical technique used for IMA preservation during surgery. Group A comprised patients treated with Valdoni’s technique, group B included those who underwent tubular resection technique, and group C comprised patients who underwent peripheral dissection technique.

Three articles, accounting for a total of 262 patients (mean age 64 ± 9.6 years), with 125 (47.7%) being female, were included in group A [2–4] (Table 4). According to the ASA classification, most patients were scored as class I, with class III accounting only for 5.4%. Data on Hinchey classification was available in 109 patients (41.6%). A similar percentage of Hinchey I and II was observed (50.5% and 49.5% respectively) with no patient experiencing purulent of faecal peritonitis (class III, IV). A successful laparoscopic approach was feasible in 117 (44.6%) patients. The mean operative time was 174.5 ± 27.4 min. Overall, 37 patients (14%) experienced 30-days postoperative complications.

Table 2 Assessment of risk of bias of the included articles based on risk of Bias in non-randomised studies – of interventions (ROBINS-I) [18]. Low: low risk of bias (the study is comparable to a randomised trial). Moderate: moderate risk of bias (the study provides sound evidence for a nonrandomised study but cannot be considered comparable to a randomised trial). Serious: serious risk of bias (the study has important problems)

Author, year, type of study	Bias due to confounding	Bias in selection participants	Bias in classification of interventions	Bias due to deviations from intended interventions	Bias due to missing data	Bias in measurement of outcomes	Bias in selection of reported result	Overall
Silvestriet al., 2023, prospective [8]	Low	Moderate	Low	Low	Low	Low	Low	Moderate
Bracaleet al., 2021, retrospective [9]	Low	Moderate	Low	Low	Low	Low	Low	Moderate
Posabellaet al., 2021, retrospective [10]	Low	Moderate	Low	Low	Low	Low	Low	Moderate
De Nardiet al., 2018, retrospective [2]	Low	Low	Low	Low	Low	Low	Low	Low
Mariet al., 2017, prospective [6]	Low	Moderate	Low	Low	Low	Low	Low	Moderate
Sohnet al., 2017, retrospective [7]	Low	Moderate	Low	Low	Low	Low	Low	Moderate
Borchertet al., 2015, retrospective [11]	Low	Low	Low	Low	Low	Low	Low	Low
Pignataet al., 2006, retrospective [3]	Low	Moderate	Low	Low	Low	Low	Low	Moderate

Table 3 Assessment of risk of bias of the randomized clinical trials included in the review using ROB 2 [19]. Low: low risk of bias. Some: some concerns. High: high risk of bias

Author, year	Bias arising from the randomization process	Bias due to deviations from intended interventions	Bias due to missing outcome data	Bias in measurement of the outcome	Bias in selection of the reported result	Overall
Mariet al., 2021 [5]	Low	Some	Low	Low	Low	Some
Masoniet al., 2012 [12]	Low	Some	Some	Low	Low	Some
Tocchiet al., 2001 [4]	Some	Some	Low	Low	Low	Some

Anastomotic leak rate was 5%. Postoperative mortality rate was 0.42%. The mean LOS was 11.4 ± 3.6 days (Table 4).

Group B included three articles, with a total of 272 patients (mean age 55 ± 13.6 years), with 136 (50%) being female [5–7]. According to the ASA classification, most patients were classified as ASA 2 (45.2%) and no paper reported data on Hinchey score. A laparoscopic approach was attempted in all 272 patients (100%) and was successfully completed in 93.4% of the patients. The average duration of the operation was 165.9 min. Overall, 30-days postoperative complications occurred in 48 patients (17.6%). Anastomotic leak rate was 2.6%. A high percentage of abdominal wall dehiscence was reported (7.6%) and 6 patients (5.2%) required reoperation. The mean LOS was 8.4 ± 5.7 days (Table 5).

