

Intracorporeal versus Extracorporeal Anastomosis in Laparoscopic Right Colectomy: Short-Term Outcomes

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ABSTRACT

Background: Recently, there has been a growing enthusiasm in developing new techniques of intracorporeal anastomosis following laparoscopic colectomy, which are more challenging than extracorporeal techniques. However, the evidence is still lacking regarding the outcomes' comparison of both procedures.

Methods: We designed a retrospective study comparing intracorporeal and extracorporeal anastomosis following laparoscopic right colectomy. A total of 115 consecutive patients operated for right colon disease were identified, from September 1st 2014 to May 31st 2017. Patient demographics included age, gender, ASA score, past abdominal surgery, anticoagulant and steroid therapy, Diabetes Mellitus and preoperative diagnosis. The analysed outcomes included length of stay, operative time, blood loss, extraction site, postoperative complications (ileus, anastomotic failure and surgical site infection), reoperation rate, readmission rate and 30-day mortality.

Results: The extracorporeal group included 84 and the intracorporeal group 31 patients. The intracorporeal group had less surgical site infections (3,2% versus 27,4%, $p < 0,05$). There were no statistically significant differences in operative time, blood loss, ileus, anastomotic failure or mortality.

Conclusion: Our study reveals similar outcomes for both intra- and extracorporeal anastomosis following laparoscopic right colectomy. Therefore, intracorporeal anastomosis seems to be a feasible and safe technique in the hands of experienced laparoscopic colorectal surgeons.

Key words: laparoscopy, colectomy, surgical anastomosis, retrospective study

BACKGROUND

Nowadays, laparoscopic colectomy is considered a safe and effective surgical technique regarding short- and long-term outcomes, as well as specific oncologic outcomes (1). The feasibility and safety of laparoscopic colon resections have been proven by several trials with high level of evidence, such as COST (2), COLOR (3) and CLASICC (4) trials. The advantages of the laparoscopic approach include reduced intraoperative blood loss, reduced intensity of postoperative

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pain, shorter rates of postoperative ileus, decreased overall morbidity and enhanced recovery.

Intra-corporeal (IA) anastomosis techniques are demanding procedures, when compared to extra-corporeal (EA) techniques; requiring advanced training in order to achieve expertise in laparoscopic manual sutures, and a longer learning curve (5). Nevertheless, the growing enthusiasm about minimally invasive approaches has propelled surgeons to develop totally intra-corporeal anastomotic techniques. Its theoretical advantages are the easier handling of structures, lower risk of mesenteric torsion and the ability to choose the incision site for specimen extraction. However, according to some authors, there are some disadvantages, such as a longer operative time, a higher risk of fecal contamination and a more demanding technique (6).

Although the evidence is vast when it comes to compare laparoscopic surgery with EA and hand-assisted or laparotomic surgery, there are only a few comparative trials that state the feasibility and safety of IA techniques (7, 8). A meta-analysis published in 2014 (9), including 484 patients in six case-control trials, compared IA and EA techniques after laparoscopic right colectomy: this showed some encouraging results in the IA group (faster return of bowel movement, shorter length of stay and better cosmetic outcome). However, there were no statistically significant differences in anastomotic failure or early post-operative morbidity. Another meta-analysis (10) recently published which included 12 comparative non-randomised trials concluded that IA technique after laparoscopic right colectomy for colonic cancer showed less overall post-operative morbidity and shorter length of stay; these differences were even more significant in those trials published after 2012, which suggests better results come with a longer learning curve and higher expertise of surgeons. There were no differences in mortality rates, ileus or anastomotic failure.

During our literature research, we did not find any randomised controlled trials comparing EA and IA, and no papers published in Portugal.

Aims

The two aims of this study are: 1) to assess the feasibility and safety of IA technique after laparoscopic right colectomy; 2) to compare operative and post-operative outcomes of IA and EA techniques after laparoscopic right colectomy.

