Extracorporeal Hand-Sewn vs. Intracorporeal Mechanic Anastomosis During Laparoscopic Right Colectomy

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ABSTRACT

Background and Objectives: To compare the outcomes of extracorporeal hand-sewn side-to-side isoperistaltic ileocolic anastomosis (EHSIA) versus intracorporeal mechanic side-to-side isoperistaltic ileocolic anastomosis (IMSIA) during laparoscopic right hemicolecction for adenocarcinoma.

Methods: This is a retrospective propensity score-matched analysis of prospectively collected data. Fifty-four patients who underwent surgery with EHSIA (intervention group) were paired with 54 patients who underwent surgery with IMSIA (control group) based on patients’ demographics and type of surgery (standard right hemicolecction or extended right hemicolecction).

Results: Fifty-four patients were included for each group. Statistically significant differences between groups were not observed in patients’ demographics and type of surgery. Conversion occurred in three patients of the intervention group due to intra-abdominal adhesions for previous surgery (5.6%) (p = 0.079). Median operative time was statistically significant shorter in the control group in comparison to the intervention group (85 and 117.5 minutes, respectively, p ≤ 0.0001). In both groups one anastomotic leakage was observed (1.9%) (Clavien-Dindo grade III-a). In the control group one patient (1.9%) underwent reintervention for acute postoperative anemia (Clavien-Dindo grade III-b). Median number of harvested lymph-nodes was 17 and 12 (p ≤ 0.0001), in the intervention and the control group, respectively. Median hospital stay was statistically significant lower in the control group in comparison to the intervention group (5 and 6.5 days, respectively, p ≤ 0.013).

Conclusion: IMSIA showed lower operative time and hospital stay in comparison to EHSIA. Further randomized studies are required to draw definitive conclusions about the best anastomotic technique during laparoscopic right hemicolecction.

Key Words: Anastomotic bleeding, Anastomotic leakage, Extracorporeal anastomosis (ECA), Intracorporeal anastomosis (ICA), Laparoscopic right hemicolecction.

INTRODUCTION

Laparoscopic right hemicolecction for adenocarcinoma is a feasible and safe procedure, both in terms of surgical and oncological results. It is well recognized in the literature that minimally invasive right hemicolecction has several advantages in comparison to open surgery, such as reduced blood loss, less postoperative pain, quicker return to normal bowel function, reduced immunosuppression, and shorter postoperative hospital stay.

In the last decade, the research about minimally invasive surgery (MIS) for right hemicolecction continued with the aim to improve the already encouraging results. For this purpose, robotic surgery, Enhanced Recovery After Surgery (ERAS) protocol, and single port hemicolecction have been proposed. A great effort has been also dedicated about the investigation regarding the intracorporeal...
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(ICA) versus extracorporeal anastomosis (ECA) during minimally invasive right hemicolecotomy. As reported in the literature, the most employed surgical technique for the anastomosis creation, both in case of ICA and ECA, is the mechanical one with the hand-sewn closure of the enterotomy.

The aim of the present propensity score-matched (PSM) analysis is to compare the surgical outcomes in patients who underwent laparoscopic right hemicolecotomy with extracorporeal hand-sewn side-to-side isoperistaltic ileocolic anastomosis (EHSIA) and intracorporeal mechanic side-to-side isoperistaltic ileocolic anastomosis (IMSIA) for adenocarcinoma.

MATERIALS AND METHODS

This is a retrospective PSM analysis of prospectively collected data. Institutional review board approval and informed consent from all participants were obtained.

From October 1, 2018 to November 30, 2021, 66 patients underwent right hemicolecotomy in Hospital San Paolo in Civitavecchia, Rome, Italy. Of these, 57 patients underwent elective laparoscopic right hemicolecotomy with EHSIA for adenocarcinoma. Three patients were excluded from this study due to associated cholecystectomy was performed during right hemicolecotomy. Finally, 54 patients were included in this analysis, forming the intervention group.

From October 1, 2014 to July 31, 2021, 93 patients underwent elective laparoscopic right hemicolecotomy with IMSIA for adenocarcinoma without associated procedures in University Hospital Virgen del Rocio in Sevilla, Spain, forming the control group (Figure 1).

