Original Article

Intracorporeal versus extracorporeal ileocolic anastomosis after laparoscopic right hemicolectomy in patients with cancer colon on the right side: A prospective comparative study

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ABSTRACT

Background: Laparoscopic right hemicolectomy (LRH) is an effective treatment for right colon cancer. However, the choice between extracorporeal anastomosis (ECA) and intracorporeal anastomosis (ICA) remains controversial.

Aim: This study aimed to evaluate the effects of ECA and ICA techniques on perioperative safety and postoperative recovery following LRH.

Patients and Methods: A prospective comparison was conducted involving 40 patients diagnosed with right-sided colon cancer between October 2022 and May 2024.

Participants were divided into two groups: group A (23 patients) underwent LRH with ECA, while group B (17 patients) underwent total LRH with ICA using a three-step stapled isoperistaltic technique.

Results: The findings revealed that the mean operative time was significantly longer in the ECA group (246.91±44.97 min) than in the ICA group (215.94±36.20 min, *P=0.025*). Additionally, the duration of anastomosis was longer in the ECA group (19.48±2.33 min) versus ICA (15.35±1.17 min, *P<0.01*). Recovery metrics, such as bowel function, time to liquid intake, and hospital stay, were also significantly longer in the ECA group. Postoperative pain, as measured by visual analog scale scores, was notably lower in the ICA group during the first 48 h. However, complications such as bleeding, anastomotic leakage, intestinal obstruction, and SSI were not significantly different between groups, whereas postoperative ileus was significantly more prevalent in the ECA group (34.8 vs. 5.9%; *P=0.03*).

Conclusion: The results indicate that LRH with ICA is associated with shorter operative times, quicker recovery of bowel function, earlier resumption of oral intake, reduced hospital stays, and lower postoperative pain in the initial recovery period than LRH with ECA, without compromising oncologic outcomes or safety.

Key Words: Anastomosis, colon cancer, extracorporeal, intracorporeal, laparoscopic right hemicolectomy.

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INTRODUCTION

Laparoscopic surgery has gained widespread acceptance and popularity over time. The initial laparoscopic right hemicolectomy (LRH) for colon cancer was documented in 1991[1]. Several variations of the procedure have been described, among which is ileocolic anastomosis, which is performed using an extracorporeal or intracorporeal technique and is one of the most critical steps of the operation[2]. The extracorporeal anastomotic (ECA) approach is more commonly used and is comparable to open surgery[3]. This approach requires greater externalization and mobilization of the colon through an abdominal incision for subsequent steps[4]. Intracorporeal anastomosis (ICA) serves as a viable alternative, allowing anastomosis completion without bowel externalization. However, this method limits the choice of extraction site, typically a small midline incision[4], and intestinal alignment issues may occur following extraction.

The first report of complete LRH with ICA was published in 2003[5]. ICA has been shown to enhance cosmetic outcomes, accelerate early bowel function restoration, and reduce wound-related complications[6,7]. Nevertheless, conclusive data about the impact of anastomosis type on the short-term results after right hemicolectomy must be obtained, particularly concerning anastomotic leaks and short-term morbidity[8]. This study aimed to compare intracorporeal and extracorporeal ileocolic anastomosis after LRH and to evaluate the impact of each anastomosis technique on perioperative safety and postoperative evolution.

PATIENTS AND METHODS:

This prospective comparative study involved 40 patients with right-sided colon cancer, divided into group A (23 patients underwent LRH with extracorporeal ileocolic anastomosis, ECA) and group B (17 patients underwent total LRH with three-step stapled isoperistaltic

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intracorporeal ileocolic anastomosis, ICA). Conducted at the General Surgery Department of Ain Shams University Hospitals from October 2022 to May 2024, the procedures were performed by the same team of experienced colorectal surgeons. Ethical Committee and Research Institute approval and written informed consent were obtained from all patients. The sample size was calculated in accordance with the Community Medicine Department at Ain Shams University and previously discussed in the Ethics committee. Using the PASS 15 program for sample size calculation, setting power at 95% and alpha error at 0.05 and according to Eltih *et al*.[9], the expected rate of complications in IC group=10.1% and EC group=88.9%. A sample size of 15 patients per group was enough to detect the difference between the two groups. Sample size was increased to 20 patients per group for any loss of follow, and due to the technical difficulty of the ICA using the three-step stapled technique, three cases were managed and shifted to the ECA group.

Study population

All adult patients who were referred for treatment of right colon cancer (RCC) that was confirmed by biopsy and required a standard LRH with the aim of cure were considered for inclusion.

Inclusion criteria

The analysis included patients aged 20–60 years with cancer of the ileocecum, ascending colon, or hepatic flexure, without serosa layer invasion or metastases, who underwent LRH for curative intent.