MATERIAL AND METHODS

We designed a retrospective comparative study to assess short-term outcomes of IA and EA techniques after laparoscopic right colectomy. We made a review of 115 consecutive patients who underwent laparoscopic right colectomy between September 1st 2014 and May 31st 2017 at Centro Hospitalar de Leiria. The procedures were performed by four experienced colorectal laparoscopic surgeons of our Colorectal Unit, and the choice of the anastomosis technique (IA or EA) was left at the discretion of each surgeon. Cases were divided into two groups: those with intracorporeal ileocolic anastomosis (IA) and those with extracorporeal anastomosis (EA).

Demographic data included age, gender, ASA score, previous abdominal surgery, anticoagulant and steroid therapy, history of diabetes mellitus and pre-operative diagnosis.

Intraoperative variables analysed were operative time, blood loss, site and size of incision for specimen extraction.

The variables for early postoperative (30 days) period were length of hospital stay, postoperative complications (ileus, anastomotic failure, intra-abdominal abscess and surgical site infection), reoperation rate, readmission within 30 days and mortality rate within 30 days. In this study, anastomotic failure was defined as fecal or gas leak originated in the anastomosis and either collected inside the abdominal cavity, or exteriorised through the surgical wound or a surgical drain. Cases of fever, abscess, septicemia, peritonitis and/or multiorgan failure in association with imagiologic evidence (CT scan) were also considered as anastomotic failure.

Surgical technique

The choice of the anastomosis technique (IA or EA) was left at the surgeon's will. Laparoscopic right colectomy was performed employing medial-to-lateral dissection technique, according to the usual standardized procedure of our Colorectal Unit. An extracorporeal anastomosis was constructed after exteriorization and section of the specimen through a median mini-laparotomy or para-umbilical transverse incision, and then creating a stapled side-to-side antiperistaltic anastomosis with a 80mm stapler (functional end-to-end anastomosis). An intracorporeal anastomosis was constructed by firing a 60 mm endostapler in a side-to-side isoperistaltic fashion, followed by manual closure of the enterotomies

using a single layer of mid-term absorbable braided and coated running suture (fig. 1-4).

All the patients included in this study received the same antibioprophylaxis and thromboprophylaxis scheme.