Pre-operative mechanical bowel preparation was administered to both groups of patients and ERAS protocol was not used in any case.

Surgical Technique

All surgical procedures were performed by laparoscopy under general anesthesia. The procedures were performed by the Chief Surgeons of both Units (P.L. and S.M.C.).

Laparoscopic Right Hemicolecotomy with EHSIA

Patient is in supine position with open legs. The surgeon stands at the patient’s left side. Four trocars are used. Surgery is performed by bipolar diathermy (LigaSure™ tissue fusion, Covidien, Mansfield, Massachusetts, USA). The first step of the procedure is the identification and division between Hem-o-lok (Weck® Hem-o-lok, Teleflex, North Carolina, USA) of the ileocolic vessels at their origin. Right colon with hepatic flexure is then mobilized using the medial to lateral approach and the parietocolic groove is opened.

A median supraumbilical abdominal wall incision of about 5–10 cm is performed and protected by a wound protector (Alexis, Applied Medical, Rancho Santa Margarita, California, USA) for the right colon and ileum extraction. Both ileum and colon are divided with 75 mm linear stapler (Linear Stapler, Ethicon™, Cincinnati, Ohio, USA). In the last 10 patients of this experience, the supposed section lines are marked by the surgeon using the electric scalpel, and after that indocyanine green (ICG) is administered to perform the fluorescence angiography to decide the exact section level based on the fluorescence imaging. In all cases, before the anastomosis, colonic and ileal stumps were reinforced by a hemostatic hand-sewn suture in prolene 5.0.

Ileum and colon are approached side-to-side, isoperistaltic, by a row of single stitches in vicryl 2.0 (step 1). Then, the colon and ileal walls at the antimesenteric sides of the terminal ileum and the transverse colon (tenia) are opened by a cold blade scalpel, above the row of single stitches (step 2). Two stitches in vicryl 2.0 are placed in the middle of the posterior wall of the anastomosis and their tails are tied together (step 3). Both stitches serve as semicontinuous suture, starting from the middle of the posterior wall of the anastomosis up to the anterior wall of the anastomosis (step 4). The two sutures are tied together in the center of the anterior wall of the anastomosis (step 5). After that, just above the anastomosis, another row of single stitches in vicryl 2.0 is performed (step 6). If necessary, single stitches of reinforcement are placed at the corners of the anastomosis (Figure 2). The mesenteric defect is always closed. Specimen is removed using the median incision.

Laparoscopic Right Hemicolecotomy with IMSIA

Patient is placed in supine position with open legs. The surgeon stands at the patient’s left side. Four trocars are used. Surgery is performed by bipolar diathermy (LigaSure™ tissue fusion, Covidien, Mansfield, Massachusetts, USA). The first step of the procedure is the retroperitoneal dissection and duodenum identification. The hepatic flexure is mobilized using the medial to lateral approach. The ileocolic and right colic artery and vein are identified and divided by bipolar diathermy, and the right parietocolic groove is opened. Before dividing the terminal ileum and the
transverse colon, the supposed section lines are marked by the surgeon using the electric scalpel, and after that ICG is administered in order to perform the fluorescence angiography to decide the exact section level. Based on the fluorescence imaging, terminal ileum is divided using a linear stapler (Endo GIA™ Ultra Universal Stapler, Covidien, Minneapolis, Minnesota, USA) with a 60 mm white cartridge and the transverse colon with a 60 mm purple cartridge.

Ileum and colon are approached side-to-side, isoperistaltic, and an enterotomy is performed on each side by a monopolar diathermy (step 1). The intracorporeal mechanic anastomosis is performed with a linear stapler (60 mm purple cartridge) (step 2). In order to reduce the anastomotic tension, a stitch in vicryl 2.0 is placed between the ileum and colon behind the anastomosis (step 3). The enterotomy is closed using two continuous sutures with absorbable 2.0 barbed suture (V-loc™, Medtronic, Minneapolis, Minnesota, USA). The first continuous suture is placed in the upper part of the enterotomy and served as traction for the anastomosis anchoring it to the peritoneum of the abdominal wall (step 4). The second continuous suture is placed in the lower part of the enterotomy to finish its closure (step 5). After that, the two continuous sutures are tied between them (step 6) (Figure 3).

