Randomized clinical trial

# Randomized clinical trial of intracorporeal *versus* extracorporeal anastomosis in laparoscopic right colectomy (IEA trial)

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**Background:** **Several non-randomized and retrospective studies have suggested that intracorporeal anastomosis (IA) has advantages over extracorporeal anastomosis (EA) in laparoscopic right colectomy, but scientific evidence is lacking. The aim was to compare short-term outcomes and to define the possible benefits of IA compared with EA in elective laparoscopic right colectomy.**

**Methods:** **An RCT was conducted from May 2015 to June 2018. The primary endpoint was duration of hospital stay. Secondary endpoints were intraoperative technical events and postoperative clinical outcomes.**

**Results:** **A total of 140 patients were randomized. Duration of surgery was longer for procedures with an IA than in those with an EA (median 149 (range 95–215) *versus* 123 (60–240) min; $P < 0{\cdot}001$). Wound length was shorter in the IA group (median 6·7 (4–9·5) *versus* 8·7 (5–13) cm; $P < 0{\cdot}001$). Digestive function recovered earlier in patients with an IA (median 2·3 *versus* 3·3 days; $P = 0{\cdot}003$) and the incidence of paralytic ileus was lower (13 *versus* 30 per cent; $P = 0{\cdot}022$). Less postoperative analgesia was needed in the IA group (mean(s.d.) weighted analgesia requirement 39(24) *versus* 53(26); $P = 0{\cdot}001$) and the pain score was also lower ($P = 0{\cdot}035$). The postoperative decrease in haemoglobin level was smaller (mean(s.d.) 8·8(1·7) *versus* 17·1(1·7) mg/dl; $P = 0{\cdot}001$) and there was less lower gastrointestinal bleeding (3 *versus* 14 per cent; $P = 0{\cdot}031$) in the IA group. IA was associated with a significantly better rate of grade I and II complications ($P = 0{\cdot}016$ and $P = 0{\cdot}037$ respectively). The duration of hospital stay was slightly shorter in the IA group (median 5·7 (range 2–19) *versus* 6·6 (2–23) days; $P = 0{\cdot}194$).**

**Conclusion:** **Duration of hospital stay was similar, but IA was associated with less pain and fewer complications. Registration number: NCT02667860 (http://www.clinicaltrials.gov).**

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## Introduction

Laparoscopy has become the preferred surgical approach for elective colonic cancer resection[1–4]. Laparoscopic right colectomy is a well established technique, but is usually assisted by a minilaparotomy for specimen extraction and bowel anastomosis[5–7]. Improvement in surgical skills and intracorporeal suturing has facilitated the technical option of a total laparoscopic procedure with intracorporeal anastomosis (IA), using a minilaparotomy only for specimen extraction. A full laparoscopic dissection with IA has been considered a potentially less aggressive procedure, with quicker postoperative recovery, a shorter hospital stay and less morbidity. However, no evidence-based studies have been published to date[8–19]. Current data suggest that IA is clinically superior to extracorporeal anastomosis (EA), but findings are based on non-randomized or retrospective studies. Prospective randomized evidence providing definitive support for this hypothesis is lacking. The aim of this RCT was to compare the two surgical techniques, and to define the possible benefits of IA *versus* EA in patients undergoing elective right colectomy.

## Methods

This randomized, single-blind and single-centre clinical trial, the Intracorporeal *versus* Extracorporeal Anastomosis

(IEA) study, was conducted at Hospital de la Santa Creu i Sant Pau, a centre with expertise in laparoscopic colorectal surgery. The study was a parallel group trial with a 1 : 1 allocation ratio. The same team of four colorectal surgeons performed both types of anastomosis.

The study followed the Ethical Principles for Medical Research Involving Human Subjects as outlined in the Declaration of Helsinki. The study protocol was approved by the Ethics Committee and Research Institute at Hospital de la Santa Creu i Sant Pau. The study protocol was registered at www.ClinicalTrials.gov (NCT02667860).

## Study population

All patients aged at least 18 years old who were referred for treatment of a right colonic adenocarcinoma, confirmed by biopsy and requiring a standard laparoscopic right colectomy with the aim of R0 resection, were considered for inclusion.