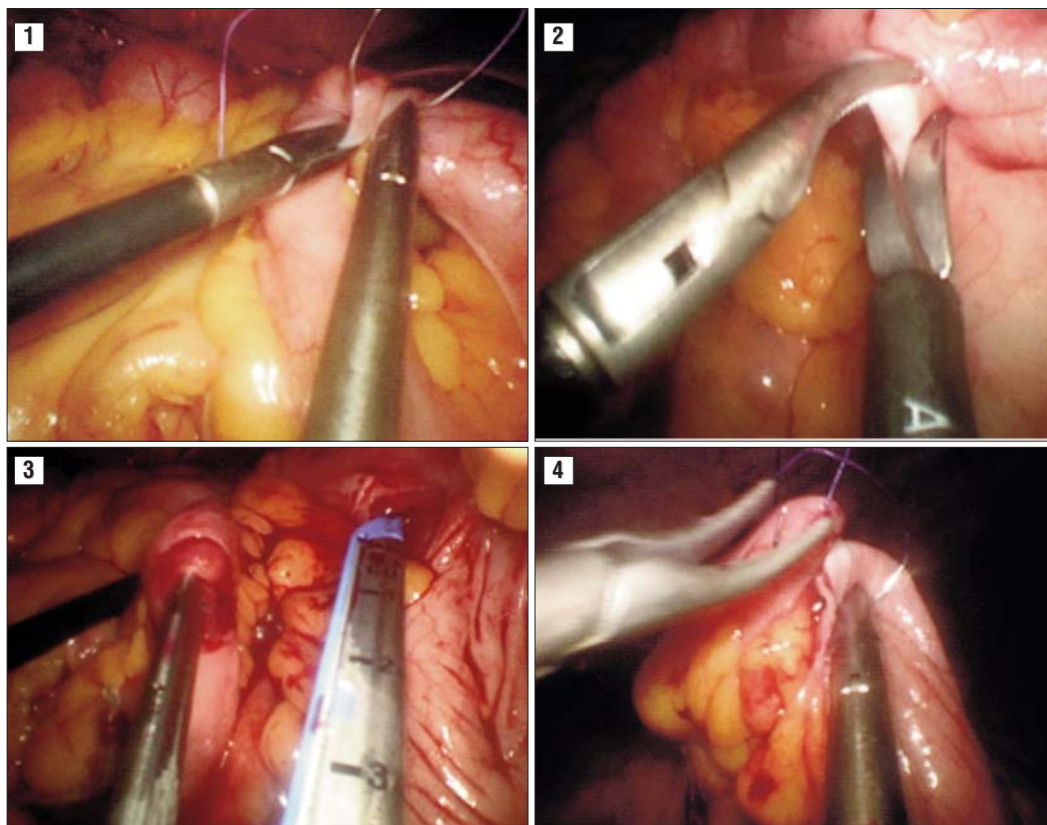
Statistical analysis

Statistical analysis was performed with the IBM SPSS Statistics v24® software. Demographics and comorbidity data were summarized in *table 1*. The categorical variables are expressed as mean \pm standard deviation and continuous variables as n and percentage (%). Statistically significant differences were assessed with t-Student's test for continuous variables and Chi-square or exact Fisher's test for categorical variables. Multivariable analysis was also performed for EA and IA cohorts. Statistical significance was considered for $p < 0,05$, with a confidence interval of 99,5%.

RESULTS

Patient demographics and disease-related characteristics

We reviewed a total of 115 consecutive patients who underwent laparoscopic right colectomy. The EA group included 84 patients and the IA group 31 patients. Mean age was $69 \pm 13,2$ years for the EA group and $72 \pm 12,8$ years for the IA group, with similar gender distribution. The majority of patients had a I or II ASA score, with a mean score of $2,38 \pm 0,64$ for the EA group and $2,52 \pm 0,65$ for the IA group. In 24,8% of EA group and 16,1% of IA group there was history of previous abdominal surgery. The most frequent pre-operative diagnosis was colonic neoplasm. Mechanic bowel preparation was made in most of the patients of the IA group (90,3%), in contrast with 34,5% of the patients in the EA group; this difference had statistical significance ($p < 0,05$, CI 99,5%). In both groups, the



Figures 1 to 4 - Confection of intracorporeal ileocolic anastomosis. After performing the right colectomy with dissection in a medial-to-lateral fashion, the specimen is extracted in a organ endobag through a mini-Pfannenstiel incision. Anchorage of bowel in the chosen position for anastomosis with a single reabsorbable suture knot (1). After enterotomy and colotomy incisions (2), introduction of the endostapler for construction of an ileocolic latero-lateral isoperistaltic mechanic anastomosis (3). Closing of the incisions with a manual single layer inverting absorbable suture (4).

Table 1 - Demographic data

Variable	EA (n = 84)	IA (n = 31)	p value
Age (mean ± SD)	69 ± 13,2	72 ± 12,8	NS
Gender (F/M)	38 / 46	14 / 17	NS
ASA score (mean ± SD)	2,38 ± 0,64	2,52 ± 0,65	NS
ASA I or II (n)	52	15	
ASA III (n)	30	15	
ASA IV (n)	2	1	
Previous abdominal surgery	20 (23,8%)	5 (16,1%)	NS
Diabetes Mellitus	18 (21,4%)	7 (22,6%)	NS
Anticoagulation	8 (9,5%)	2 (6,5%)	NS
Steroids	1 (1,2%)	0 (0%)	NS
Preoperative diagnosis			NS
Neoplasm	82 (97,6%)	30 (96,8%)	
Ischaemia	0 (0%)	1 (3,2%)	
Crohn's disease	1 (1,2%)	0 (0%)	
Appendicular plastron	1 (1,2%)	0 (0%)	
Mechanic bowel preparation	29 (34,5%)	28 (90,3%)	p < 0,05
Emergent / Elective surgery	7 / 77 (91,7%)	3 / 28 (90,3%)	NS

majority of patients had elective surgery (91,7% for the EA and 90,3% for the IA group).

Demographics and pre-operative data are summarized in *table 1*.

Operative outcomes

Intraoperatively we analysed the operative time, estimated blood loss, site and size of surgical incision for specimen extraction; these data are summarized in *table 2*. The mean operative time was similar in both groups (121 ± 27,1 minutes in the IA group versus 125 ± 33,2 minutes in the EA group). The mean estimated blood loss was slightly lower in the IA group (32,9 ± 31,9 mL versus 50,5 ± 58,4mL), although it did not reach statistical significance.