Exclusion criteria

Patients with locally advanced colon cancer, distant metastases, malignant obstruction, or perforation of the colon that needed emergency colectomy, those who were primarily included and managed by laparoscopic colectomy but converted to laparotomy, and those who refused to be included in the study were excluded.

Preoperative assessment

All patients went through preoperative clinical history and examination, essential preoperative laboratories, computed tomography scan of the abdomen and pelvis with oral and i.v. contrast, computed tomography of the chest, colonoscopy, and biopsy.

Prior to the surgical procedure, patients received prophylactic antibiotics intravenously (ceftriaxone 1 g and metronidazole 500 mg i.v.) 30–60 min before the incision. Conservative intravenous fluids were administered. Sequential elastic stockings were used for patients with significant thrombosis risk factors. Standard practice included the use of a perioperative urinary catheter and a warming blanket.

Operative technique

Patients are divided into two groups:

Group A: 23 patients underwent LRH with ECA.

Technique: preoperative bowel preparation, intravenous antibiotic administration, and nutritional status monitoring were performed in all patients. Patients were administered general anesthesia and placed in a supine position.

The first assistant surgeon stood on the patient's right side, while the surgeon and the second assistant surgeon, who held the camera, stood on the patient's left side. Using a Veress needle at the umbilicus and inflating the abdomen with carbon dioxide gas to a pressure of 14 mmHg created a pneumoperitoneum. A 12 mm trocar was placed beneath the lower rib border on the left middle axillary line to function as the primary working port, and a 10 mm trocar was positioned 3 cm below the umbilicus for viewing. Following proper insufflation and trocar insertion, the patient was turned right side up in the Trendelenburg position. Any visible metastatic lesions or other abnormalities in the abdomen were examined. The ileocolic vessels were identified and elevated, and the peritoneum was incised lateral to the ileocolic vessels and superior mesenteric vein. Hemoclips were used to ligate the ileocolic and right colic arteries at their vascular pedicles. Using a medial-to-lateral and inferior-to-superior approach, the plane between the colon and Gerota fascia is precisely defined, and the retroperitoneal plane is further developed and maintained in Toldt's space, passing the pancreas and duodenum anteriorly, and the ascending colon and transverse colon posteriorly. During dissection, the colic branch of the gastrocolic vessels was ligated. Subsequently, the right lateral peritoneum was dissected, fully mobilizing the ascending colon and terminal ileum.

The hepatic flexure is mobilized by division and dissection of the greater omentum and hepatocolic ligament. The intramesenteric lymphatic tissue was simultaneously removed when the mobilization of the right mesocolon was completed. The ileocolic anastomosis stage was as follows: further mobilization of the transverse colon may be necessary for LRH with ECA.

For bowel extraction, either a 7–10 cm midline supraumbilical incision or a 12–15 cm right subcostal incision was performed. The terminal ileum and the right or proximal transverse colon were exteriorized. Resection of the terminal ileum and right hemicolon was performed, followed by side-to-side isoperistaltic stapled anastomosis using a GIA stapler (Linear Cutters 60 mm-3.8 mm, blue cartridge; Covidien (PXG8+24 Jersey City, New Jersey, USA). The common enterotomy and colotomy, through which the stapler was inserted, were then closed with a single running suture (PDS 3/0 by Ethicon (H8GX+RM Raritan, New Jersey, USA). After completing the anastomosis, the fascia at the extraction site was closed, and the peritoneal cavity was reinspected. A drainage tube was positioned in the right upper quadrant.

Group B: 17 patients who underwent total LRH with isoperistaltic stapled ICA, ileal mesentery, and mesocolon were fully liberated to reach the target resection margin prior to the anastomosis. The anastomosis was a three-step stapled procedure.

First, an endo-GIA stapler blue cartridge was used to divide the transverse colon.

In the second step, an endo-GIA stapler blue cartridge was used to divide the terminal ileum.

The ileum and transverse colon were aligned in parallel in an isoperistaltic pattern (Fig. 1). An anterior wall colotomy was performed 10 cm distal to the transected transverse colon, and an enterotomy was performed on the ileum 1–2 cm from the ileal stapled edge to avoid ischemic edges (Fig. 2). The two jaws of the endoscopic stapler were inserted into the bowels. The stapler was fired and withdrawn, and a side-to-side anastomosis was created using an endo-GIA stapler (60 mm, 3.5 mm blue cartridge by Covidien) (Fig. 3).

In the third step, the common enterotomy was closed with laparoscopic intracorporeal continuous PDS 3/0 Ethicon sutures (Fig. 4). The drainage tube was positioned after specimen bagging and extraction through a 10 cm Pfannenstiel incision, which was protected by an Alexis wound protector, and the mesenteric defect between the ileal and colon mesenteries was not closed in either group.