All patients gave written informed consent to participate in the study. Inclusion criteria were: a right colonic adenocarcinoma confirmed by biopsy; ASA fitness grade I, II or III; surgery with a curative intention; and tumour location in the caecum, ascending colon or hepatic flexure. Exclusion criteria were: refusal to participate in the study; locally advanced tumour (cT4b) or TNM stage IV; emergency surgery; need for more than one simultaneous surgical procedure; and extended right colectomy with sectioning of the middle colic vessels or segmental resection.

## Randomization, allocation concealment, and blinding

Patients were included in the study consecutively from inclusion of the first eligible patient according to the selection criteria. The randomization programme was designed explicitly for this project, adapted to the SPSS® package (IBM, Armonk, New York, USA). The randomization list, in blocks of ten, was produced by a statistician, without any involvement of the surgical team, using a computerized random number generator. The assignment was made using sequentially numbered, sealed, opaque envelopes that were opened when the surgeon considered that local conditions allowed laparoscopic resection of the right colon and anastomosis.

## Interventions

The laparoscopic right colectomy technique used in this study has been reported previously[20]. The surgeon and both assistants stood on the left side of the patient, and the laparoscopy screen was situated to the right of the patient. The first trocar, Endopath® XCEL™ with Optiview™ (Ethicon, Tampa, Florida, USA), was inserted in the left iliac fossa to create the pneumoperitoneum, and an exploratory laparoscopy undertaken. A second trocar was placed at the right iliac fossa and another in the suprapubic region to act as working ports. A fourth trocar was positioned in the left subcostal flank for assistance. The dissection started with identification of the ileocolic vessels and ligation with haemostatic clips. The colon was mobilized from medial to lateral with retroperitoneal dissection, identifying the duodenum and pancreas. The right colic artery and right branch of the middle colic artery were identified and ligated with haemostatic clips. Mobilization of distal ileum and right colon was started, with dissection of Toldt's fascia until free mobilization of the hepatic flexure had been achieved. The right part of the omentum was dissected. The randomization envelope was then opened.

If IA was designated, dissection of the mesocolon was completed, and the ileum and transverse colon were transected using an endo-GIA stapler (Echelon Flex™, 60 mm, blue cartridge; Ethicon). A side-to-side antiperistaltic ileocolic anastomosis was created with the endo-GIA stapler (60 mm, blue cartridge) and the enterotomy was closed with two running sutures of Prolene® 2/0 (Ethicon). The specimen was extracted through a Pfannenstiel incision, which was protected with an Alexis® wound protector (Applied Medical, Rancho Santa Margarita, California, USA).

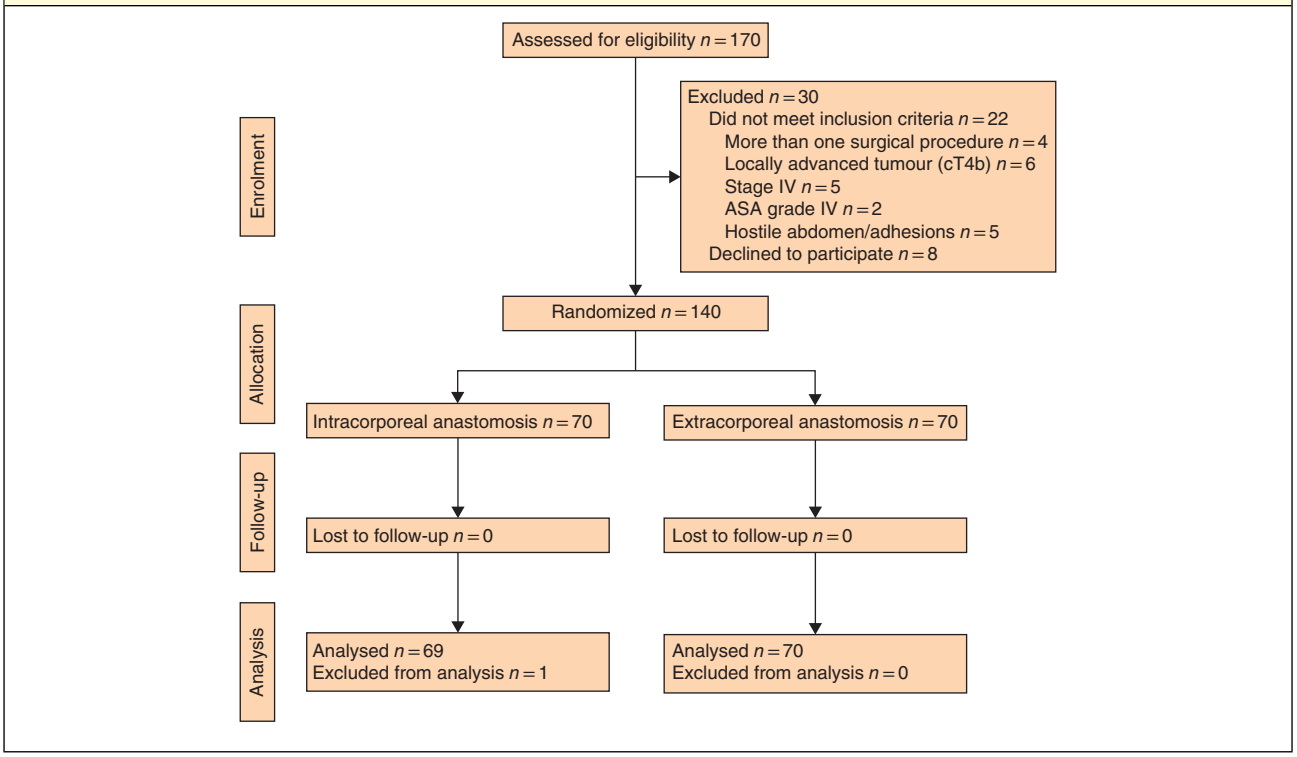
If EA was designated, a transverse incision was made, protected with an Alexis® device. The ileum and colon were extracted, and dissection of the mesocolon completed. A side-to-side antiperistaltic anastomosis was created with a GIA stapler (Proximate® 75 mm, blue cartridge; Ethicon) and the two bowel ends were closed with a TA stapler (Proximate® TX 90 mm; Ethicon).