Group C comprised five articles [8–12], including 455 patients with a mean age of 60.5 ± 10.7 years, with 210 (46.1%) being female. According to the ASA classification, most patients were classified as ASA 2 (49.1%). Data on the Hinchey score were available in only two studies, accounting for 154 patients. (33.8%). Among these patients, the majority were scored as Hinchey II and III (53% and 41%, respectively). Additionally, 54 patients (35%) were scored between Hinchey 0 and II. A mini-invasive approach was attempted in 431 cases (94.7%), and conversion to open surgery was necessary in 31 cases (6.8%). The mean duration of the operation was 152.35 ± 46.9 min. Overall, 30 days postoperative complications occurred in 108 patients (27%). Anastomotic leak rate was 1.1%. No postoperative death occurred, and remaining complications are reported in Table 6. The mean LOS was 8.3 ± 3.6 days.

Table 7 provides a comparative analysis of the three groups. Patients in the group A were significantly older compared to the other two group in study (p value < 0.01). Moreover, patients in group A, were significantly healthier according to ASA Physical status classification with more

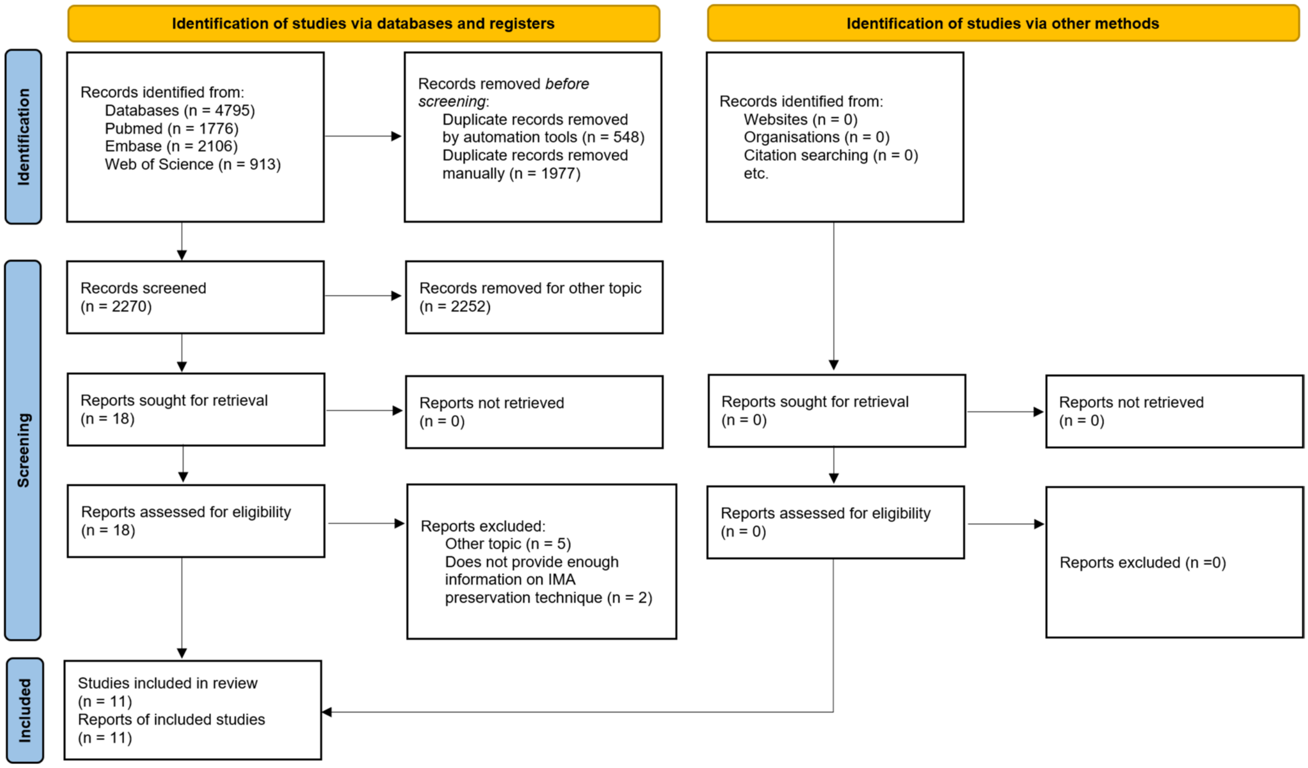

Fig. 2 Preferred reporting items for systematic review and meta-analysis (PRISMA) flow diagram [21]

than 50% of patients being in class I, while in group B, only 43 (37.4%) fell into this category, and in group C, the number decreased further to 24 (11.1%) (p value < 0.01). With respect to the surgical technique, a mini-invasive approach was feasible in almost all patients in group B and C. In contrast, in group A fewer than half of the patients underwent a laparoscopic approach with no conversion to open surgery (p value A vs. B: <0.01, A vs. C: <0.01, B vs. C: 0.88). Conversely in group B and C a conversion rate of 6.8% was observed.

