Original Article

Short-term outcomes of intracorporeal versus extracorporeal ileotransverse anastomosis in laparoscopic right colectomy: A prospective randomized study

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ABSTRACT

Background: Laparoscopic right colectomy is a widely accepted surgical technique for colon cancer resection, commonly using either intracorporeal anastomosis (ICA) or extracorporeal anastomosis (ECA). Our study compares the benefits of ICA versus ECA, as ICA has been suggested to provide faster recovery and shorter hospital stays. However, there is a lack of scientific evidence in this regard.

Patients and Methods: An randomized clinical trial was conducted from November 2021 to June 2023 to compare intraoperative technical events and short-term postoperative clinical outcomes.

Results: A total of 71 were randomized. The median operative time for the ECA group was 226.67 min (range: 167–310) and 222.78 min for the ICA group (range: 158–263) with no significant difference between them (*P=0.606*). There is no significant difference in the number of harvested lymph nodes between the ECA group (mean: 13.88, range: 12–15) and the ICA group (mean: 13.78, range: 12–16) (*P=0.664*). The incidence of postoperative ileus, vomiting, and intestinal obstruction did not differ significantly between the two groups (*P=0.728*, 0.795, and 0.885, respectively). Significantly, there was a higher incidence of wound infection in the ECA group (*P=0.047*). The ICA group had significantly lower pain scale scores on the postoperative day (*P<0.001*). Significantly shorter mean length of postoperative hospital stays was seen in the ICA group (4.15 vs. 5.27 for ECA, *P<0.001*). Delayed postoperative complications showed no significant difference (*P=0.061* and 0.362 for incisional hernia and internal hernia, respectively).

Conclusion: ICA has less postoperative pain, shorter time to first flatus, shorter length of hospital stays, and lower rates of wound infection with nearly the same operative time compared with ECA.

Key Words: Extracorporeal anastomosis, hospital stay, incisional hernia, intracorporeal anastomosis, laparoscopic right colectomy, wound infection.

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INTRODUCTION

Colorectal cancer is the most common cancer affecting the gastrointestinal system. Unfortunately, the number of people affected and deaths caused by this cancer has increased in recent years[1]. Jacobs *et al*.[2] were the first to apply laparoscopic-assisted technology to colon resection in the early 1990s. Minimally invasive right hemicolectomy has gradually become the standard procedure for right hemicolectomy[3,4], whether laparoscopic or robotic colectomy.

Laparoscopic right colectomy is a well-established technique for elective resection of cancer colon. Two anastomotic techniques can be used in this procedure: intracorporeal anastomosis (ICA) and extracorporeal anastomosis (ECA). The total laparoscopic procedure with ICA enables precise visualization ensuring proper conformation, facilitating the selection of the incision location and length required for removing the specimen while preventing rotation or traction[5]. It is also a less invasive method that offers a faster postoperative recovery, shorter hospital stays, and lower morbidity. Despite its potential benefits, no evidence-based studies have been conducted so far[6–11]. This randomized controlled study aimed to compare ICA with ECA in patients who underwent elective laparoscopic right hemicolectomy.

PATIENTS AND METHODS:

This is a prospective randomized clinical trial, single-blinded and single-center, comparing ICA versus ECA. This study was conducted at the Colorectal Unit, Ain Shams University Hospitals from November 2021 to June 2023. The same team of four colorectal surgeons with advanced laparoscopic expertise performed both types of anastomoses. The total number of study patients was 71 patients. The study followed the Ethical Principles for

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Medical Research Involving Human Subjects outlined in the Declaration of Helsinki. The Ethics Committee and Research Institute at Ain Shams University Hospitals approved the study protocol.

Study population

All adult patients who were referred from November 2021 to June 2023 for treatment of a right colonic adenocarcinoma or appendiceal tumor that was confirmed by biopsy and required a standard laparoscopic right hemicolectomy with the aim of R0 resection were considered for inclusion. All patients who participated in the study provided a signed written consent.

The inclusion criteria were as follows: the patient had a right-sided colonic lesion in which a laparoscopic right hemicolectomy decision was taken, had an American Society of Anesthesiologists Classification fitness grades I, II, or III, underwent surgery with a curative intention, and had the tumor located in the cecum, ascending colon, or hepatic flexure.

Patients were excluded if they refused to participate in the study, had a locally advanced tumor (cT4b) or required emergency surgery, needed a simultaneous surgical procedure such as synchronous colonic lesions or segmental liver resection, patients converted from laparoscopic to open procedure in difficult cases and cases in which radicality during laparoscopy would be questioned.

Randomization, allocation concealment, and blinding

Patients were consecutively included in the study from the enrollment of the first eligible patient meeting the selection criteria. A specific randomization program was created for this project and customized to work with the SPSS software (Statistical analysis was done using IBM SPSS statistics for windows, Version 23.0. Armonk, NY: IBM Corp).