In both groups, a midline incision was used only if there had been one previously. The mesenteric defect was not closed, and a closed silicone drain was placed if the surgeon deemed this necessary.

## Perioperative management

All patients were diagnosed with right colonic cancer by colonoscopy and biopsy of the lesion. Abdominal CT and a routine blood test were performed routinely. Patients did not undergo mechanical colon preparation or preoperative prophylaxis with oral antibiotics. Intravenous cefazoline and metronidazole were used for perioperative antibiotic prophylaxis. Carbohydrate beverages were allowed up to 2 h before surgery.

**Fig. 1 CONSORT diagram for the trial**




The surgery was performed under general anaesthesia with endotracheal intubation, bladder catheterization, nasogastric tube insertion and antithrombotic measures. Special care was taken regarding normothermia and control of glycaemia. A regimen of fluids and electrolytes was established to maintain normovolaemia.

All patients were managed using an enhanced recovery after surgery (ERAS) protocol[21]. A liquid trial was started 6 h after surgery along with early mobilization. The same analgesic regimen was administered to all patients: 1 g paracetamol and 25 mg dexketoprofen every 8 h, 20 mg metamizole as necessary, and 4 mg morphine as rescue medication. Discharge criteria were tolerance of oral intake and absence of complications.

## Outcome measures

The primary endpoint of the study was duration of hospital stay, measured in days. The hospital stay was measured from the first postoperative day, beginning at 08.00 hours. The final day was the day of medical discharge at 08.00 hours.

Secondary endpoints were: duration of operation, intraoperative complications, decrease in haemoglobin level, need for blood transfusion, length of the surgical wound, time to start and tolerance of oral intake, time to restoration of digestive function (first passage of stool), postoperative

**Table 1 Preoperative variables**

| | Intracorporeal anastomosis (*n* = 69) | Extracorporeal anastomosis (*n* = 70) |
|---|---|---|
| **Age (years)*** | 72·7(10·4) (45–89) | 70·9(11·7) (28–90) |
| **Sex ratio (M : F)** | 34 : 35 | 39 : 31 |
| **BMI (kg/m²)*** | 27·4(5·4) | 26·3(4·7) |
| **ASA fitness grade** | | |
| I | 1 (1) | 3 (4) |
| II | 39 (57) | 41 (59) |
| III | 29 (42) | 26 (37) |
| **Previous abdominal operations** | | |
| 0 | 40 (58) | 36 (51) |
| 1 | 24 (35) | 28 (40) |
| 2 | 5 (7) | 6 (9) |
| **Tumour location** | | |
| Caecum | 29 (42) | 27 (39) |
| Ascending colon | 21 (30) | 12 (17) |
| Liver flexure | 19 (28) | 31 (44) |

Values in parentheses are percentages unless indicated otherwise; *values are mean(s.d.) (range).