Overall, patients in group A experienced a lower rate of 30-day postoperative complications when compared to the other two groups in study, with group C showing the highest rate of complications (p value A vs. B: 0.28, A vs. C: <0.01, B vs. C: <0.01). On the other hand, anastomotic leak rates were comparable between groups A and B, with 13 (5%) and 7 (2.6%) events recorded, respectively. Likewise, groups B and C demonstrated similar rates, with 7 (2.6%) and 2 (1.1%) occurrences, respectively. However, group A exhibited a significantly higher incidence of anastomotic leakage compared to group C (p value A vs. B: 0.17, A vs. C: 0.03, B vs. C: 0.98). One death (0.4%) occurred in group A, and reoperation was required for 6 (5.2%) patients in group B.

When postoperative stay was considered, patient in group A experienced a longer hospital stay, when compared to patients in groups B and C (p value A vs. B: <0.01, A vs. C: <0.01, B vs. C: 0.98).

Discussion

We undertook this review to investigate the surgical outcomes following elective left colon resection utilizing the three different techniques reported by the international literature used for IMA preservation in diverticular disease [15–17].

In the present analysis, patients who underwent left colon resection using the Valdoni's technique experienced longer operative times when compared to the other two groups in the study. This finding should be interpreted according to the greater technical complexity associated with the Valdoni's technique as reported by Li et al. [22]. The complexity of Valdoni's technique is further evident in the choice of surgical approach, as a laparoscopic approach was used in only 44.6% of the cases. In contrast, in the other two groups a minimally invasive approach was feasible in almost all patients, with conversion rates which are similar to percentage reported by others on the same subject [5, 7, 10].

The drawbacks associated with Valdoni's technique might be offset in an oncologic context due to its potential for increased oncologic radicality. This is attributed to the

Table 4 Studies presenting Valdoni's technique for preserving the IMA (Group A). SD: standard deviation. ASA: American Society of Anesthesiologists. n.r.: not reported. n.a.: not applicable

Author	*N*. of patients	M/F	Mean age ± SD or range (years)	ASA score, *n* (%)	Hinchey classification, *n* (%)	Mean operative time ± SD or range (minutes)	Laparoscopic approach, *n* (%)	Conversion to laparotomy, *n* (%)	< 30 day-postoperative complications	Mean hospital stay ± SD or range (days)
De Nardi [2]	153	65/88	62.8 ± 11.8	I: 91 (38.6) II: 49 (32) III: 13 (8.5)	n.r.	191 ± 41.7	94 (38.6)	0 (0)	Postoperative complications: 19 (12.4) Mortality: 0 (0) Anastomotic leakage: 6 (3.9)	9.4 ± 4.4
Pignata [3]	23	n.r.	n.r.	n.r.	I: 18 (78.3) II: 5 (21.7)	n.r.	23 (100)	0 (0)	Postoperative complications: 3 (13) Anastomotic leakage: 0 (0) Bleeding 3 (13) SBO: 0 (0)	n.r.
Tocchi [4]	86	49/37	66.8 ± 7.5	0: 15 (17.4) I: 40 (46.6) II: 31 (36)	I: 37 (43) II: 49 (57)	158 ± 13.2	0 (0)	n.r.	Postoperative complications: 15 (17.4) Mortality: 1 (1.1) Anastomotic leakage: 7 (8.1)	13.4 ± 2.8
TOTAL	262	114/125	64.8 ± 9.65	0: 15 (6.3) I: 131 (54.8) II: 80 (33.5) III: 13 (5.4)	I: 55 (50.5) II: 54 (49.5)	174.5 ± 27.4	117 (44.6)	0 (0)	Postoperative complications: 37/262 (14) Mortality: 1/239 (0.42) Anastomotic leakage: 13/262 (5) Bleeding: 3/23 (13) SBO: 0/23 (0)	11.4 ± 3.6