All patients were followed up for 12 months postoperatively. Postsurgery, dextrose and ringer infusions were administered according to body weight. Mobilization began 3 h after recovery on the day of the operation. The urinary catheter and sequential elastic stockings were removed at 6:00 a.m. on the first day after surgery (POD 1). Thromboprophylaxis with LMWH was administered according to the patient's weight. Pain management consisted of intravenous acetaminophen (1 g, four times daily) with additional doses of either morphine (5 mg) or pethidine (25 mg), as needed. Upon signs of bowel function recovery, such as audible intestinal sounds or flatus passage, patients were allowed a liquid nutritive diet, progressing to soft and semi-solid foods with snacks as required, followed by a regular diet as tolerated. Intravenous fluid administration was discontinued if vomiting did not occur. The discharge criteria included controlled abdominal pain with oral medication, good oral diet tolerance, restored bowel function, and normal vital signs and blood tests. A follow-up appointment was scheduled at 2 weeks postsurgery. The patients diagnosed with cancer underwent a regular surveillance protocol conducted by the surgeon.

Short-term outcomes and complications

This study had several endpoints including the operation time, duration of the ileocolic anastomosis, intraoperative blood loss, postoperative pain using visual analog scale (VAS), postoperative bleeding, time to intestinal function recovery, onset of oral intake, ileus (defined as time to the first passage of flatus ≥4 days), intraabdominal abscess, surgical site infection, hospital stay duration, and anastomotic leakage incidence. Long-term outcomes and complications such as intestinal obstruction and incisional hernia were also recorded.

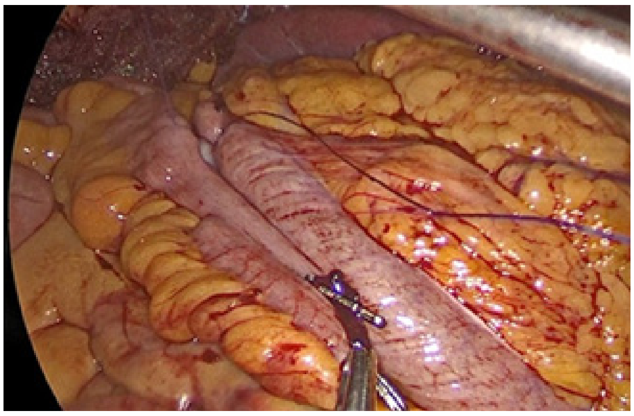
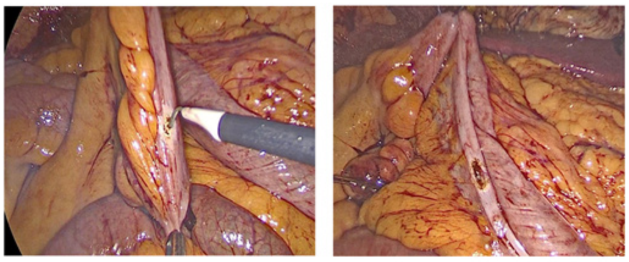


Fig. 1: Alignment of the ileum and transverse colon in an isoperistaltic way.



A B

Fig. 2: (a) Enterotomy and (b) colotomy for insertion of stapling device.

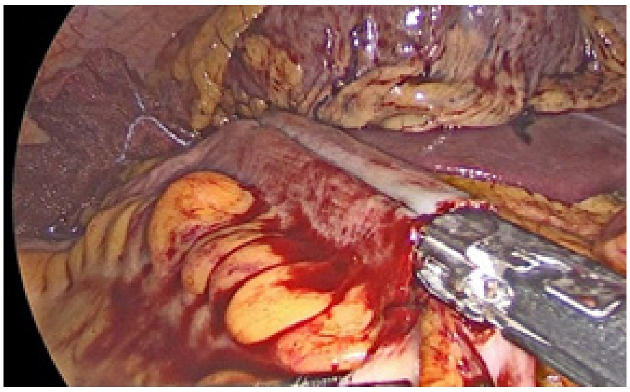


Fig. 3: Intracorporeal side-to-side isoperistaltic ileocolic anastomosis.

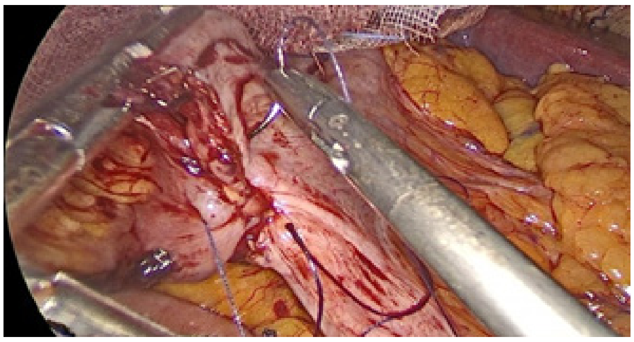


Fig. 4: Hand sewing of enterotomy after stapler removal.