**Table 2 Operative data and pathological findings**

| | Intracorporeal anastomosis (*n* = 69) | Extracorporeal anastomosis (*n* = 70) | *P*‡ |
|---|---|---|---|
| **Duration of operation (min)*** | 149 (95–215) | 123 (60–240) | < 0·001§ |
| **Incision type** | | | |
| Transverse | 0 (0) | 55 (79) | |
| Midline | 7 (10) | 14 (20) | |
| Pfannenstiel | 62 (90) | 1 (1) | |
| **Length of incision (cm)*** | 6·7 (4·0–9·5) | 8·7 (5·0–13·0) | < 0·001§ |
| **Tumour category** | | | 0·928 |
| pTis–1 | 16 (23) | 17 (24) | |
| pT2 | 15 (22) | 14 (20) | |
| pT3 | 29 (42) | 32 (46) | |
| pT4 | 9 (13) | 7 (10) | |
| **Tumour size ($cm^2$)†** | 21·0(22·9) | 20·5(19·3) | 0·886¶ |
| **Node status** | | | 0·356 |
| pN0 | 52 (75) | 48 (69) | |
| pN1a | 4 (6) | 9 (13) | |
| pN1b | 9 (13) | 3 (4) | |
| pN2a | 3 (4) | 6 (9) | |
| pN2b | 1 (1) | 4 (6) | |
| **< 12 nodes resected** | 4 (6) | 7 (10) | 0·532 |
| **Colon length (cm)†** | 25·3(5·8) | 22·7(7·8) | 0·026¶ |
| **Ileum length (cm)†** | 7·5(5·5) | 7·9(4·3) | 0·654¶ |
| **No. of resected lymph nodes†** | 19·7(6·0) | 19·1(7·1) | 0·612¶ |

Values in parentheses are percentages unless indicated otherwise; values are *median (range) and †mean(s.d.). ‡$\chi^2$ or Fisher's exact test, except §Mann–Whitney *U* test and ¶Student's *t* test.

pain measured on a visual analogue scale (VAS) and analgesic requirements, surgical wound infection, paralytic ileus, lower gastrointestinal bleeding, anastomotic leakage, need for reintervention, hospital readmission within the first 30 days after surgery, and specimen characteristics. All complications were rated according to the Clavien–Dindo classification[22,23], and the Comprehensive Complication Index (CCI)[24] was used to compare the cumulative severity of complications.

All patients with postoperative organ space infection were considered to have anastomotic leakage[25]. Paralytic ileus was defined according to the classification of Delaney and colleagues[26]. Tumours were staged in accordance with the TNM seventh edition of the AJCC[27].

## Data management

An operative case report form, including reasons for surgery, patient data and measurements from the surgical procedure, was filled out by one of the investigators. During the hospital admission, another surgeon recorded data concerning the postoperative recovery and follow-up visits.

## Statistical analysis

Calculation of the sample size was based on the primary outcome: the historical duration of hospital stay at the authors' centre (mean(s.d.) 6·7(3·8) days) and the mean in articles published before 2015[18–20,28–34]. It was assumed that the variation would be approximately 3 days (s.d.) as this value would give a coefficient of variation between 50 and 100 per cent. It was also estimated that the difference in length of stay between the two study arms would be a minimum of 1·5 days, and that the losses to follow-up would not exceed 10 per cent. The value for a type I error was specified at 5 per cent ($\alpha = 0{\cdot}05$), bilateral approximation, with a minimum power of 80 per cent (0·20 probability of type II error). The number of patients needed to be included in this trial was calculated as 140.

Analysis was performed following the intention-to-treat principle. Categorical variables, presented as number with percentage, were analysed using the $\chi^2$ test or Fisher's exact test. Continuous data are presented as mean(s.d.) or median (range), with analysis by Student's *t* test and Mann–Whitney *U* test respectively. In all instances, the level of significance was 5 per cent ($\alpha = 0{\cdot}05$). SPSS® version 22 was used for statistical analysis.