Table 5 Studies presenting peripheral dissection on sigmoid vessels technique for preserving the IMA (Group B). SD: standard deviation. ASA: American Society of Anesthesiologists. n.r.: not reported

Author	*N*. of patients	M/F	Mean age ± SD or range (years)	ASA score, *n* (%)	Hinchey classification, *n* (%)	Mean operative time ± SD or range (minutes)	Laparoscopic approach, *n* (%)	Conversion to laparotomy, *n* (%)	< 30 day-postoperative complications	Mean hospital stay ± SD or range (days)
Mari 2021 [5]	84	48/38	51 (25–75) median	I: 29 (34.5) II: 35 (41.7) III: 20 (23.8)	n.r.	n.r.	84 (100)	4 (4.7)	Postoperative complications: 13 (15.5) Re-operation: 3 (3.6) Anastomotic leakage: 2 (2.3) Bleeding: 1 (0.5)	4.5 ± 6
Mari 2017 [6]	31	18/13	60 (34–79) median	I: 14 (45.2) II: 17 (54.8)	n.r.	175 ± 31	31(100)	0 (0)	Postoperative complications: 6 (19.3) Re-operation: 3 (9.6) Anastomotic leakage: 2 (6) Bleeding: 1 (3) Ileus: 0 (0)	6 ± 2
Sohn [7]	157	72/85	59.9 (19–87) median	n.r.	n.r.	156.8	157 (100)	14 (8.91)	Postoperative complications: 29 (18.5) Anastomotic leakage: 3 (1.9) Bleeding: 3 (1.9) Intraabdominal abscess: 4 (2.5) Colonic ischemia: 1 (0.6) Abdominal wall dehiscence : 3 (1.9) Superficial wound infection: 12 (7.6)	8.3 (3–39) median

Table 5 (continued)

Author	*N*. of patients	M/F	Mean age ± SD or range (years)	ASA score, *n* (%)	Hinchey classification, *n* (%)	Mean operative time ± SD or range (minutes)	Laparoscopic approach, *n* (%)	Conversion to laparotomy, *n* (%)	< 30 day-postoperative complications	Mean hospital stay ± SD or range (days)
TOTAL	272	138/136	55 ± 13.6	I: 43 (37.4) II: 52 (45.2) III: 20 (17.4)	-	165.9	272 (100)	18 (6.6)	Postoperative complications: 48/272 (17.6) Reoperation: 6/115 (5.2) Anastomotic leakage: 7/272 (2.6) Bleeding: 5/272 (1.8) Intraabdominal abscess 4/157 (2.5) Colonic ischemia 1/157 (0.6) Abdominal wall dehiscence : 3/157 (1.9) Superficial wound infection: 12/157 (7.6)	8.4 ± 5.7

complete skeletonization of the entire IMA and removal of all associated mesentery and lymph nodes, which are potential sites of metastasis. However, in benign conditions such as diverticular disease, where such lymph node dissection is unnecessary, Valdoni's technique appears to be a less favourable option compared to peripheral dissection on the colon wall or sigmoid vessel. Furthermore, Valdoni's technique was correlated with a longer LOS compared to groups B and C. Different variables could be potentially responsible for a delay in hospital discharge [23]. Among them postoperative complications, age and patient's comorbidities seem to play a major role [24, 25]. In fact, patients in group A are older compared to the other two groups, yet they exhibit a lower ASA score and experienced fewer postoperative complications. Therefore, we could speculate that the prolonged hospital stay observed in Valdoni's technique group may be attributed to the increased utilization of open surgical approaches.

A meta-analysis conducted by Huang et al. [26] examined five studies involving a total of 307 patients who underwent laparoscopic total mesorectal excision (TME) surgery with preservation of both the superior rectal artery (SRA) and left colonic artery (LCA), and 454 patients without preservation for upper-rectal and sigmoid colon cancers. The analysis revealed that the vascular preservation group experienced fewer total postoperative complications (RR: 0.49, 95% CI: 0.33–0.73), a lower anastomotic leakage rate (RR: 0.19, 95% CI: 0.07–0.54), a shorter length of stay (SMD: -0.42, 95% CI: -0.73- -0.11), and longer operative time (SMD: 0.73, 95% CI: 0.27–1.19). These findings underscore the potential benefits of vascular preservation.