Specimen is removed using a Pfannesteil incision protected by a wound protector (Alexis, Applied Medical, Rancho Santa Margarita, California, USA).

In both cases, after the anastomosis creation, hemostasis is performed if necessary, and drainage is placed in the site of the trocar in right iliac fossa according to surgeon’s preference.

Study Data and Analysis

Gender, age, body mass index (BMI), comorbidities (including hypertension, ischemic heart disease, type 2 diabetes mellitus, and smoking habit) American Society of Anesthesiologists grade and type of surgery.

**Figure 1.** Patient selection. Abbreviations: EHSIA, Extracorporeal hand-sewn side-to-side isoperistaltic ileocolic anastomosis; IMSIA, Intracorporeal mechanic side-to-side isoperistaltic ileocolic anastomosis.
of Anesthesiologists (ASA) grade, type of surgery (standard right hemicolectomy or extended right hemicolectomy), intraoperative complications, conversion to open surgery, operative time, postoperative complications (graded according to the Clavien-Dindo classification\textsuperscript{5}), number of harvested lymph-nodes, radicality of resection, reintervention, postoperative hospital stay, 30-day mortality, readmission, and incisional hernia occurrence were recorded in a Microsoft Excel program (Microsoft Corporation, Redmond, Washington, USA).

### Statistical Analysis

Continuous variables are expressed as median and 95% confidence intervals (CI) and categorical variables such as frequencies and percentages. The nonparametric Mann Whitney U test and $\chi^2$ test were used for the comparison between groups of continuous and categorical variables, respectively.

In order to minimize the risk of bias and potential confounding factors, and improve the validity of the statistical comparison, the PSM analysis was performed to match 1:1 patients of the intervention and the control groups, using the following covariates which might affect the peri and postoperative outcomes: gender, age, BMI, hypertension, ischemic heart disease, diabetes, smoking habit, ASA grade, and type of surgery.

A $p$ value lower than 0.05 was considered statistically significant. Statistical analyses were carried out with IBM SPSS software 22.0 (SPSS Inc., Chicago, Illinois, USA).

### RESULTS

After the PSM analysis 54 patients were included for each group (Figure 1). Results are reported in Table 1. After pairing, statistically significant differences between intervention and control group were not observed in patients' demographics and type of surgery.

Conversion to open surgery occurred in three patients of the intervention group due to intra-abdominal visceral adhesions for previous surgery (5.6%), while conversion did not occur in the control group. After pairing a statistically significant difference was not observed ($P = 0.079$).

Median operative time was statistically significant shorter

![Figure 2. Extracorporeal hand-sewn side-to-side isoperistaltic ileocolic anastomosis (EHSIA) technique. 1) Ileum and colon are approached side-to-side, isoperistaltic, by a row of single stitches in vicryl 2.0. 2) Above the row of single stitches, colon and ileum are opened by a cold blade scalpel. 3) Two stitches in vicryl 2.0 are placed in the middle of the posterior wall of the anastomosis and their tails are tied together. 4) Both stitches serve as semi-continuous suture, starting from the middle of the posterior wall of the anastomosis up to the anterior wall of the anastomosis. 5) The two sutures are tied together in the center of the anterior wall of the anastomosis. 6) Above the anastomosis created another row of single stitches in vicryl 2.0 is performed.](image)

![Figure 3. Intracorporeal mechanic side-to-side isoperistaltic ileocolic anastomosis (IMSIA) technique. Ileum and colon are approached side-to-side, isoperistaltic, and an enterotomy is performed on each side by a monopolar diathermy (Step 1). The intracorporeal mechanic anastomosis is performed with a linear stapler (60 mm purple cartridge) (Step 2). In order to reduce the anastomotic tension, a stitch in vicryl 2.0 is placed between the ileum and colon behind the anastomosis (Step 3). The enterotomy is closed using two continuous suture with absorbable 2.0 barbed suture (V-locTM, Medtronic, Minneapolis, Minnesota, USA). The first continuous suture is placed in the upper part of the enterotomy and served as traction for the anastomosis anchoring it to the peritoneum of the abdominal wall (Step 4). The second continuous suture is placed in the lower part of the enterotomy to finish its closure (Step 5). After that, the two continuous sutures are tied between them (Step 6).](image)
### Table 1.
**Results**