The randomization list was created by a skilled statistician using a computerized random number generator, eliminating bias from the surgical team. The surgical procedure involving the resection of the right colon and anastomosis was initiated through the use of sequentially numbered, sealed, opaque envelopes. The surgeon would carefully evaluate the local conditions before opening the envelopes to determine if laparoscopic resection was appropriate. This methodology ensured a systematic approach to the surgical process, promoting accuracy and precision while minimizing the risk of errors.

Surgical technique

The technique used in this study for laparoscopic right hemicolectomy was as follows. The surgeon, along with two assistants, stood on the left side of the patient, while the laparoscopy monitor was placed on the right side of the patient. The pneumoperitoneum was achieved using a Veress needle at the left Pulmer's point and four trocars were inserted. A 12 mm port was placed at the umbilicus for the camera. Another 12 mm port was placed at the left upper quadrant for the surgeon's right hand and a 5 mm port at the left iliac region for the surgeon's left hand. There was another 5 mm port at the right lumbar region for the assistant.

The colon was mobilized from medial to lateral with retroperitoneal dissection, and the ileocolic vessels were identified for ligation. The right colic artery and right branch of the middle colic artery were also identified and ligated with hemostatic clips. Mobilization of the distal ileum and right colon was initiated, followed by dissection of Toldt's fascia until free mobilization of the hepatic flexure is achieved. The right portion of the omentum was dissected.

If the patient is going for an ECA, a right upper quadrant transverse incision was made and protected using an Alexis device. The ileum and colon were then extracted, and the mesocolon was dissected. A side-to-side isoperistaltic anastomosis was created using a GIA stapler (Proximate Linear Cutters 60 mm, blue cartridge; Ethicon). Finally, the common enterotomy and colotomy from which the stapler has been introduced were closed with a single running barbed suture (V-Loc 3/0 by Covidien).

If the patient is going for an ICA (Fig. 1), the mesocolon dissection was done first and then transecting the ileum and transverse colon with the Echelon Flex endo-GIA stapler (60 mm, blue cartridge by Ethicon). Using the same stapler, we created a side-to-side isoperistaltic ileocolic anastomosis, the common enterotomy and colotomy from which the stapler has been introduced were closed with a single running barbed suture (V-Loc 3/0 by Covidien). Finally, we extracted the specimen through a 10 cm Pfannenstiel incision, which was protected by an Alexis wound protector.

A closed tube drain was inserted intra-abdominally. The mesenteric defect between the ileal and colon mesenteries was not closed in both groups.

Perioperative management

All patients were diagnosed with right colonic cancer through colonoscopy, biopsy, abdominal computed tomography, and routine blood tests which were done preoperatively. Perioperative antibiotic prophylaxis was administered through intravenous ceftriaxone and metronidazole. The surgery was performed under general anesthesia with endotracheal intubation, nasogastric tube insertion, bladder catheterization, and antithrombotic measures. Normothermia, normovolemia, and glycemia control were maintained through special care and a regimen of fluids and electrolytes.

Following surgery, each patient was cared for through an Enhanced Recovery after Surgery protocol. This included a 6-h trial of liquids and a strong emphasis on early mobilization. All patients were given a standardized pain management regimen consisting of 1 g of paracetamol every 8 h, 25 mg of Ketorolac twice daily, and 20 mg of Nalbuphine HCL (Nalufen) as needed. Eligibility for discharge was based on the patient's ability to tolerate oral intake and a complication-free recovery.

Outcome measures

The study had several endpoints including the duration of operation, intraoperative complications such as bleeding, size of the surgical wound, time to start and tolerate oral intake, time to restoration of digestive function (first passage of flatus), and postoperative pain that was measured on a visual analog scale (Fig. 2), surgical wound infection, paralytic ileus, anastomotic leakage, duration of hospital stay measured in days, oncological outcomes including the number of lymph node removed, and the need for reintervention or hospital readmission within the first 30 days after surgery.

The Clavien-Dindo classification[12,13] was used to evaluate surgical complications. The Comprehensive Complication Index[14] was used to compare the severity of complications. Paralytic ileus was classified according to Delaney *et al*.[15]. Tumor staging was done by the TNM seventh edition of the AJCC[16].

Data management

One of our investigators filled out an operative case report form that contained reasons for surgery, patient data, and measurements from the surgical procedure. Another surgeon recorded data regarding postoperative recovery and follow-up visits during the hospital admission.

Statistical analysis

Data were collected, tabulated, and statistically analyzed by an IBM-compatible personal computer with SPSS Statistical Package, Version 26. Two types of statistics were used: descriptive statistics, for example: number and percent for qualitative data, mean, and SD for quantitative data. Analytic statistics, for example: Student's t test is a test used for comparison between two groups having quantitative normally distributed variables. χ^2 was used to study the association between two qualitative variables. *P value* less than 0.05 was considered statistically significant.