Statistical analysis

Data were collected, revised, coded, and entered into the Statistical Package for Social Science IBM (1 New Orchard Road, Armonk, New York 10504-1722, United States), SPSS, version 27. The quantitative data were presented as mean, SDs, and ranges when parametric and median and interquartile range (IQR) when data were found to be nonparametric. Qualitative variables were presented as numbers and percentages. The *P values* were considered significant as follows: *P value* more than 0.05: nonsignificant, *P value* less than 0.05: Significant, *P value* less than 0.01: highly significant.

RESULTS:

This prospective comparative study included 40 patients who were divided into two groups. Group A included 23 patients who underwent ECA and group B included 17 who underwent ICA.

The demographics of these patients are shown in (Table 1), which showed no significant differences were found between the ECA and ICA groups regarding their demographic data (*P>0.05*).

The comorbidities of these patients are shown in (Table 2), which showed no significant differences were found between the ECA and ICA groups regarding their comorbidities (*P>0.05*).

The tumor site, T stage, N stage, proximal and distal margin distance, and number of harvested lymph nodes were not significantly different between the studied groups (*P>0.05*), whereas the length of the specimen was significantly larger in group B (ICA) (*P=0.012*) as shown in (Table 3).

In our study, the mean operative time was significantly longer in the ECA group than the ICA group (246.91±44.97 vs. 215.94±36.20, *P=0.025*). The mean duration of anastomosis was significantly longer in the ECA group than in the ICA group (19.48±2.33 vs. 15.35±1.17, *P<0.01*). While estimated blood loss was not significantly different between the studied groups (*P=0.903*), as shown in (Table 4).

Bowel function recovery median (IQR) 4 (2–4) days versus median (IQR) 2 (1–2) days *P value* of 0.000, time to liquid intake mean±SD (3.17±0.83 vs. 2.41±0.71 days, *P=0.004*), and hospital stay duration (mean±SD=5.96±0.82 and 3.94±0.9 days, *P=0.000*) were highly significantly longer in the ECA group than in the ICA group (*P<0.01*) as shown in (Table 5).

VAS on the day of surgery and 1 and 2 days postoperative was significantly higher in group A than in group B (*P<0.05*), while at 3, 4, and 5 days postoperative, it was not significantly different between the studied groups as shown in (Fig. 5).

As regards surgical complications, postoperative bleeding (0.4.3% in ECA group vs. 0% in ICA group), anastomotic leakage (0% in ECA group vs. 0% in ICA group), wound infection (SSI) (17.4% in ECA group vs. 5.9% in ICA group), intestinal obstruction (17.4% in ECA group vs. 5.9% in ICA group), and incisional hernia (8.7% in ECA group vs. 5.9% in ICA group) were insignificantly different between the studied groups. While postoperative ileus was significant in the ECA group (34.8% in ECA group vs. 5.9% in ICA group), as shown in (Table 6).

Table 1: Comparison between group A (extracorporeal anastomosis) and group B (intracorporeal anastomosis) regarding demographic data and characteristics of the studied patients

Demographic data	Group A (*N*=23)	Group B (*N*=17)	Test value	*P* value	Significance
Age					
Mean±SD	45±8.66	46.65±10.2	–0.551•	0.585	NS
Range	28–60	29–59			
Sex [*n* (%)]					
Female	13 (56.5)	7 (41.2)	0.921*	0.337	NS
Male	10 (43.5)	10 (58.8)			
WT					
Mean±SD	75.83±10.74	72.47±14.47	0.843•	0.405	NS
Range	55–97	57–97			
HT					

Mean±SD	1.68±0.09	1.66±0.11	0.533•	0.597	NS
Range	1.51–1.85	1.5–1.81			
BMI					
Mean±SD	27±4.66	26.57±6.82	0.238•	0.813	NS
Range	20.07–39.47	18.01–43.11			
ASA [*n* (%)]					
I	5 (21.7)	5 (29.4)	2.576*	0.277	NS
II	15 (65.2)	7 (41.2)			
III	3 (13)	5 (29.4)			

*: Chi-square test; •: Independent t-test

Table 2: Comparison between group A (extracorporeal anastomosis) and group B (intracorporeal anastomosis) regarding comorbidities of the studied patients

Comorbidities	Group A (*N*=23) [*n* (%)]	Group B (*N*=17) [*n* (%)]	Test value	*P* value	Significance
Smoking	7 (30.4)	7 (41.2)	0.496*	0.481	NS
DM	5 (21.7)	5 (29.4)	0.307*	0.580	NS
HTN	2 (8.7)	1 (5.9)	0.112*	0.738	NS
Anemia	4 (17.4)	2 (11.8)	0.243*	0.622	NS
ISHD	1 (4.3)	2 (11.8)	0.775*	0.379	NS
Weight loss	3 (13)	4 (23.5)	0.744*	0.388	NS
Previous surgery	1 (4.3)	1 (5.9)	0.048*	0.826	NS
Free	6 (26.1)	5 (29.4)	0.054*	0.816	NS

P value more than 0.05: nonsignificant; *P value* less than 0.05: significant; *P value* less than 0.01: highly significant.