Our study revealed a statistically significant difference in the choice of incision site for specimen extraction, with a clear preference for hypogastric

incision in the IA group (90,3%) and mesogastric in the EA group (97,6%) (p<0,05, CI 99,5%). The incision size was similar in both groups.

Short-term outcomes and complications

The analysed variables in the early postoperative period (30 days) were mean length of hospital stay, postoperative complications (ileus, anastomotic failure, intra-abdominal abscess and surgical site infection), and overall mortality. These results are summarized in *table 3*.

The rate of surgical wound infection was significantly lower in the IA group (21,4% vs. 3,2%, p<0,05 and CI 99,5%); moreover, the IA group had a lower rate of abdominal abscess (6% vs. 0%), although with no statistically significant difference for this variable alone.

We also verified a slightly shorter mean length of hospital stay for the IA group (9,3 days ± 5,4 versus 11,3

Table 2 - Intraoperative data. NS – non-significant (p>0,05)

Variable	EA (n = 84)	IA (n = 31)	p value
Mean operative time (minutes)	125 ± 33,2	121 ± 27,1	NS
Mean estimated blood loss (mL)	50,5 ± 58,4	32,9 ± 31,9	NS
Mean incision size (cm)	5,8	5,2	NS
Incision site Mesogastric	82 (97,6%)	3 (9,7%)	p < 0,05
Hypogastric	2 (2,4%)	28 (90,3%)	p < 0,05

Table 3 - Postoperative outcomes. NS – non-significant ($p > 0,05$)

Variable	EA (n = 84)	IA (n = 31)	p value
Mean length of hospital stay(days)	11,3 \pm 13,3	9,3 \pm 5,4	NS (0.168157)
Postoperative complications			
Ileus (n / %)	17 (20,2%)	5 (16,1%)	NS
Anastomotic failure (n / %)	6 (7,1%)	2 (6,5%)	NS
Intra-abdominal abscess (n / %)	5 (5,9%)	0	NS
Surgical wound infection (n / %)	18 (21,4%)	1 (3,2%)	$p < 0,05$
Reoperation rate (n / %)	5 (5,9%)	2 (6,5%)	NS
Readmission within 30 days (n / %)	1 (1,2%)	1 (3,2%)	NS
Mortality (30 days)	2 (2,4%)	1 (3,2%)	NS

$\pm 13,3$ days), although not reaching statistical significance. Anastomotic failure rate was similar in both groups (EA 7,1% vs. IA 6,5%).

There were no differences in reoperation rate (6% for EA versus 6,5% for IA group) or readmission within 30 days (1,2% versus 3,2% for EA and IA groups, respectively).

Mortality rate was also similar in both groups.

DISCUSSION

The benefits of laparoscopic colorectal surgery have been proven by multiple randomised trials with high levels of evidence. The growing experience of laparoscopic colorectal surgeons allows a higher range of techniques and choices for the confection of colorectal anastomosis, such as the intracorporeal anastomosis. This type of technique after laparoscopic right colectomy has been used by several groups reporting exciting results; however, these studies are merely observational. It is not proven yet the non-inferiority of intracorporeal versus extracorporeal techniques by large randomised controlled trials.

In the analysis of our 115 patients, there were no demographic differences between the two groups, with a similar mean age and gender distribution. Also, we found no difference in mean ASA score, which means both groups had similar surgical risk. The comorbidities analysis also showed the homogeneity between both groups, with similar rates of previous abdominal surgery, diabetes mellitus and steroid or anticoagulant therapies. The preoperative diagnosis was colonic cancer for most patients, except for 3 cases of benign disease (colonic ischaemia, Crohn's disease and appendicular plastron). There was no difference in pre-operative diagnosis for both groups. When it comes to the distribution of emergent/elective procedures, there

was no statistically significant difference; in both groups, the majority of patients had elective procedures. Overall, this analysis shows that our cohort was homogeneous, thus diminishing a possible selection bias.