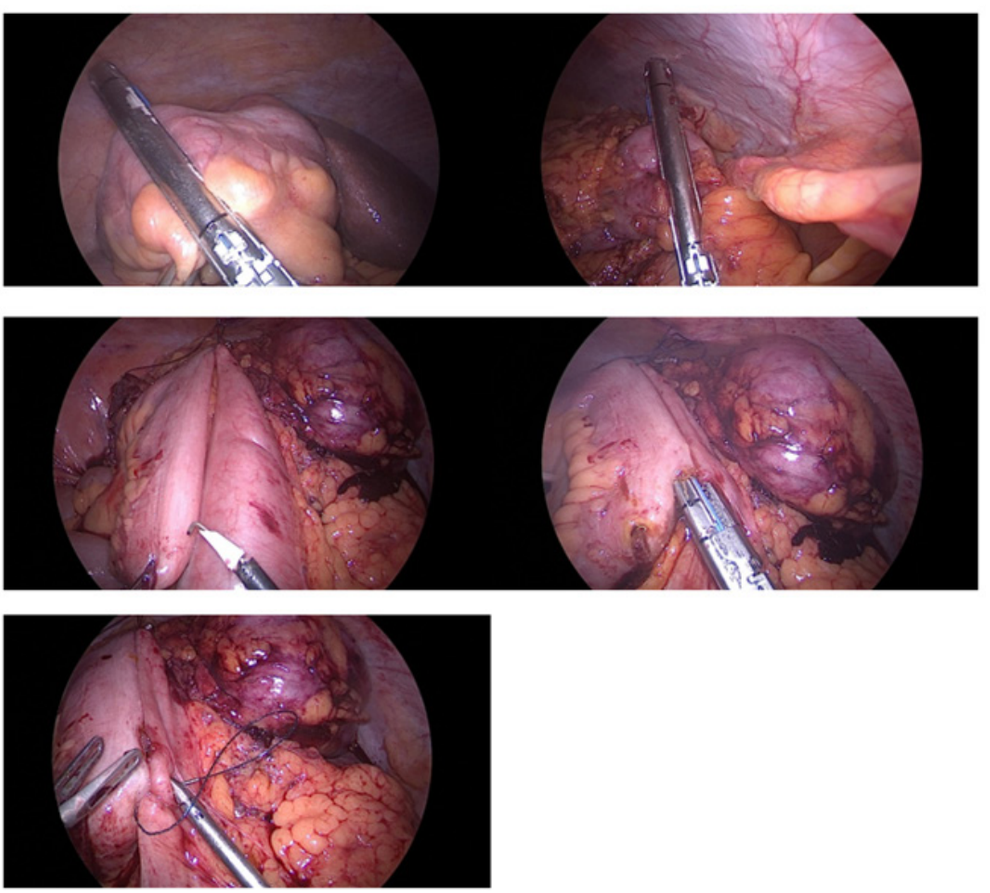


Fig. 1: Stappled intracorporeal anastomosis and closure of the common enterotomy and colotomy from which the stapler has been introduced with a single running barbed suture.

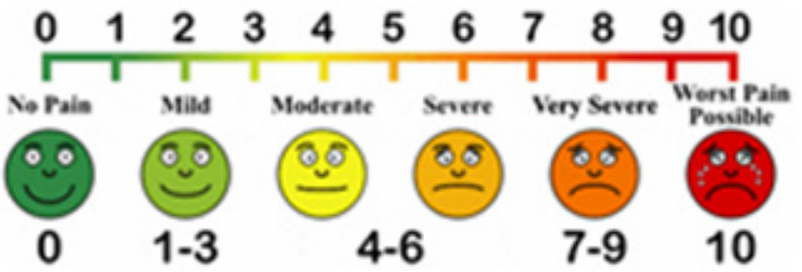


Fig. 2: Visual analog scale (VAS) used in our study.

RESULTS:

The total number of study patients was 71 patients. Of these, 38 patients underwent extracorporeal ileocolic anastomosis (ECA group) and 33 patients underwent intracorporeal ileocolic anastomosis (ICA group). Five patients from the ECA group and six patients from the ICA group were lost during our follow-up period and were excluded from the results.

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

Table 1: Demographic data

	Ileotransverse anastomosis			
Baseline characteristics	Extracorporeal (*N*=33)	Intracorporeal (*N*=27)	Test of significance	*P* value
Age (years)				
Mean±SD	56.67±7.29	58.78±7.66	*t*=1.09	0.280
Range	32-73	45-71		
Sex [*n* (%)]				
Male	21 (63.6)	18 (66.7)	χ^2=0.06	0.807
Female	12 (36.4)	9 (33.3)		
BMI (kg/m^2)				
Mean±SD	35.42±4.61	37.00±5.09	*t*=1.26	0.214
Range	27-43	25-46		
Relevant abdominal operation:				
Free	16 (48.5)	14 (51.9)	χ^2=0.07	0.795
Present	17 (51.5)	13 (48.1)		
Types of relevant abdominal operation				
Appendectomy McBurney	2 (6.1)	5 (18.5)		
Lap appendectomy	1 (3.0)	0	χ^2=8.81	0.117
Lower midline appendectomy	1 (3.0)	0		
Open hysterectomy	1 (3.0)	3 (11.1)		
Inguinal hernia	1 (3.0)	2 (7.4)		
Lap cholecystectomy	3 (9.1)	2 (7.4)		
Open cholecystectomy	3 (9.1)	0		
Pelvicalyceal stone	1 (3.0)	1 (7.4)		
PUH	4 (12.1)	0		
Medical history				
No	19 (57.6)	17 (63.0)	χ^2=1.87	0.866
Diabetes mellitus	4 (12.1)	3 (11.1)		
Hypertension	5 (15.2)	5 (18.5)		
Cardiac disease	3 (9.1)	2 (7.4)		
Cerebrovascular accident	1 (3.0)	0		