Table 3: Comparison between group A (extracorporeal anastomosis) and group B (intracorporeal anastomosis) regarding pathology results and tumor characteristics of the studied groups

Pathology results	Group A (*N*=23) [*n* (%)]	Group B (*N*=17) [*n* (%)]	Test value	*P* value	Significance
Tumor site					
Ascending colon	13 (56.5)	6 (35.3)	2.172*	0.338	NS
Hepatic flexure of the colon	5 (21.7)	7 (41.2)			
Ileocecum	5 (21.7)	4 (23.5)			
T stage					
T1	5 (21.7)	3 (17.6)	1.471*	0.689	NS
T2	5 (21.7)	4 (23.5)			
T3	13 (56.5)	9 (52.9)			
T4a	0	1 (5.9)			
N stage					
N0	14 (60.9)	12 (70.6)	0.669*	0.716	NS
N1	6 (26.1)	4 (23.5)			
N2	3 (13)	1 (5.9)			
N3	0	0			
M stage					
M0	23 (100.0)	17 (100.0)	NA	NA	NA
Proximal margin distance (cm)					
Median (IQR)	8 (5–15)	13 (11–16)	−1.633≠	0.102	NS
Range	1–20	1–18			
Distal margin distance (cm)					

Median (IQR)	10 (6–17)	9 (7–16)	−0.055≠	0.956	NS
Range	2–19	2–19			
Length of specimen					
Mean±SD	29.13±1.49	30.47±1.70	−2.652•	0.012	S
Range	27–33	28–33			
Number of lymph nodes collected					
Mean±SD	19.61±9.29	20.47±7.94	−0.308•	0.760	NS
Range	6–35	5–35			

*χ^2 test; •Independent t test; ≠Mann–Whitney test.
P value more than 0.05: nonsignificant; *P value* less than 0.05: significant; *P value* less than 0.01: highly significant.

Table 4: Comparison between group A (extracorporeal anastomosis) and group B (intracorporeal anastomosis) regarding intraoperative data of the studied groups

Intraoperative data	Group A (*N*=23) [*n* (%)]	Group B (*N*=17) [*n* (%)]	Test value	*P* value	Significance
Anastomotic configuration					
Side to side	23 (100)	17 (100)	–	–	–
Anastomotic method					
Stapled	23 (100)	17 (100)			
Operative time (min)					
Mean±SD	246.91±44.97	215.94±36.20	2.333	0.025	S
Range	178–321	167–280			
Duration of anastomosis (min)					
Mean±SD	19.48±2.33	15.35±1.17	6.681	0.000	HS
Range	16–23	14–17			
Estimated blood loss (ml)					
Mean±SD	51.74±23.38	52.65±22.78	−0.123•	0.903	NS
Range	10–80	20–100			

•Independent t test.
P value more than 0.05: nonsignificant; *P value* less than 0.05: significant; *P value* less than 0.01: highly significant.

Table 5: Comparison between group A (extracorporeal anastomosis) and group B (intracorporeal anastomosis) regarding postoperative outcomes of the studied groups

Postoperative outcomes	Group A (*N*=23)	Group B (*N*=17)	Test value	*P* value	Significance
Bowel function recovery, days					
Median (IQR)	4 (2–4)	2 (1–2)	−3.541≠	0.000	HS
Range	1–5	1–3			
Time to liquid intake, days					
Mean±SD	3.17±0.83	2.41±0.71	3.035•	0.004	HS
Range	2–4	1–3			
Hospital stays, days					
Mean±SD	5.96±0.82	3.94±0.9	7.354•	0.000	HS
Range	5–7	3–5			

•Independent t test.
P value more than 0.05: nonsignificant; *P value* less than 0.05: significant; *P value* less than 0.01: highly significant.