**Table 3 Early postoperative outcomes**

| | Intracorporeal anastomosis (*n* = 69) | Extracorporeal anastomosis (*n* = 70) | *P*# |
|---|---|---|---|
| **Time to first passage of stool (days)*** | 2·3 (1–7) | 3·3 (1–15) | 0·003** |
| **Time to oral intake (days)*** | 1 (1–13) | 1 (1–12) | 0·232** |
| **Decrease in haemoglobin level (g/l)†‡** | 8·8(1·7) | 17·1(1·7) | 0·001 |
| **Red blood cell transfusion** | 5 (7) | 9 (13) | 0·399†† |
| **Analgesia requirements†§** | | | |
| Paracetamol | 17·0(7·1) | 23·5(7·1) | 0·001 |
| Dexketoprofen | 9·0(6·6) | 12·5(7·8) | 0·029 |
| Metamizole | 0·0(4·2) | 0·5(3·2) | 0·026 |
| Morphine | 0·08(0·29) | 0·0(0·89) | 0·070 |
| Weighted analgesia requirement¶ | 39(24) | 53(26) | 0·001 |
| **Postoperative pain score (1–10 VAS)†** | | | 0·035 |
| Day 1 | 2·73(2·32) | 3·01(2·29) | |
| Day 2 | 1·81(1·85) | 2·91(2·25) | |
| Day 3 | 2·06(2·19) | 2·36(2·12) | |
| Day 4 | 1·72(1·91) | 2·49(2·23) | |
| Day 5 | 1·71(2·18) | 2·42(1·93) | |

Values in parentheses are percentages unless indicated otherwise; values are *median (range) and †mean(s.d.). ‡Difference between preoperative level and that on first day after operation (normal haemoglobin level 120–150 g/l).§Number of doses in first 10 days after operation. ¶Total sum of doses of analgesia: one dose of paracetamol, 1 point; one dose of dexketoprofen, 2 points; one dose of metamizole, 3 points; one dose of morphine, 4 points. VAS, visual analogue scale. #Student's *t* test, except **Mann–Whitney *U* test and ††$\chi^2$ or Fisher's exact test.

## Results

From May 2015 to June 2018, 170 patients underwent laparoscopic right colectomy. Thirty patients were excluded from the study: eight declined to participate, and 22 did not meet the inclusion criteria (*Fig. 1*). One hundred and forty patients were randomized to IA (70) or EA (70). One patient was excluded from the IA group as tumour was identified at the splenic colonic flexure. No operations were converted to open surgery after randomization in either group, and no procedures in the IA group were converted to EA.

Preoperative characteristics were similar in the two groups (*Table 1*). There were no differences in age, BMI, ASA grade, tumour location or previous abdominal surgery.

Duration of operation was significantly longer in the IA group than the EA group (median 149 (range 95–215) *versus* 123 (20–240) min; $P < 0{\cdot}001$). Wound length was shorter in procedures involving an IA (6·7 (4–9·5) *versus* 8·7 (5–13) cm; $P < 0{\cdot}001$). There were no significant differences in pathological findings. The length of resected colon was greater in the IA group (mean(s.d.) 25·3(5·8) *versus* 22·7(7·8) cm; $P = 0{\cdot}026$) (*Table 2*).

*Table 3* shows early postoperative outcomes. The time to resumption of oral diet was similar in the two groups ($P = 0{\cdot}232$), but recovery of digestive function (time to first passage of stool) was earlier in the IA group (median 2·3 *versus* 3·3 days; $P = 0{\cdot}003$) and the incidence of paralytic ileus was lower (13 *versus* 30 per cent; $P = 0{\cdot}022$).

The weighted postoperative analgesia requirement was lower in the IA group (mean(s.d.) 39(24) *versus* 53(26); $P = 0{\cdot}001$), and the pain score measured on a VAS was also lower ($P = 0{\cdot}035$).

IA was associated with a smaller decrease in haemoglobin level after operation (mean(s.d.) 8·8(1·7) *versus* 17·1(1·7) g/l; $P = 0{\cdot}001$) and the incidence of lower gastrointestinal bleeding (3 *versus* 14 per cent; $P = 0{\cdot}031$).

The rate of postoperative complications, graded according to the Clavien–Dindo classification, was lower in the IA group: grade I, 10 *versus* 27 per cent ($P = 0{\cdot}016$); grade II, 19 *versus* 36 per cent ($P = 0{\cdot}036$); grade III, 1 *versus* 7 per cent ($P = 0{\cdot}209$) (*Table 4*). The CCI score was also lower (mean(s.d.) 5·3(9·2) *versus* 11·2(14·3); $P = 0{\cdot}006$). There was no death in either group.