We found no statistically significant differences in intraoperative data, namely mean operative time ($125 \pm 33,2$ minutes for the EA, and $121 \pm 27,1$ minutes for the IA group) or mean blood loss ($50,5 \pm 58,4$ mL versus $32,9 \pm 31,9$ mL for EA and IA groups, respectively). There have been multiple studies analysing the differences in operative time between the two techniques, most of them failing to show a significant difference. Chaves et al. (11) reported a shorter operative time for the EA group in an analysis of 25 patients, although not statistically significant. Fabozzi et al. (12) reported a significant decrease in the IA group with 50 patients. Hanna et al. (7) found an improvement in median operative time from 240 minutes in 2005 to 170 minutes in 2014, although failing to reach a statistically significant difference, in a cohort of 71 patients in the IA group. Our study shows similar results for both groups. In the hands of experienced surgeons, mean operative time should be similar for both techniques.

Our study revealed a statistically significant difference in surgical wound infection rate, which was lower in the IA group (21,4% vs. 3,2%, $p < 0,05$ and 99,5% CI), as well as a slightly lower rate of intra-abdominal abscess in the same group (6% vs. 0%), although failing to reach statistical significance. Moreover, when we consider overall local infectious complications (surgical site infection, SSI) we find a statistically significant difference in favour of the IA group (3,2% versus 27,4%, $p < 0,05$ and 99,5% CI).

These findings are supported by several studies reporting significantly lower rates of SSI in the IA group. However, there is no consensus in the literature regarding the reasons to explain these differences, and

we found several possible explanations.

One author (13) explained this difference with the higher tension applied on tissues and traumatic damage of surgical site during specimen extraction in the EA technique. In addition, an IA technique has the advantage of less mobilization of the transverse colon and pancreaticoduodenal block, theoretically resulting in less surgical trauma and therefore less infectious risk.

Theoretically, using a IA technique should lead to an increase in intra-abdominal infections due to the necessity of intraperitoneal opening of contaminated ileon and transverse colon. In an attempt to decrease the risk of fecal contamination when performing the enterotomies for the anastomosis confection, Grams et al. (14) described the use of atraumatic bulldog clamps. Our Unit, on the other hand, used mechanical bowel preparation in order to avoid intraperitoneal fecal spillage after performing the enterotomies. Almost all patients in the IA group received this preparation (90,3%), versus 34,5% in the EA group, with statistically significant difference ($p < 0,05$, 99,5% CI). The remaining patients in the IA group were submitted to emergent procedures, thus not receiving bowel preparation. Both groups received the same antibiotic prophylaxis with a single dose of intravenous cefazolin and metronidazole.

On the other hand, we found a significant difference in the choice of surgical incision site, with a clear preference for a hypogastric incision (mini Pfannenstiel) in the IA group and a mesogastric incision (either mini-laparotomy or transverse para-umbilical incision) in the EA group ($p < 0,05$, 99,5% CI). The mean incision size was similar for both groups (5,8 cm for the EA and 5,2 cm for the IA group). The IA technique allows a larger rate of possibilities for this choice, given the ability to easier manipulation of tissues and therefore the possibility to perform an incision in a lower region of the abdomen. The hypogastric incision offers some advantages previously reported (16), such as better cosmetic results, lower intensity of postoperative pain possibly due to smaller incisions with minimum muscle tear, fewer respiratory complications related to hypoventilation caused by abdominal pain, fewer rates of surgical site infection and fewer rates of incisional herniation (18).

In conclusion, we cannot yet state which factors definitely contribute to a lower rate of surgical site infection in the IA technique, due to the heterogeneity of published studies. In our analysis, the difference found in SSI seems to be related to mechanical bowel preparation (which the majority of IA patients have received), and the choice of extraction site favouring the hypogastric incision.

We found a trend toward a lower anastomotic

failure rate in the IA group, although not reaching statistical significance (6,5% versus 7,1%). This finding could be explained with the lower tension and thorough manipulation of bowel and respective mesentery for the confection of the anastomosis, and the lower risk of mesenteric torsion due to the ability of direct visual control. As such, we can consider some advantages of the IA technique regarding a higher flexibility of tissue manipulation and the choice of the incision site, as has been stated by some authors. These advantages could translate into enhanced recovery, decreased complications rate and improved long-term results.