Table 6: Comparison between group A (extracorporeal anastomosis) and group B (intracorporeal anastomosis) regarding postoperative complications among the studied patients

Postoperative complications	Group A (*N*=23) [*n* (%)]	Group B (*N*=17) [*n* (%)]	Test value	*P* value	Significance
Postoperative bleeding	1 (4.3)	0	0.758*	0.384	NS
Anastomotic leakage	0	0	–	–	–
Postoperative ileus	8 (34.8)	1 (5.9)	4.682*	0.030	S
Wound infection (SSI)	4 (17.4)	1 (5.9)	1.184*	0.277	NS
Intraabdominal abscess	0	0	–	–	–
Intestinal obstruction	2 (8.7)	1 (5.9)	0.112*	0.738	NS
Incisional hernia	3 (13)	0	2.397*	0.122	NS

*χ^2 test.
P value more than 0.05: nonsignificant; *P value* less than 0.05: significant; *P value* less than 0.01: highly significant.

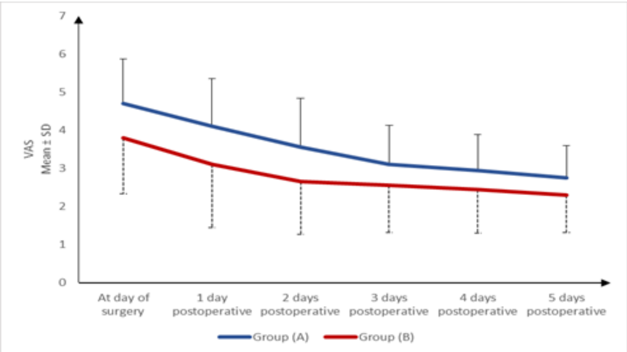


Fig. 5: VAS between the studied groups. VAS, visual analog scale.

DISCUSSION

Colon cancer is the third most common cancer in both males and females, and RCCs are frequently discovered at advanced stages. LRH is an effective treatment for RCCs. However, the procedure lacks standardization because of concerns about creating ileocolic anastomosis[10]. Recent research has identified the benefits of ICA over ECA, including reduced postoperative complications, fewer open surgery conversions, and shorter hospital stays[11,12].

In our study, age, sex, weight, height, BMI, and ASA physical status were not significantly different between the groups. The mean age of the patients in group A was 45 years. Group B had a mean age of 46.65 years. Group A was comprised of 10 (43.5%) males and 13 (56.5%) females. Group B included seven (41.2%) males and 10 (58.8%) females.

In our study, smoking, DM, HTN, anemia, ISHD, weight loss, and previous surgery were not significantly different between the groups. According to Eltih *et al*.[9], the study included 18 patients with an average age of 53.1±13.9 years. Men comprised the majority at 61.1%, while women made up 38.9% of the group. Among the participants, four had diabetes, two had ischemic heart disease, and one had hypertension.

Our study population was notably younger than those in the research conducted by Allaix *et al*.[13], Aiolfi *et al*.[14], and Milone *et al*.[15]. This age difference can be attributed to the earlier onset of colon cancer diagnosis in Egyptians, as documented in previous population-based studies.

Our research revealed that the BMI of patients in group A ranged from 20.07 to 39.47, while group B's BMI spanned from 18.01 to 43.11. According to Ishizaki *et al*.[16], the prevalence of obesity is expected to increase in the coming years. Obese individuals typically have larger and heavier specimens, more substantial fatty mesenteries, and considerably thicker abdominal walls. Consequently, surgeons performing laparoscopic procedures may need to employ ICA in these patients.

Our study found no significant difference in the number of lymph nodes harvested between the two groups. Group A had a mean±SD of 19.61±9.29, compared to 20.47±7.94 for group B (*P=0.760*). This finding aligns with Allaix *et al*.[13], who reported no notable disparities in lymph node collection following ICA and ECA. Similarly, Biondi *et al*.[17] observed no significant variations in lymph node yield between the two techniques (19.46±7.06 in the ICA group vs. 22.68±8.79 in the ECA group; *P=0.086*). Prior research has indicated that the number of lymph nodes collected could serve as a prognostic indicator following colorectal cancer surgery[18]. A recent study demonstrated a significant correlation between lymph node yield and survival outcomes in patients with stages I and II colorectal cancer. Harvesting 20 or more lymph nodes was associated with improved survival outcomes, whereas collecting fewer than 12 lymph nodes did not result in inferior survival outcomes compared to yields between 12 and 19[19]. Similarly, Liao *et al*.[20], who compared the oncological outcomes and pathologic differences between ICA and ECA, revealed that the number of retrieved lymph nodes was not significantly different between the ICA and ECA groups, although some studies demonstrated a higher number of harvested lymph nodes using the ICA method[21,22].