The incidence of anastomotic leak (4 *versus* 7 per cent; $P = 0{\cdot}719$) and wound infection (both 4 per cent) were similar in the IA and EA groups. The duration of hospital stay was slightly shorter in the IA group, but the difference was not significant (median 5·7 (range 2–19) *versus* 6·6 (2–23) days; $P = 0{\cdot}194$). There was a trend towards a lower readmission rate in the IA group (0 *versus* 7 per cent; $P = 0{\cdot}058$).

**Table 4 Postoperative data**

| | Intracorporeal anastomosis ($n = 69$) | Extracorporeal anastomosis ($n = 70$) | $P$‡ |
|---|---|---|---|
| **Clavien–Dindo complication grade** | | | |
| **Grade I** | 7 (10) | 19 (27) | 0·016 |
| Paralytic ileus | 4 | 10 | |
| Wound seroma | 3 | 3 | |
| Lower gastrointestinal bleeding | 0 | 6 | |
| Acute renal failure | 0 | 1 | |
| **Grade II** | 13 (19) | 25 (36) | 0·037 |
| Cardiac event | 1 | 3 | |
| Respiratory event | 0 | 2 | |
| Paralytic ileus and parenteral nutrition | 5 | 11 | |
| Anaemia with RBC transfusion | 3 | 5 | |
| Lower gastrointestinal bleeding with RBC transfusion | 2 | 3 | |
| Wound infection | 3 | 3 | |
| Catheter infection | 0 | 2 | |
| Colitis | 0 | 1 | |
| Urinary infection | 1 | 5 | |
| Anastomotic leak with antibiotic treatment | 2 | 3 | |
| **Grade III** | 1 (1) | 5 (7) | 0·209 |
| IIIa | 0 | 1 | |
| IIIb | 1 | 4 | |
| **Grade IV** | 0 (0) | 1 (1) | |
| **Grade V** | 0 (0) | 0 (0) | |
| **CCI score*** | 5·3(9·2) | 11·2(14·3) | 0·006§ |
| **Surgical morbidity** | | | |
| Wound infection | 3 (4) | 3 (4) | 1·000 |
| Paralytic ileus | 9 (13) | 21 (30) | 0·022 |
| Lower gastrointestinal bleeding | 2 (3) | 10 (14) | 0·031 |
| Anastomotic leak | 3 (4) | 5 (7) | 0·719 |
| Antibiotic treatment | 2 | 3 | |
| Radiological drainage | 0 | 1 | |
| Surgical reoperation | 1 | 1 | |
| **Reoperation** | 1 (1) | 4 (6) | 0·366 |
| Anastomotic leak | 1 | 1 | |
| Lower gastrointestinal bleeding | 0 | 1 | |
| Ileal ischaemia | 0 | 1 | |
| Intra-abdominal haematoma | 0 | 1 | |
| **Readmission to hospital within 30 days** | 0 (0) | 5 (7) | 0·058 |
| **Duration of hospital stay (days)†** | 5·7 (2–19) | 6·6 (2–23) | 0·194¶ |

Values in parentheses are percentages unless indicated otherwise; values are *mean(s.d.) and †median (range). RBC, red blood cell. ‡$\chi^2$ or Fisher's exact test, except §Student's $t$ test and ¶Mann–Whitney $U$ test.

## Discussion

In this trial, laparoscopic right colectomy with IA entailed reduced surgical injury in comparison with EA. Regarding the primary outcome, there was no significant reduction in duration of hospital stay in the IA group. However, a significant improvement in secondary endpoints was observed among patients with an IA: lower postoperative decrease in haemoglobin level, smaller wound size, and a quicker recovery of digestive function with less paralytic ileus. The authors believe that the lower perception of pain reduced analgesic requirements, and reduced morbidity led to an earlier recovery. No differences were observed between groups in anastomotic leakage or surgical-site infection.

The present findings are in concordance with those of previous studies and seven meta-analyses[8–14]. However, an important strength of this RCT is that it provides

evidence-based outcomes whereas most previous studies were retrospective or non-randomized, which may have biased the results. A second strength of the study is the randomization immediately before anastomosis. This precluded IA being a proxy for higher surgical skill as all four surgeons performed both IA and EA in the study. Carrying out the entire procedure intracorporeally poses greater technical difficulty and requires advanced technical skills in laparoscopic surgery[35], possibly therefore increasing the duration of surgery[15,18,19,33,34,36,37]. Operative time can be decreased, however, with surgeon experience[16,17,30,32,38].