Cirrhosis	1 (3.0)	0		
ASA				
II	20 (60.6)	17 (63.0)	χ^2=0.04	0.852
III	13 (39.4)	10 (37.0)		

Operative parameters

The intraoperative parameters for ICA and ECA groups are listed in (Table 2). There were no significant differences in blood loss between the two groups. Conversion to laparotomy was considered as an exclusion criterion.

The mean operative time showed no significant differences between the two groups (226.67 for ECA vs. 222.78 min for ICA group, *P=0.606*). There was a significant difference between the ECA group and the ICA group regarding the type of extraction wound. Pfannenstiel incision was performed in all patients with ICA, while a right upper quadrant transverse wound was performed in all patients with ECA (*P<0.001*).

Table 2: Operative parameters

	Ileotransverse anastomosis [*n* (%)]			
Operative data	Extracorporeal (*N*=33)	Intracorporeal (*N*=27)	Test of significance	*P* value
Extraction wound				
Pfannenstiel	0	27 (100.0)	χ^2=60.00	***<0.001***
RUQ transverse	33 (100.0)	0		
Bleeding more than 100 ml				
No	28 (48.8)	22 (81.5)	χ^2=0.12	***0.728***
Yes	5 (15.2)	5 (18.5)		
Operative time (min)				
Mean±SD	226.67±30.99	222.78±26.18	*t*=0.52	***0.606***
Range	167–310	158–263		

Pathological data and the number of harvested lymph nodes in the final spacemen are shown in (Table 3, Figs 3–5). There was no significant difference between the ECA group and the ICA group regarding their diagnosis and pathological data and the number of harvested lymph nodes (*P=0.664*).

Table 3: Pathological data and the number of harvested lymph nodes in the final spacemen

	Ileotransverse anastomosis [*n* (%)]			
Diagnosis and pathological parameters	Extracorporeal (*N*=33)	Intracorporeal (*N*=27)	χ^2	*P* value
Diagnosis				
Ascending colon mass	17 (51.5)	12 (44.4)	0.78	0.854
Cecal mass	6 (18.2)	6 (22.2)		
Hepatic flexure mass	6 (18.2)	4 (14.8)		
Proximal transverse colon mass	4 (12.1)	5 (18.5)		
pT stage				
I	5 (15.2)	5 (18.5)	0.55	0.969
II	6 (18.1)	5 (18.5)		
III	17 (51.5)	14 (51.8)		
Iva	5 (15.2)	3 (11.1)		
pN stage				
N0	1 (3.0)	1 (3.7)	0.15	0.927
N1	5 (15.2)	5 (18.5)		
N2	27 (81.8)	21 (77.8)		

M stage				
M0	33 (100.0)	27 (100.0)	–	–
Lymph node removed	13.88±0.86	13.78±0.93	0.44	0.664
	12–15	12–16		