Our study revealed that the ECA group experienced significantly longer operative time and anastomosis duration compared to the ICA group (246.91±44.97 vs. 215.94±36.20 min). Fabozzi *et al*.[22] proposed that ICA could potentially decrease operative time. Heggy *et al*.[23] demonstrated the superiority of the intracorporeal approach to the extracorporeal approach in terms of operative time. Małczak *et al*.[24] reported a significantly longer median operative time for ECA (*P<0.001*), which is consistent with our findings. However, Biondi *et al*.[17] found no significant difference (199±48.90 min for ICA vs. 183.64±35.80 min for ECA; *P=0.109*). Additionally, a comprehensive meta-analysis by Selvy *et al*.[25] showed no disparities in the duration of surgery. Similarly, Arredondo Chaves *et al*.[26] conducted a case–control study with 60 patients (35 ICA and 25 ECA) between June 2004 and June 2010 and found no significant differences in operation time between groups. Conversely, numerous studies suggest that ICA has a longer operative time than ECA owing to increased technical challenges[27,28]. Shapiro *et al*.[40] and Vignali *et al*.[29] also indicated that the ICA group might have extended operative times. A recent large observational study by Anania *et al*.[2] reported that ECA was associated with shorter operative times, which contradicts our results. Liao *et al*.[20] reported significantly longer surgical times in the ICA group than in the ECA group. This is primarily attributed to the necessity for hand sewing and knotting within the abdominal cavity, with many surgeons requiring additional training to perform intracorporeal sutures efficiently.

Our research revealed that the ECA group experienced significantly longer periods of bowel function recovery, time to liquid intake, and hospital stay than the ICA group (*P<0.01*). This finding aligns with that of Heggy *et al*.[23], who demonstrated the superiority of the intracorporeal approach over the extracorporeal approach in terms of postoperative hospital stay duration. Our observations support this hypothesis, as patients who underwent ICA exhibited faster recovery and shorter hospital stays, consistent with previous research[15]. However, Anania *et al*.[30] and Ricci *et al*.[31] found no disparities in postoperative hospital stay duration. A recent study by Vallribera *et al*.[32] noted higher overall morbidity in ECA patients compared to ICA patients (23.5 vs. 40.2%, *P=0.014*; 5.9 vs. 14.9%, *P=0.039*, respectively), although no significant differences were observed in anastomotic leakage rates (9.8 vs. 10.3%, *P=0.55*). Allaix *et al*.[13] reported faster postoperative bowel function recovery following ICA versus ECA [gas: 2 (IQR 2–3) vs. 3 (IQR 2–3) days, *P=0.003*; stool: 4 (IQR 3–5) vs. 4.5 (IQR 3–5) days, *P=0.032*] but found no significant differences in median hospital stay length [6 (IQR 5–7) vs. 6 (IQR 5–8) days; *P=0.839*]. Biondi *et al*.[17] also identified significant differences between ICA and ECA groups in terms of bowel function return (2.21±1.01 days for ICA vs. 3.45±1.82 days for ECA; *P=0.0001*) and hospital stay duration (7.53±1.91 days for ICA vs. 8.77±3.66 days for ECA; *P=0.036*).

The observed results could be attributed to minimal mobilization of the mesentery and digestive system, facilitating a quicker restoration of intestinal function. Additionally, a reduced incision size may contribute to decreased postoperative discomfort, fewer respiratory issues, and shorter hospital stays[33]. Numerous studies have demonstrated that patients with lower abdominal incisions experience faster recovery of mobility and normal bowel function, as well as reduced pulmonary complications[34]. Liao *et al*.[20] reported significantly shorter bowel movement times in their ICA group. This study revealed a markedly reduced mean length of stay postsurgery in the ICA group, particularly for stays under 5 days. The abbreviated length of stay indicates an overall superior recovery following ICA surgery, encompassing reduced wound pain, reduced intestinal stress, and improved bowel function recovery.

Our study showed significantly higher VAS scores in group A ECA than in group B ICA on the day of surgery and the first two postoperative days (*P<0.05*), while no significant differences were observed between days 3 and 5 postoperatively. These findings align with those of Fabozzi *et al*.[22] and Grams *et al*.[35], confirming that ICA was associated with reduced postoperative pain and analgesic requirements compared to ECA. This is further corroborated by a recent multicenter randomized clinical trial (The IVEA-study) conducted by Ferrer-Márquez *et al*.[36] involving 168 patients undergoing LRH for RCC, which demonstrated that ICA significantly reduced postoperative pain (*P=0.000*) compared to ECA.

Consistent with these findings, Liao *et al*.[20] observed a notable improvement in pain scale (VAS) scores on the third day after surgery in the ICA group. This improvement can be attributed to the Pfannenstiel extraction incision used in ICA, which causes less discomfort and has minimal involvement with the anterior abdominal wall muscles that participate in breathing compared to the RUQ transverse incision. Research has shown that postoperative pain can influence early patient mobility and the development of paralytic ileus. Furthermore, multiple studies have demonstrated that patients with lower abdominal incisions experience reduced postoperative discomfort[34]. However, Scatizzi *et al*.[37] found no significant differences in postoperative pain levels and analgesic usage between the two groups.