|                                      | Before Propensity Score Matching | After Propensity Score Matching |
|--------------------------------------|----------------------------------|---------------------------------|
|                                      | Intervention group (n = 54)       | Control group (n = 93)          | Intervention group (n = 54) | Control group (n = 54) |
| Sex ratio (Men : Women)              | 32 (59.3) : 22 (40.7)            | 50 (53.8) : 43 (46.2)          | 32 (59.3) : 22 (40.7)      | 27 (50) : 27 (50)     |
| Median age, years (CI 95%)           | 74 (68.9–74.6)                   | 70 (67.2–71.5)                 | 74 (68.9–74.6)             | 71.5 (69.4–74.5)      |
| Median body mass index, kg/m² (CI 95%) | 25.5 (24.9–27.1)               | 26.7 (26.4–28)                 | 25.5 (24.9–27.1)          | 25.8 (25.2–27.2)     |
| Comorbidities, n (%)                 |                                  |                                 |                             |                          |
| Hypertension                         | 30 (55.6)                        | 40 (43)                        | 30 (55.6)                  | 26 (48.1)              |
| Ischemic heart disease               | 4 (7.4)                          | 12 (12.9)                      | 4 (7.4)                    | 7 (13)                 |
| Type 2 diabetes mellitus             | 9 (16.7)                         | 18 (19.4)                      | 9 (16.7)                   | 12 (22.2)              |
| Smoking habit                        | 14 (25.9)                        | 23 (24.7)                      | 14 (25.9)                  | 14 (25.9)              |
| ASA grade, n (%)                     |                                  |                                 |                             |                          |
| I                                    | 1 (1.9)                          | 6 (6.5)                        | 1 (1.9)                    | 1 (1.9)                |
| II                                   | 21 (30.9)                        | 47 (50.5)                      | 21 (30.9)                  | 23 (42.6)              |
| III                                  | 29 (53.7)                        | 40 (43)                        | 29 (53.7)                  | 30 (55.6)              |
| IV                                   | 3 (5.6)                          | –                              | 0.022*                     | 3 (5.6)                |
| Type of surgery, n (%)               |                                  |                                 |                             |                          |
| Right hemicolectomy                  | 46 (85.2)                        | 86 (92.5)                      | 46 (85.2)                  | 49 (90.7)              |
| Extended right hemicolectomy         | 8 (14.8)                         | 7 (7.5)                        | 8 (14.8)                   | 5 (9.3)                |
| Intraoperative complications, n (%)  |                                  |                                 | 1.000                      | –                      |
| Conversions to open surgery, n (%)   | 3 (5.6)                          | –                              | 0.022*                     | 3 (5.6)                |
| Median operative time, minutes (CI 95%) | 117.5 (113.1–127.1)           | 85 (80.6–90.6)                 | <0.0001*                   | 117.5 (113.1–127.1)   |
| Complications, n (%), Clavien-Dindo classification, grade | | | | |
| Ileum                                | 7 (13)                           | 8 (8.6)                        | 7 (13)                     | 4 (7.4)                |
| Anemia required transfusion          | 3 (5.6, II)                      | 1 (1.1, II)                    | 3 (5.6, II)                | 1 (1.9, II)            |
| Acute cholecystitis                  | 1 (1.9, II)                      | –                              | 0.188                      | 1 (1.9, II)            |
| Rectorrhagia                         | –                                | 1 (1.1, II)                    | 0.445                      | –                      |
| Pneumonia                            | 1 (1.9, II)                      | –                              | 0.188                      | 1 (1.9, II)            |
| Wound infection                      | 5 (9.3, II)                      | 3 (3.2, II)                    | 0.120                      | 5 (9.3, II)            |
| Anemia required surgery              | –                                | 1 (1.1, III-b)                 | 0.445                      | –                      |
in the control group in comparison to the intervention group before (80 and 117.5 minutes, respectively, p ≤ 0.0001) and after pairing (85 and 117.5 minutes, respectively, p ≤ 0.0001) (Table 1).

After PSM analysis, in both groups one anastomotic leakage was observed (1.9%), both treated by computed tomography scan guided radiological drainage (Clavien-Dindo grade III-a). In the control group one patient (1.9%) underwent reintervention for acute postoperative anemia, however no signs of intra-abdominal bleeding were observed (Clavien-Dindo grade III-b) (Table 1).