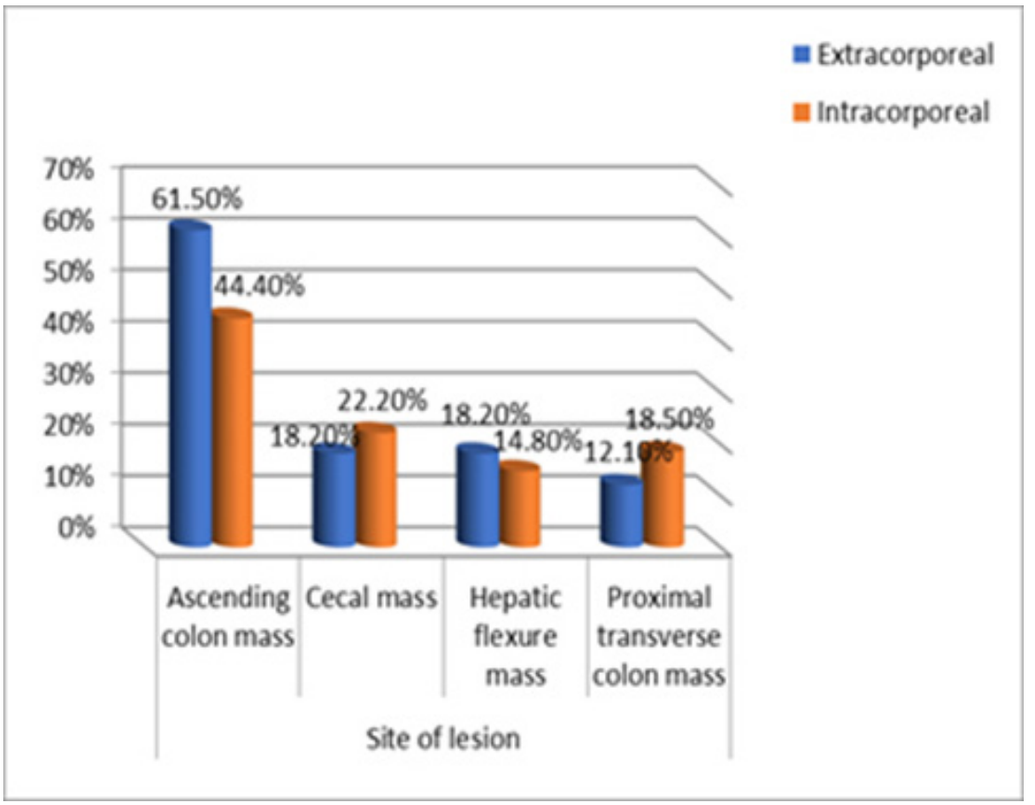


Fig. 3: No significant difference between the sites of lesions in the two groups. The most common site was the ascending colon in both groups.

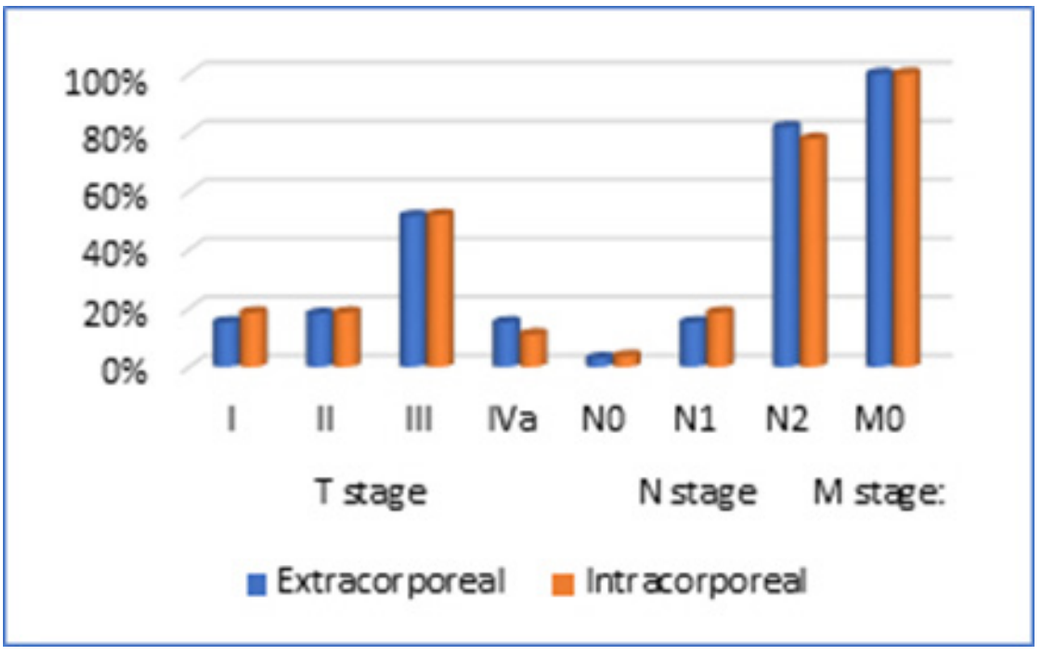


Fig. 4: Pathological TNM staging of ECA and ICA groups. ECA, extracorporeal anastomosis; ICA, intracorporeal anastomosis.