In this study, the tumor location, T stage, and N stage were not significantly different among the studied groups. Liao *et al*.[20] observed that the primary T stage of resected tumors in their series was T3 or T4, suggesting that tumor characteristics may be more crucial than the surgical approach. Our study revealed that the specimen length was considerably greater in the intracorporeal group than in the extracorporeal group (30.47±1.70 vs. 29.13±1.49). Similarly, Biondi *et al*.[38] reported that the ICA method yielded superior specimen and vascular pedicle lengths, with a greater colon length achieved using ICA than ECA (20.36 vs. 17.45 cm, *P=0.01*). A single-blind, randomized clinical trial conducted by Bollo *et al*.[39] also demonstrated that colon length was longer in the ICA group than in the ECA group (25.3 vs. 22.7 cm, *P=0.026*).

Our study found no significant differences between the groups regarding surgical complications such as postoperative bleeding, anastomotic leakage, wound infection (SSI), intestinal obstruction, and incisional hernia. These findings align with those of Heggy *et al*.[23], Anania *et al*.[30], and Ricci *et al*.[31], who reported no substantial differences in postoperative complications between groups. However, our study noted a significant occurrence of postoperative ileus in the ECA group (*P=0.03*). Notably, no anastomotic leakage was observed in our study in either group, which corresponds to Ishizaki *et al*.[16], who suggested that residual intraperitoneal bacterial activity might peak on postoperative day 3, as indicated by the inflammatory response. Similarly, Vallribera *et al*.[32] reported no significant differences in anastomotic leakage (9.8 vs. 10.3%, *P=0.55*). Biondi *et al*.[17] also found no significant differences in postoperative complications like abscesses, bleeding, and postoperative ileus (*P=0.366*), with anastomotic leakage occurring in 4/64 (6%) patients in the ICA group and 3/44 (7%) patients in the ECA group. A recent multicenter randomized clinical trial (The IVEA study) by Ferrer-Márquez *et al*.[36], involving 168 patients undergoing LRH for RCC, demonstrated that ICA reduced surgical site infection compared with ECA (3.65 vs. 16.67%, *P=0.008*). Additionally, a recent meta-analysis of 24 studies showed that ICA, compared to ECA, following laparoscopic right colectomy for both benign and malignant diseases significantly reduced parietal abscesses (odds ratio=0.526, confidence interval: 0.333–0.832; *P=0.006*), time to first gas and stools, surgical repair, and length of hospitalization, while general complications remained comparable[25].

Conversely, Ishizaki *et al*.[16] reported that the risk of SSI was notably higher in the ICA group compared to the ECA group. Additionally, on the third day after surgery, the ICA group exhibited significantly elevated CRP levels and body temperature. This could be attributed to potential fecal contamination resulting from incisions in the bowel lumen, possibly leading to infections within the abdominal cavity.

A case-control study by Milone *et al*.[15] examined 286 patients who underwent LRH with ICA and 226 matched patients who underwent LRH with ECA. Their research indicated that laparoscopic colectomy using ICA was associated with fewer postoperative complications (odds ratio=0.65, 95% confidence interval: 0.44, 0.95, *P=0.027*). The occurrence of leaks and bleeding was comparable regardless of whether the anastomosis was performed intracorporeally or extracorporeally. However, wound infections were more prevalent after laparoscopic-assisted colectomy. No statistically significant difference in the operative time was observed between the groups.

Shapiro *et al*.[40] noted a reduced incidence of incisional hernia in ICA cases, which is consistent with our study. In the ICA technique, patients received a suprapubic Pfannenstiel extraction incision ~10 cm long, which was used solely for specimen removal. In contrast, the ECA group required a larger extraction incision in the RUQ, ranging from 15 to 20 cm, for both specimen extraction and ECA performance, resulting in a more extensive wound than that in the ICA group. Pfannenstiel incisions not only have a lower risk of wound infection (17.4 vs. 5.9%) and incisional hernias (13 vs. 0%) but also yield superior cosmetic outcomes when compared to right transverse or midline incisions.

Wu *et al*.[41] and Widmar *et al*.[42] highlighted several benefits of the ICA method, including reduced analgesic usage, quicker bowel movement and flatus passage, shorter time to solid food consumption, and decreased hospital stay duration. These studies also noted that postoperative complications were similar between the two methods.

CONCLUSION

Based on our results, LRH with ICA demonstrated a significantly shorter operative time, faster recovery of bowel function, earlier liquid intake, shorter hospital stay, and less postoperative pain in the initial 48 h compared to LRH with ECA without compromising oncologic outcomes or safety. The two surgical approaches did not differ significantly in terms of lymph node yield, margin distances, complication rates, or tumor characteristics.

CONFLICT OF INTEREST

There are no conflicts of interest.

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