There are several reasons why IA appeared to result in reduced surgical injury. The smaller decrease in haemoglobin level in procedures involving IA, owing to less blood loss, can be explained largely by better control of bleeding during vessel ligation and intracorporeal dissection of the mesocolon. This dissection in turn creates less tension when extracting the specimen. The tension exerted on the mesocolon at the moment of specimen extraction and performance of EA could cause unnoticed bleeding from the mesocolon and Henle's trunk. The smaller decrease in haemoglobin level with an IA could also be explained by reduced lower gastrointestinal bleeding once the anastomosis has been created. Anastomosis in both groups was carried out using a blue cartridge (1·5 mm closed staple height), but extracorporeal stapling consisted of two rows whereas intracorporeal stapling consisted of three rows. Foo and colleagues[39] reported a lower morbidity rate in anastomoses with a triple row of staples in terms of anastomotic leakage and anastomotic bleeding. It has also been suggested that a handsewn anastomosis in EA could reduce the incidence of gastrointestinal bleeding[40]. Another advantage of IA is clearer visualization of the mesentery during the procedure. This better view helps to avoid mesenteric twisting, an event reported to be common with EA[41–43].

From an oncological point of view, both IA and EA interventions are safe, and the number of nodes harvested is similar with both approaches. Here, the surgical specimen was longer when an IA was constructed, in line with previous findings[19,33].

The benefit of IA over EA in reducing postoperative pain and use of analgesics[30,36,43] was confirmed in the present study. The most widely accepted explanation is that, in contrast to EA, IA does not involve traction of the mesenteric–portal axis. The size and location of the wound can also play an important role in the development of pain. Furthermore, it seems that, besides mediating postoperative pain, traction is also responsible for the occurrence of paralytic ileus. It appears that the greater the manipulation, the higher the incidence of paralytic ileus, especially in obese patients[4,30].

It has been suggested that bowel function returns earlier in patients undergoing IA, particularly in terms of first flatus and stool passage[18,19,32,33]. Tolerance of a solid diet has also been reported to occur earlier in patients with an IA[11,18,19,31]. Contrary to this, however, most patients in both groups in the present study were able to tolerate an oral diet from the first day after surgery owing to application of an ERAS protocol.

A suprapubic incision, exclusively for the extraction of the surgical specimen, was used in patients undergoing IA. Pfannenstiel incisions have a lower incidence of wound infection and incisional hernia (0–2 *versus* 1–25 per cent), but also give better aesthetic results than a right transverse or midline incision[13,37,41–47]. In procedures involving an EA, the specimen extraction site is especially limited by the extent of bowel mobilization. As the present authors usually made a right transverse incision to extract the specimen and perform the anastomosis in the EA group, the wound was longer than that in the IA group[15,30,31,33,38].

A controversial issue is potential faecal contamination of the peritoneal cavity when IA is performed. No intra-abdominal complication related to contamination occurred in the present series. Intraoperative contamination can be prevented, however, by careful surgical technique, use of aspiration devices and placing a gauze at the lower edge of the enterotomy. Mechanical colon preparations with prophylactic oral antibiotics and intestinal clamps could be useful in preventing spillage of intestinal contents and surgical-site infection[38,48–50].

In line with other studies, there was no significant difference between IA and EA techniques regarding anastomotic leakage in the present study. Mortality in this type of surgery is uncommon and did not differ between groups[15–19,30–34,36,37]. However, in this trial, short-term morbidity, in terms of Clavien–Dindo grades and CCI score, was significantly reduced in favour of IA owing to a lower incidence of ileus and lower gastrointestinal bleeding.

In this study, IA was associated with a shorter hospital stay by almost 1 day. Although this difference was not statistically significant, most likely owing to the sample size, it may be relevant clinically. Other studies[16,17,30,32,37] have reported a significantly decreased hospital stay for IA.

This RCT has some limitations. The study focused on short-term results, and follow-up is needed, especially in relation to the incidence of incisional hernia and oncological outcomes. Another limitation is that the study may have been underpowered to identify statistical differences in complication rates owing to the low incidence of events.

A multicentre study with a larger number of patients could validate the present results and further clarify the benefits of IA.

## Disclosure

The authors declare no conflict of interest.

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