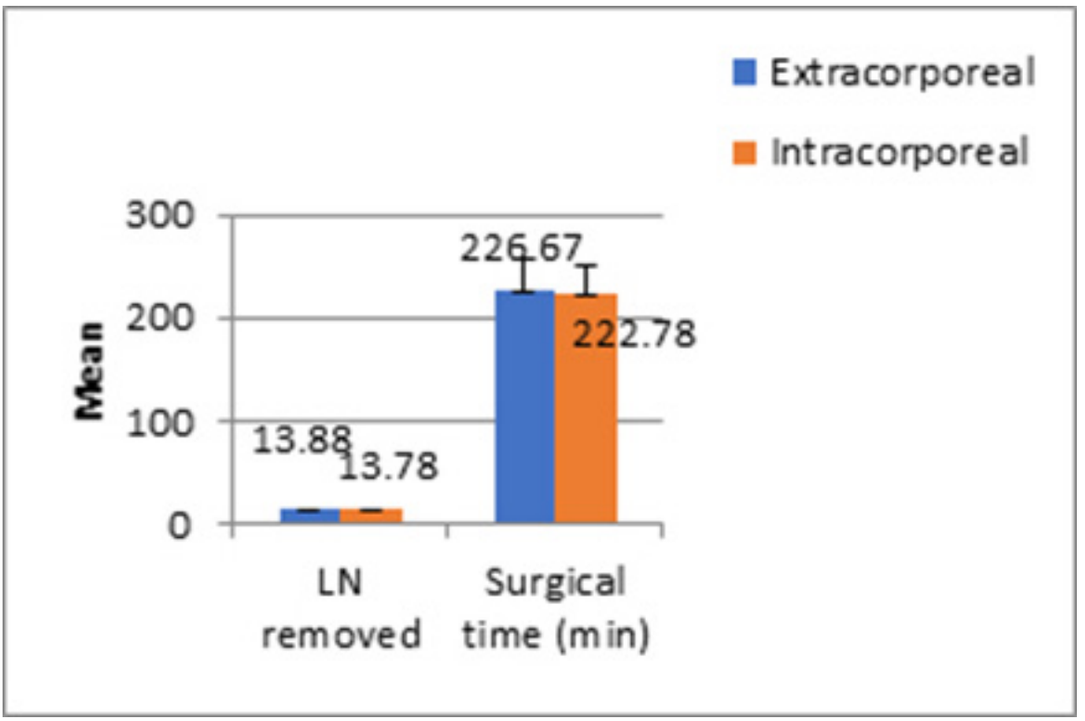


Fig. 5: Surgical time and lymph node removed.

Early postoperative outcomes

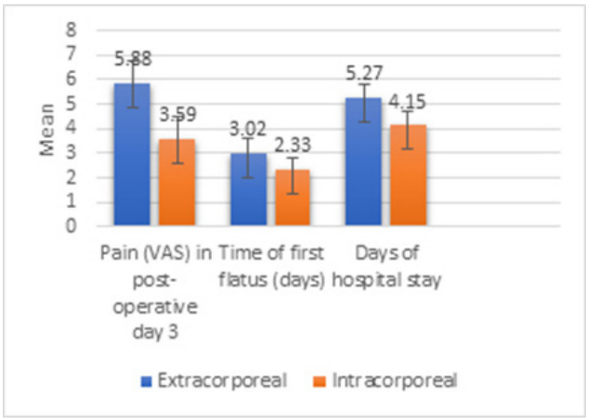
There was no significant difference between the rate of the overall complication between the two groups: the postoperative ileus, postoperative vomiting, intestinal obstruction, and postoperative bleeding showed no significant difference observed between the two groups. All patients who experienced ileus and vomiting recovered after conservative treatment. However, two patients experienced delayed postoperative leakage, one patient in each group and were readmitted to the hospital and were managed conservatively as it was a minor leakage.

No mortality occurred in either group. There was a significantly higher incidence of wound infection in the ECA group (*P=0.047*), seven patients experienced wound infection in the ECA group, and one of them needed readmission for parenteral antibiotics and local wound debridement. Patients who underwent ICA had significantly lower pain scale scores at postoperative day 3 than those who underwent ECA (3.59 vs. 5.88, *P<0.001*). Better recovery was observed in the ICA group than in the ECA group in terms of time to first flatus (2.33 vs. 3.02 days, *P<0.001*), early ambulance, and significantly shorter mean length of postoperative stay (4.15 vs. 5.27, *P<0.001*). The proportion of patients in the ECA group who had a length of stay shorter than 5 days was 3.03%, whereas that in the ICA group was 85.18% (*P<0.001*). Postoperative complications and short-term parameters are listed in (Table 4, Fig. 6a and b).

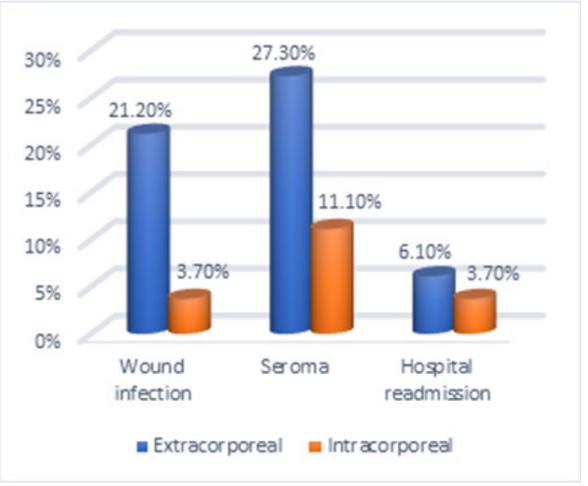
Table 4: Early postoperative parameter

	Ileotransverse anastomosis [*n* (%)]			
Early postoperative outcomes	Extracorporeal (*N*=33)	Intracorporeal (*N*=27)	χ^2	*P* value
Ileus more than 4 days				
No	27 (81.8)	23 (85.2)	0.12	0.728
Yes	6 (18.6)	4 (14.8)		
Vomiting				
No	30 (90.9)	24 (88.9)	0.07	0.795
Yes	3 (9.1)	3 (11.1)		
Obstruction				
No	32 (96.9)	26 (96.3)	0.02	0.885
Yes	1 (3.0)	1 (3.7)		