Median number of harvested lymph-nodes was statistically significant higher in the intervention group in comparison to the control group before and after PSM analysis (17 and 12 lymph-nodes, respectively, p < 0.0001) (Table 1).

Median postoperative hospital stay was significantly lower in the control group in comparison to the intervention group before (5 and 6.5 days, respectively, p ≤ 0.0001) and after the PSM analysis (5 and 6.5 days, respectively, p ≤ 0.013). Mortality was nil in both group (Table 1).

At median follow up of 23 (CI 95% 17.7 – 23.4) and 45 months (CI 95% 33.2 – 45.5) for the intervention and the control group, respectively, one incisional hernia was observed in the intervention group after PSM analysis (1.9%) (P = .315) (Table 1).

DISCUSSION

The present study was conducted with the aim to compare the surgical outcomes obtained with laparoscopic right hemicolectomy with EHSIA versus IMSIA, in patients with adenocarcinoma. Overall, the only statistically significant differences observed between the two groups were the operative time and hospital stay in favor of IMSIA and the number of harvested lymph-nodes in favor of EHSIA, while statistically significant differences were not observed about other analyzed variables.

Several studies, in which ECA versus ICA are compared, have been recently published (Table 2).6–22 ICA required longer operative time, although the overall complication rate, including the anastomotic leakage rate, is similar between ECA and ICA (Table 2).6–22 In the present series, this data was not confirmed as shorter operative times were observed with ICA.

As expected, and as in the present study, ICA is always performed in the same manner, using a laparoscopic linear stapler closing the enterotomy by a hand-sewn

### Table 1. Continued

|                          | Before Propensity Score Matching |                      | After Propensity Score Matching |                      |
|--------------------------|----------------------------------|----------------------|----------------------------------|----------------------|
|                          | Intervention group (n = 54)       | Control group (n = 93)| p value                          | Intervention group (n = 54) | Control group (n = 54) | p value                          |
| Anastomotic leakage      | 1 (1.9, III-a)                   | 2 (2.2, IIIa, III-b) | 0.902                            | 1 (1.9, III-a)         | 1 (1.9, IIIa)           | 1.000                            |
| Pulmonary embolism       | –                                | 1 (1.1, IV)          | 0.445                            | –                    | 1 (1.9, IV)             | 0.315                            |
| Cardiovascular           | –                                | 1 (1.1, IV)          | 0.278                            | –                    | –                      | 1.000                            |
| complications            |                                  |                      |                                  |                      |                        |                                  |
| Median number of         | 17 (16.6–20)                     | 12 (12–13.1)         | <0.0001*                         | 17 (16.6–20)         | 12 (11.7–13.4)           | <0.0001*                         |
| harvested lymph-nodes    | (CI 95%)                         |                      |                                  |                      |                        |                                  |
| (CI 95%)                 |                                  |                      |                                  |                      |                        |                                  |
| R0 resection, n (%)      | 54 (100)                         | 93 (100)             | 1.000                            | 54 (100)             | 54 (100)               | 1.000                            |
| Reintervention, n (%)    | –                                | 2 (2.2)              | 0.278                            | –                    | 1 (1.9)                | 0.315                            |
| Median hospital stay,    | 6.5 (5.9–7)                      | 5 (4.9–7.8)          | <0.0001*                         | 6.5 (5.9–7)          | 5 (4.8–9.8)             | 0.013*                           |
| days (CI 95%)            |                                  |                      |                                  |                      |                        |                                  |
| 30-day mortality, n (%)  |                                  | 1.000                |                                  | 1.000                | 1.000                  |                                  |
| Re-admission, n (%)      |                                  | –                    | 1.000                            | –                    | –                      | 1.000                            |
| Incisional hernia        | 1 (1.9)                          | 1 (1.1)              | 0.695                            | 1 (1.9)              | –                      | 0.315                            |
| occurrence, n (%)        |                                  |                      |                                  |                      |                        |                                  |

*Statistically significant differences in bold. Abbreviation: CI, confidence interval.