Fabozzi et al (12) reported a significant decrease in the risk of anastomotic leak ($p < 0,05$) in a retrospective study including 50 patients. However, these findings were not replicated by any other retrospective analysis found in the literature. Hannah et al. (7) published a retrospective study, which included 195 patients (86 in the IA and 109 in the EA group), reporting a lower risk of anastomotic failure in the IA group that did not reach statistical significance (AOR 0.29, 95% CI, $p < 0,05$). A meta-analysis (9) of 484 patients (including 272 patients in the IA group and 212 patients in the EA group) did not find any significant difference in anastomotic leak rates (OR 0.98, 95% CI). These findings suggest that a potential benefit or harm of the IA technique regarding anastomotic failure remains unclear.

There were no differences in reoperation rate, with 5 cases (6%) in the EA group and 2 cases (6,5%) in the IA group. Of these, two cases had internal herniation with small bowel obstruction (one case in each group), one had complications of an umbilical herniorrhaphy (IA group), and four patients in the EA group were reoperated for anastomotic failure with peritonitis.

In our analysis, we considered as length of hospital stay the total time spent in hospital, which included the day the patient was admitted to preoperative preparation and the day of the surgical intervention (D-1 and D0). The mean length of hospital stay was slightly shorter for the IA group ($9,3 \pm 5,4$ days versus $11,3 \pm 13,3$), although not reaching statistical significance ($p > 0,05$).

In our literature research, we found small trials supporting this difference. Roscio et al. (15) reported a faster return of bowel movement for the patients submitted to IA, with a significant difference, relating this finding to significantly shorter length of hospital stay for the same group. A meta-analysis published in 2017 (10) which included 12 studies published between 2010 and 2015, with a total of 1492 patients, also reveals a difference in the mean length of hospital stay in favor of IA group (MD -0.77 days, 95% CI -1.46 to -0.07); however, due to the cohorts' heterogeneity, this difference did

not reach statistical significance. Nonetheless, a subgroup analysis including only the studies posterior to 2012 stated a statistically significant difference for this particular outcome (0.77 days, 95% CI -1.17 to -0.37), which could be related to a lower rate of postoperative complications in the IA group. Our study showed a difference in postoperative infectious complications, which may have influenced the outcomes in length of hospital stay.

There were two cases of hospital readmission (one in each group), with no statistically significant difference between the two groups.

We found no differences in overall mortality between the two groups, which is consistent with the available literature.

Limitations and biases

Some limitations of this study must be addressed. The major limitation lies in the study design, which is based on the evaluation of retrospective data, thus lacking randomisation of patients; this could possibly originate a selection bias. Nonetheless, demographic and preoperative data analysis showed no significant differences between the two groups.

Another limitation is related with the small cohort of the study, decreasing the study potency to truly understand its statistical significance.

Also, the follow-up was only of 30 days, focusing on the immediate postoperative outcomes. Our Colorectal Unit intends to design a prospective study addressing long-term outcomes and survival rates, as well as oncologic-specific outcomes.

Nonetheless, we consider these results encouraging, leading us to consider the possibility of stating the non-inferiority of IA technique over the EA technique.

In conclusion, we present our first results of intracorporeal anastomosis after laparoscopic right colectomy, performed by a team of experienced colorectal laparoscopic surgeons. We emphasize the lack of randomised-controlled trials worldwide, and the absence of studies regarding this issue published in Portugal so far.

CONCLUSION

Our study presents similar postoperative results of IA and EA techniques after laparoscopic right colectomy. Possible advantages of the IA technique are the versatility to choose the location of incision site for specimen extraction and lower rates of surgical site infection. Therefore, we can state the safety and feasibility of intracorporeal technique, when performed

by experienced colorectal laparoscopic surgeons. We recommend a solid and well-defined learning model in laparoscopy, adapting the IA technique into the practice of surgeons ascending the learning curve.

Disclosure

We have no conflict of interests to declare.

Ethical considerations

Approval for this study was obtained from the Ethical Committee of Centro Hospitalar de Leiria.

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