Bleeding				
No	33 (100.0)	27 (100.0)	–	–
Leakage				
No	32 (96.9)	26 (96.3)	0.02	0.885
Yes	1 (3.0)	1 (3.7)		
Wound infection				
No	26 (78.8)	26 (96.3)	3.94	0.047
Yes	7 (21.2)	1 (3.7)		
Seroma				
No	24 (72.7)	24 (88.9)	2.42	0.119
Yes	9 (27.3)	3 (11.1)		
Hospital readmission				
No	31 (93.9)	26 (96.3)	0.17	0.677
Yes	2 (6.1)	2 (7.4)		
Pain (visual analog scale) in postoperative day 3	Mean±SD	Mean±SD	t test	
	5.88±0.89	3.59±0.93	9.68	<0.001
	4–8	2–5		
Time of first flatus (days)	3.02±0.57	2.33±0.48	5.00	<0.001
	2–5	2–3		
Days of hospital stay:	5.27±0.57	4.15±0.53	7.79	<0.001
	4–7	3–6		



(a)



(b)

Fig. 6: (a) Postoperative outcomes and (b) postoperative outcomes.

Delayed postoperative outcomes

There was no significant difference between patients undergoing extracorporeal and patients undergoing intracorporeal ileotransverse anastomosis regarding delayed postoperative complications (incisional hernia or internal hernia). The follow-up period was 6 months. Four incisional hernias occurred during follow-up periods in the EA group, whereas no incisional hernia occurred in the IA group. This insignificance may be owing to the sample size, it may be relevant clinically. Also, the short period of follow-up may be a factor. So, further follow-up with longer periods is recommended. Delayed postoperative complications are shown in (Table 5, Fig. 7).

Table 5: Delayed postoperative complication; values in parentheses are percentages

	Ileotransverse anastomosis [*n* (%)]			
Delayed postoperative complications	Extracorporeal (*N*=33)	Intracorporeal (*N*=27)	χ^2	*P* value
Incisional hernia				
No	29 (87.9)	27 (100.0)	3.51	0.061
Yes	4 (12.1)	0		
Internal hernia				
No	32 (97.0)	27 (100.0)	0.83	0.362
Yes	0	0		

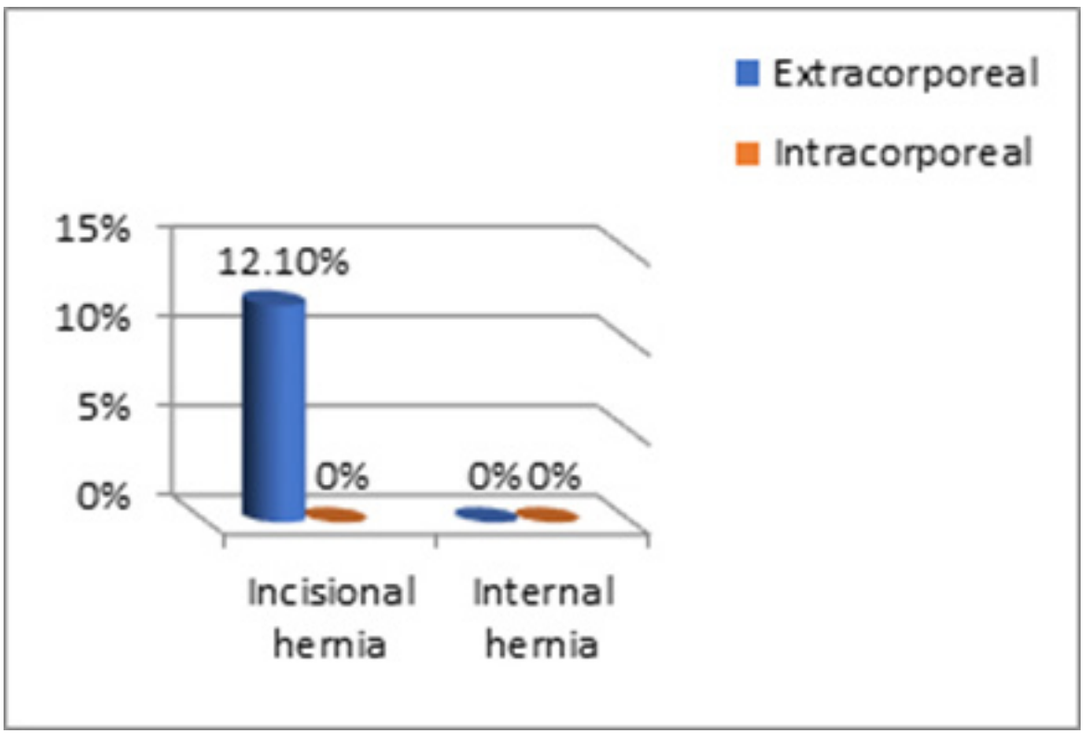


Fig. 7: Delayed postoperative complications.