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suture or by another stapled line.\textsuperscript{6–22} On the other hand, ECA is performed by linear stapler in most cases,\textsuperscript{6–16} but some authors performed ECA by either stapler or hand-sewn suture,\textsuperscript{17–21} and few by hand-sewn (Table 2).\textsuperscript{22}

In our series, in patients who underwent surgery with ECA, an ileal and colonic stump staple line reinforcement is performed to control a possible further source of bleeding. The cold blade scalpel is used to allow a better scarring of the anastomosis in comparison to the electric scalpel.

Our results do not differ from those reported in literature, in comparison with ICA and mechanical or manual ECA.\textsuperscript{6–22} It is important to consider that in the literature some authors reported shorter hospital stay in comparison to the present series, but in their studies the ERAS protocol is adopted.\textsuperscript{6,8,9,22}

In the present series, encouraging results are observed also in terms of harvested lymph-nodes, re-admission, re-operation, and mortality rates in comparison to the literature both in case of ICA and ECA,\textsuperscript{6–22} despite the small number of patients. Even if the median number of harvested lymph-nodes between groups is statistically significantly different, in both groups it is sufficient to make a correct tumor staging, and, moreover, the number of analyzed lymph-nodes could depend on the different pathologists from the two included centers.

| Authors            | Number of patients | Median Operative Time, minutes (range) | Anastomotic Leakage Rate, n (%) | Anastomotic Bleeding Rate, n (%) | Median Hospital Stay, days (range) |
|--------------------|--------------------|---------------------------------------|--------------------------------|--------------------------------|----------------------------------|
| Bolo et al.        | 70                 | 123 (60–240)                          | 5 (7)                         | 10 (14)                        | 2 (3)                            |
| Ishizaki et al.    | 50                 | 198 (78–402)                          | 0                             | 0                              | 0                                |
| Vignali et al.     | 30                 | Mean 135 ± 27                         | 2 (6.6)                       | 0                              | 0                                |
| Trépanier et al.   | 155                | Mean 144.4 ± 48.1                     | 8 (5.2)                       | 2 (2.8)                       | 0                                |
| Hanna et al.      | 109                | Mean 144.4 ± 48.1                     | 5 (4.6)                       | 1 (1.2)                       | 0                                |
| Magistro et al.    | 40                 | Mean 203 ± 48                         | 0                             | 0                              | 3 (5)                            |
| Scatizzi et al.    | 40                 | 150 (105–215)                         | 0                             | 0                              | 0                                |
| Anania et al.      | 69                 | 190 (170–220)                         | n.r.                          | n.r.                           | 8 (IQR 7–11)                     |
| Cleary et al.      | 124                | Mean 175.5 ± 56                       | 0                             | 1 (0.6)                       | 2 (1.6)                          |
| Ferrer-Márquez et al. | 78              | Mean 97.35 ± 28.05                    | 6 (7.7)                       | 4 (4.9)                       | 0                                |
| Zhang et al.       | 180                | Mean 163.2 ± 38.5                     | 2 (1.1)                       | 1 (0.8)                       | 1 (0.5)                          |
| Allazi et al.      | 70                 | Mean 130 (110–180)                    | 2 (2.9)                       | 7 (10)                        | 1 (1.4)                          |
| Biondi et al.      | 54                 | Mean 188.77 ± 59.15                   | 1 (1.9)                       | 0                              | 0                                |
| Jarry et al.       | 79                 | Mean 150 (120–180)                    | 3 (3.8)                       | 2 (1.7)                       | 7 (3.7)                          |
| Saleh et al.       | 447                | Mean 195 (60–695)                     | 10 (2)                        | 64                             | 0                                |
| Hoyuela et al.     | 55                 | Mean 146 ± 40.3                       | 4 (7.3)                       | 0                              | 3 (3.6)                          |
| Malczak et al.     | 50                 | 190 (150–230)                         | 2 (4)                         | 0                              | 2 (4)                            |
| Present series     | 54                 | 117.5 (CI 95% 113.1–127.1)            | 1 (1.9)                       | 1 (1.9)                       | 0                                |

Abbreviations: ECA, extracorporeal anastomosis; ICA, intracorporeal anastomosis; IQR, interquartile range; CI, confidence interval; n. r., not reported.