In our study the incidence of postoperative surgical complications was comparable between groups A and B, while notably higher in group C. However, it is important to note that most complications in group C are those reported by Silvestri et al. [8] that were classified as minor (grade I according to the Clavien-Dindo classification [27]). Upon excluding these minor complications, the percentage of complications in group C decreases, aligning more closely with the rates observed in the other groups. Group A exhibited a similar occurrence of anastomotic leakage compared to group B and slightly higher than group C. The bleeding rate was similar between group A and C, which was higher compared to group B.

Recently intraoperative indocyanine-green (ICG) angiography has been introduced to assess colon vascularization in left colon resection, which has gained popularity, and it is widely employed among the surgical community [28]. Although none of the reported studies mentioned it, ICG could serve as a valuable tool to aid surgeons during vascular sparing procedures. In a recent study by Wang et al. [29], comparing 96 patients who underwent laparoscopic radical resection for proctosigmoid colon cancer with intraoperative

Table 6 Studies presenting tubular resection technique for preserving the IMA (Group C). SD: standard deviation. ASA: American Society of Anesthesiologists. n.r.: not reported

Author	N. of patients	M/F	Mean age ± SD or range (years)	ASA score, n (%)	Hinchey classification, n (%)	Mean operative time ± SD or range (minutes)	Laparoscopic approach, n (%)	Conversion to laparotomy, n (%)	< 30 day-postoperative complications	Mean hospital stay ± SD or range (days)
Silvestri [8]	62	24/38	58 ± 12	I: 8 (13) II: 33 (53) III: 21 (34) IV: 0 (0)	n.r.	171 ± 52	62 (100)	0 (0)	Postoperative complications: 62 (100) Anastomotic leakage: 0 (0)	4.8 ± 1.4
Bracale [9]	22	6/16	57 ± 11.7 median	I-II: 15 (68.2) III-IV: 7 (31.8)	n.r.	171.4 ± 48.8	22 (100)	0 (0)	Postoperative complications: 5 (22.7) Anastomotic leakage: 1 (4.5) Bleeding: 3 (13.6) SBO: 0 (0) Ileus: 1 (4.5)	5 (4–6) median
Posabella 2021 [10]	217	87/130	61.9 ± 9.2	n.r.	n.r.	n.r.	217 (100)	17 (7.8)	Postoperative complications: 35 (16.1%)	n.r.
Borchert [11]	100	n.r.	62.1 ± 12.7	II: 49 (49) III: 49 (49) IV: 2 (2)	0: 2 (2) I: 4 (4) II: 53 (53) III: 41 (41)	129 ± 42	76 (76)	14 (14)	Postoperative complications: 6 (6) Anastomotic leakage: 1 (1) Ileus: 1 (1) Wound dehiscence 1 (1) Intraabdominal abscess: 0 (0) Sepsis: 2 (2)	15.2 ± 9
Masoni [12]	54	28/26	63.5 ± 7.7	I: 16 (29) II: 24 (44) III: 14 (27)	0-II: 54 (100)	138 ± 45	54 (100)	0 (0)	n.r.	n.r.
TOTAL	455	145/210	60.5 ± 10.7	I: 24 (11.1) II: 106 (49.1) III: 84 (38.9) IV: 2 (0.9)	0: 2 (1.3) I: 4 (2.6) II: 53 (34.4) III: 41 (26.6) 0-II: 54 (35)	152.35 ± 46.9	431 (94.7)	31 (6.8)	Postoperative complications: 108/401 (27) Anastomotic leakage: 2/184 (1.1) Bleeding: 3/22 (13.6) Superficial wound infection: 1/100 (1) SBO: 0/22 (0) Ileus: 2/122 (1.6) Intraabdominal abscess: 0/100 (0) Sepsis: 2/100 (2)	8.3 ± 3.6