DISCUSSION

In this study, patients who underwent laparoscopic right hemicolectomy with ICA entailed better recovery in comparison with the ECA group. Regarding the overall complication rate, there was no significant difference between the two groups. However, a significant improvement in some endpoints was observed among patients with an ICA such as smaller wound size, quicker recovery of bowel function, shorter length of postoperative hospital stays, and lower incidence of wound infection.

Vergis *et al*.[17], Trastulli *et al*.[18], and Fabozzi *et al*.[19] stated that the median length of hospital stay was significantly shorter for ICA groups. Ferrer-Márquez *et al*.[20] proved that there was no significant difference for the length of hospital stays between the two groups. However, our study showed that ICA was associated with a significantly shorter hospital stay in line with other studies[17-19].

Scatizzi *et al*.[21] found no significant difference in postoperative pain and analgesic use between the two groups. Our study was in line with the findings of Fabozzi *et al*.[19] and Grams *et al*.[22], confirming that ICA was associated with less postoperative pain and the need for analgesics compared with ECA. We believe that this is because the Pfannenstiel extraction incision of the ICA is less painful and less related to the anterior abdominal wall muscles sharing in respiration, compared with the RUQ transverse incision. It has also been found that postoperative pain can contribute to early patient ambulance as well as the occurrence of paralytic ileus.

Several studies, including Anania *et al*.[23], Chaves *et al*.[24], Roscio *et al*.[25], and Magistro *et al*.[26], have suggested that patients who undergo ICA may experience a quicker return of bowel function, especially with regard to passing the first flatus. Our study confirms this finding. We believe that less manipulation and traction of the bowl during ICA may be the cause, rather than that done in the ECA group.

Shapiro *et al*.[27] stated a lower incidence of incisional hernia in the ICA and our study confirms that. When performing the ICA technique, patients had a suprapubic Pfannenstiel extraction incision of about 10 cm in length used only for specimen extraction. While in the ECA group, the extraction incision at the RUQ was larger ranging from 15 to 20 cm for specimen extraction and performing the ECA resulting in a longer wound compared with the ICA group. Not only the Pfannenstiel incisions have a lower risk of wound infection (21.2 vs. 7.3%) and incisional hernias (12.1 vs. 0%), but also provide better cosmetic outcomes compared with right transverse or midline incisions.

In line with our study, Vergis *et al*.[28] and Lee *et al*.[29] stated that there was no significant difference in anastomotic leakage between the ICA and ECA techniques. Moreover, there was no mortality in both groups.

Fabozzi *et al*.[19] suggested that ICA can potentially reduce operative time, while Shapiro *et al*.[27], Bollo *et al*.[30], and Biondi *et al*.[31] have suggested that the ICA group may have a longer operative time. However, the results of our study indicate that there is no statistically significant difference in operative time between the two groups. The reason for the longer operative time in the ICA group in these studies is most likely because the intestinal anastomosis needs to be performed laparoscopically. This method is more challenging and less convenient and requires technical skills that need to be learned through training to improve the learning curve. Moreover, the duration of the surgery can also be affected by the skill levels and experience of the surgeon.

The results of surgical site infections are highly controversial in previous studies. The incidence of surgical incision infections in patients is not affected by any of the two anastomotic techniques according to Hajibandeh *et al*.[32]. Hanna *et al*.[33] claimed that patients with ICA had a higher overall complication rate and surgical site infection rate than those with ECA. In our study, there was a significantly higher incidence of wound infection in the ECA group than in the ICA group.

Even though ICA is more technically challenging, it requires less dissection of the mesocolon, causes less bleeding, and reduces tissue damage. The specimen can be taken out through a smaller incision, avoiding the need for extended abdominal incisions that can cause trauma and increase the risk of wound infection. For obese patients with much abdominal fat and mesenteric hypertrophy, an ICA can be performed with less tension on the mesocolon and less dissection in the subcutaneous fat decreasing the risk of abdominal wound infection. It is important to note that any spillage from the enterotomy during the ECA may lead to wound infection, as it can spread in the subcutaneous fat. Careful attention should be given to prevent such spillage and minimize the risk of complications.

Chaves *et al*.[24] stated that the number of lymph nodes removed was higher in the ICA group. Biondi *et al*.[31] and Magistro *et al*.[34] stated that both IA and EA interventions are safe from an oncological point of view, and the number of nodes harvested is similar with both approaches. Here, our study confirms the same idea that both techniques are safe from the oncological point of view.

CONCLUSION

Laparoscopic right hemicolectomy with ICA proves to have less postoperative pain, shorter time to first flatus, shorter length of hospital stays, and lower rates of wound infection. ICA is technically feasible with nearly the same operative time compared with ECA, achieving the same oncological outcomes. However, it requires good surgical expertise and skills and a longer learning curve.

LIMITATION

Our study has a few limitations. This study was conducted at a single surgical unit with a small number of patients (n=71). The short period of follow-up may be also a factor of limitation. To overcome these limitations, we are continually recruiting patients to increase the sample size and ensure long-term follow-up with longer periods. In the future, a multicentric study will be needed to avoid investigator bias.

CONFLICT OF INTEREST

There are no conflicts of interest.

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