\textsuperscript{6}extracorporeal mechanic anastomosis; \textsuperscript{7}extracorporeal anastomosis performed by either stapler or hand-sewn suture; \textsuperscript{8}extracorporeal hand-sewn anastomosis.
Although an important difference is not observed comparing the anastomotic leakage rate between ECA and ICA, some authors advocated that leakage after ICA is related to higher clinical impact due to the severity of dehiscence in comparison to ECA.\textsuperscript{6–22} This could be related, even if not demonstrated, to the fact that the mechanical anastomosis is performed by a single layer suture in comparison to most of the manual anastomosis performed by a double layer suture.\textsuperscript{23,24} As in the present series, Espin et al. reported an analysis of 116 patients who experienced anastomotic leakage after right hemicolectomy.\textsuperscript{25} Anastomotic leakages were stratified based on the type of the anastomosis (manual versus mechanical) and grade of leakage based on the Clavien-Dindo classification and on the International Study Group of Rectal Cancer (ISGRC) classification.\textsuperscript{5,25} They found that Clavien-Dindo grade III-a leakage is more frequent in patients who underwent hand-sewn anastomosis, and that grade III-b leakage is more frequent in patients who underwent stapled anastomosis.\textsuperscript{25} Similarly, ISGRC grade C leakage is more frequent in patients who underwent stapled anastomosis.\textsuperscript{25} In our opinion, even if further studies are required to draw definitive conclusions about the severity of postoperative anastomotic leakage based on the type of the anastomosis, the treatment required in case of anastomotic leakage, such as re-operation and re-admission should be considered among the endpoints when ECA and ICA are compared. However, in the present series, anastomotic leakages III-b were not observed with ICA.

The cost to perform a mechanical anastomosis is higher in comparison to a hand-sewn anastomosis and this is related to the cost of the tristaple device in comparison to vicryl suture.\textsuperscript{26,27} In case of mechanical anastomosis, despite the major cost of the procedure could be compensated by a shorter hospital stay, another important charge could be represented by the expense necessary to treat more serious leakages, that could require re-admission and re-operation. Further studies are necessary to investigate about the cost management of these patients.

Another aspect to consider, even if is not the object of the present study, is the possibility to perform a hand-sewn anastomosis in specific situations, such as in case of inflammatory bowel disease.\textsuperscript{28} In these cases hand-sewn anastomosis may be a valid alternative to mechanical one, allowing to surgeon to shape the anastomosis if necessary.

Finally, the high incidence of wound infection and incisional hernia after midline laparotomy in comparison to Pfannenstiel incision is wide reported in literature,\textsuperscript{29,30} even if this data is not confirmed in the present study.

Few articles reported data regarding extraction site incisional hernia after minimally invasive right hemicolectomy with ICA or ECA, and it is probably due to the short follow up.\textsuperscript{6–22,31} Hanna et al. reported an incisional hernia rate of 2% and 5% in patients in which ICA and ECA were performed, respectively, at median follow up of 10 and seven months after surgery.\textsuperscript{10} Allaix et al., six months after surgery, reported an incisional hernia rate of 1.4% and 2.9% with ICA and ECA, respectively.\textsuperscript{17} Otherwise from previous authors, Biondi et al. reported an important difference regarding incisional hernia rate between ICA (1.9%) and ECA (21.2%).\textsuperscript{38} Even if we have to consider the wide difference of follow-up between the two groups (ICA: median 9.52 months, ECA: median 26.69 months). In our series the incisional hernia rate is 1.9% in the ECA group. Although long-term follow-up is required to draw definitive conclusions, in literature, incisional hernia rate is higher in patients who underwent right hemicolectomy with ECA.\textsuperscript{10,17,18} In our opinion, also the necessity of incisional hernia repair should be included in the cost management of these patients.

The main limitations of the present study are its retrospective nature, the small sample size of each group that may have affect the statistical analysis, different pathologies that may have affected the number of analyzed lymph-nodes, different surgeons involved from two centers, and the lack of the analysis of postoperative pain.

**CONCLUSION**

Based on the present study, laparoscopic right hemicolectomy with EHSIA and IMSIA showed intra and postoperative results similar to those reported in literature, in terms of operative time, anastomotic leakage, bleeding, and length of hospital stay. Further randomized studies are required to draw definitive conclusions regarding outcomes between EHSIA and IMSIA during laparoscopic right hemicolectomy.

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