Table 7 Comparison between groups. Group A: patients underwent left colon resection with Valdoni's technique for preserving the IMA. Group B: patients underwent left colon resection with peripheral dissection on sigmoid vessels technique for preserving the IMA. Group C: patients underwent left colon resection with tubular resection technique for preserving the IMA. SD: standard deviation. ASA: American Society of Anesthesiologists. SBO: small bowel obstruction

	Group A (262 patients)	Group B (272 patients)	Group C (455 patients)	*p* value
Mean age ± SD (years)	64.8 ± 9.6	55 ± 13.6	60.5 ± 10.7	A vs. B: <0.01, A vs. C: <0.01, B vs. C: <0.01
ASA score, n (%)	15 (63)	-	-	-
0	131 (54.8)	43 (37.4)	24 (11.1)	A vs. B: <0.01, A vs. C: <0.01, B vs. C: <0.01
I	80 (33.5)	52 (45.2)	106 (49.1)	A vs. B: <0.01, A vs. C: 0.0342, B vs. C: 0.0148
II	13 (5.4)	20 (17.4)	84 (38.9)	A vs. B: 0.2837, A vs. C: <0.01, B vs. C: <0.01
III	-	-	2 (0.9)	-
IV				
Hinchey Classification, n (%)	-	-	2 (2)	-
0	55 (50.5)	-	4 (4)	A vs. C: <0.01
I	54 (49.5)	-	53 (53)	A vs. C: 0.6783
II	-	-	41 (41)	-
III				
Mean operative time ± SD (minutes)	174.5 ± 27.4	165.9	152.35 ± 46.9	A vs. B: <0.01, A vs. C: <0.01, B vs. C: <0.01
Laparoscopic approach, n (%)	117 (44.6)	272 (100)	431 (94.7)	A vs. B: <0.01, A vs. C: <0.01, B vs. C: 0.88
Conversion to laparotomy, n (%)	0 (0)	18 (6.6)	31 (6.8)	A vs. B: <0.01, A vs. C: <0.01, B vs. C: 0.98
Mean hospital stay ± SD (days)	11.4 ± 3.6	8.4 ± 5.7	8.3 ± 3.6	A vs. B: <0.01, A vs. C: <0.01, B vs. C: 0.98
Postoperative complications, n (%)	37/262 (14)	48/272 (17.6)	108/401 (27)	A vs. B: 0.2882, A vs. C: <0.01, B vs. C: <0.01
Anastomotic leakage	13/262 (5)	7/272 (2.6)	2/184 (1.1)	A vs. B: 0.1743, A vs. C: 0.0311, B vs. C: 0.3238
Bleeding	3/23 (13)	5/272 (1.8)	3/22 (13.6)	A vs. B: 0.018, A vs. C: 1, B vs. C: 0.016
Superficial wound infection	-	12/157 (7.6)	1/100 (1)	B vs. C: 0.0185
SBO	0/23 (0)	-	0/22 (0)	-
Ileus	-	-	2/122 (1.6)	-
Intraabdominal abscess	-	4/157 (2.5)	0/100 (0)	B vs. C: 0.1593
Sepsis	-	-	2/100 (2)	-
Colonic ischemia	-	1/157 (0.6)	-	-
Abdominal wall dehiscence	-	3/157 (1.9)	-	-
Mortality, n (%)	1/239 (0.4)	-	-	-
Re-operation, n (%)	-	6/115 (5.2)	-	-

ICG guidance to 183 without intraoperative ICG guidance, mesenteric artery injury was identified in 2 of 183 cases. In these instances, the ischemic bowel was promptly dissected. Conversely, no such injuries occurred during ICG fluorescence-guided surgery, indicating the potential benefits of ICG guidance in safeguarding the intestinal blood supply during laparoscopic colon resections. Moreover, a multicenter RCT [30] demonstrated that intraoperative ICG angiography is safe and effective in identifying inadequate perfusion during colorectal resection, offering the possibility of adjusting the surgical approach. However, another RCT conducted by Jafari et al. [31] suggests that intraoperative ICG angiography does not influence the occurrence rates of anastomotic leak or postoperative abscess.

One might argue that preserving the IMA to enhance vascular supply to the colorectal anastomosis is redundant given the capability of ICG to assess the adequacy of vascularization in the anastomosis. However, it should be noted that assessing the extent of vascularization is not easily accomplished; only qualitative considerations can be made with confidence. While different systems or software solutions offer ICG fluorescence quantification, intraoperative applications are uncommon, and quantification techniques vary significantly [32].

This study has several limitations. Firstly, the number of patients and studies considered is relatively small; however, given the specificity of the research field, this limitation is inherent. Secondly, there was a lack of important data for comparing the three groups, such as patient comorbidities, as well as a standardized method for reporting complications, such as the Clavien-Dindo classification.

Another criticism of the present systematic review is represented by the few studies including data on Hinchey classification [3, 4, 11, 12], which is universally recognized as the gold standard to assess the extent and severity of diverticular disease [33]. As a result, we were not able to accurately assess disease severity, which play a major role in influencing intraoperative strategy as well as postoperative outcome [34, 35]. This introduces a potential confounding factor in our analysis, as disease severity, rather than the surgical technique used to preserve the IMA, may be the primary determinant of the increased use of open surgery and the increased risk of postoperative complications. Nevertheless, we can speculate that, given the elective nature of these surgeries, it's probable that most patients did not have severe, high-grade complicated diverticulitis. Another limitation of this study is the lack of homogeneity among patients across the different groups. In particular, patients in group A were older than those in group C, while patients in group C were older than those in group B. Additionally, most patients in group A were classified as ASA class I, while the majority in groups B and C belonged to class II. Moreover, group C had a higher incidence of patients classified as ASA class III. This may introduce another potential confounding factor in our analysis, as elderly patients with a high ASA score might experience more postoperative complications, regardless of the surgical technique used to preserve the IMA.

Additionally, only three of the studies analyzed were RCTs, while the others were retrospective or prospective comparative studies. The retrospective nature of the studies may impact the outcomes by introducing selection bias, as patients may have been selected based on clinical factors not uniformly applied across the study period. Additionally, retrospective data collection can result in incomplete or inaccurate information, impacting the reliability of postoperative complication rates. Furthermore, the absence of RCTs comparing different IMA-sparing techniques means that patients were not randomly assigned to specific surgical procedures, potentially leading to confounding factors. Surgeons may have selected specific techniques based on patient factors, such as comorbidities or the complexity of the case, leading to a potential selection bias. This makes it challenging to attribute differences in postoperative outcomes solely to the surgical technique. Moreover, the absence of a meta-analysis weakens the strength of our conclusions. Meta-analyses provide a more statistically robust evaluation by synthesizing data across multiple studies, offering stronger evidence for clinical practice. In contrast, our conclusions are drawn from individual studies with varied methodologies, patient populations, and designs, which reduces the overall reliability and generalizability.

While the included studies provide a comparison between IMA preservation and IMA ligation, the primary focus of our systematic review is on the different surgical techniques used to preserve the IMA. To our knowledge, there are no comparative studies available in the literature specifically addressing this topic. Furthermore, due to the predominantly retrospective nature of the included studies and the clinical and methodological heterogeneity among them, conducting a meta-analysis was not feasible. To determine the optimal surgical technique for preserving the IMA in left colon resection for diverticular disease, further RCTs are required.

In conclusion, Valdoni's technique is less favorable for inferior mesenteric artery (IMA) preservation in left colon resection for diverticular disease. Peripheral dissection on sigmoid vessels or tubular resection is preferred due to shorter operative time, increased laparoscopy usage, and shorter hospital stay. Although overall postoperative complications do not differ significantly, Valdoni's technique is associated with higher rates of anastomotic leakage and bleeding. Therefore, we recommend prioritizing peripheral dissection on sigmoid vessels or tubular resection over Valdoni's technique for IMA preservation in this context.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s00384-024-04746-0.

Author contributions Conceptualization: S.A.; literature search: S.A., F.V., A.F., G.Z., M.G.; methodology: S.A. and A.B.; data analysis: S.A.; writing - original draft preparation: S.A.; writing - review and editing: A.V.; supervision: P.S. and A.V.

Funding this research received no external funding.

Data availability No datasets were generated or analysed during the current study.

Declarations

Competing interests The authors declare no competing interests.

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