Risk of ileocolic anastomosis failure after right hemicolectomy for cancer.
A comparison between different techniques

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BACKGROUND: *In recent years, the role of laparoscopic approach in the surgical treatment of right colon cancer has increased. Results comparing the different techniques of ileocolic anastomoses are controversial, with studies only reporting some advantages of the intracorporeal laparoscopic technique. The aim of this study is to compare the outcomes between laparoscopic versus open hemicolectomy for right colon cancer, focusing on anastomotic techniques (intracorporeal vs extracorporeal in the laparoscopic procedure, and manual vs mechanical in the laparotomic procedure).*
METHODS: *This is a retrospective single center study enrolling patients with right colon cancer from January 2016 to December 2020. Primary endpoint of the study was the rate of anastomotic leak (AL).*
RESULTS: *A total of 161 patients who underwent right hemicolectomy were enrolled: 91 were performed with laparoscopic technique, and 70 with open technique. Overall, AL occurred in 15 pts (9.3%). We observed 4 AL in intracorporeal (12.9%) and 6 in extracorporeal (10%) anastomoses, respectively. In the laparotomy group 5 patients (7.1%) developed AL, of which 3 (5.7%) and 2 (11.1%) manually and mechanically performed, respectively.*
CONCLUSIONS: *Based on our findings, laparoscopic hemicolectomy has a higher incidence of anastomotic leak. In the laparoscopic group, we observed the lowest rate of AL with extracorporeal mechanical anastomosis. When performed extracorporeally with open technique, hand-sewn anastomosis has better results than mechanical.*

KEY WORDS: Anastomosis, Cancer, Ileotransverse, Leakage, Right Colectomy

Introduction

Currently many randomized trials showed non-inferior oncologic results of laparoscopic resections compared to open resections for right colon cancer [1-3]. In open right colectomy (ORC) we can perform mechanical or manual ileocolic anastomosis with different techniques and devices. In laparoscopic right colectomy (LRC) we can choose between extra or intracorporeal anastomosis [4]. The oncological outcomes of the different techniques do not differ whether there are advantages of the intracorporeal anastomosis regarding smaller incisions, reduced mesenteric traction, reduced ileus, with the disadvantage being that it is a more challenging technique than the others. Recent literature shows controversy in the results between the two approaches, reporting some advantages in favor of intracorporeal anastomosis technique, as previously stated [5,6]. The aim of the study was to analyze postoperative results of laparoscopic and open surgical approach in a single center experience.

Methods and Materials

We retrospectively enrolled 161 consecutive patients who underwent elective right open (ORC group) or laparo-

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ABBREVIATIONS

AL: Anastomotic Leakage
ECA: Extracorporeal Anastomosis
HGD: High Grade Dysplasia
ICA: Intracorporeal Anastomosis
LRC: Laparoscopic Right Colectomy
ORC: Open Right Colectomy

scopic (LRC group) hemicolectomy for cancer between January 2016 and December 2020 in our surgical department. ERAS protocol was introduced gradually in 2016 in our department, with dedicated oral and written information, preoperatory diet and physical activity regimens for the patients. No bowel preparation was applied to the patients, except 120ml enema the night before operation. All the patients were submitted to TAP block anesthesia. All patients were submitted to an endoscopic tattoo of the lesion. All ileo-caeco-colic inflammatory diseases, GIST and neuroendocrine tumors were excluded from the study.

Surgical equipes were composed by six different first operators of difference experience and learning curve course in colo-rectal surgery and laparoscopy. We standardized the technique regarding trocars sites, surgical steps, energy dissection devices, hemostatic clips and suturing devices. Surgical approach was majorly influenced by patient's ASA score and history of past abdominal surgery, favoring a laparotomic approach for patients with ASA score >3 and a positive history of past abdominal surgery. Tumors staged T4 with preoperative findings of duodenal or ureteral infiltration were not candidates for a laparoscopic approach.

Laparotomic approach consisted of a midline xifo-umbilical or transverse umbilical incision. The laparoscopic approach consisted in pneumoperitoneum with CO2 pressure of 12 mmHg was performed with open "Hasson" technique using a 12 mm trocar placed in the left pararectal on the umbilical transverse line. Two additional 10 mm trocars were positioned in the left hypochondriac and left iliac region on the hemi clavicular line, with different placements tailored on the patient's abdominal conformation. We usually used a fourth 5 mm trocar in the right iliac region. Both open and laparoscopic techniques followed the same surgical steps. Anastomotic technique (handsewn or stapled, intracorporeal or extracorporeal) was decided by the first operator at the moment of surgical intervention based on his choice and preference. Stapled isoperistaltic side-to-side anastomosis was performed using a linear NTLC blue cartridge stapler with manual enterotomy closure. Handsewn anastomosis consisted of a single layer running suture for the posterior aspect and interrupted suture for the anterior aspect. Intracorporeal anastomosis (ICA) was isoperistaltic side-to-side ileocolic anastomosis using a vascular 60mm endoGIA cartridge with enterotomy closure with a double layered running suture. For extracorporeal anastomosis (ECA), we performed transversal pararectal 8-12 cm incision with subsequent placement of a circular, single use wall protection system.

A Pfannenstiel incision of 8-12 cm with circular single use wall protection system was used for surgical specimen extraction, if ICA was performed. An enterotomy was made to confirm the presence of macroscopic tumor, to verify the resection edges and to check for palpable lymph nodes in the mesentery. In all cases, we placed a 24 or 19 Ch drainage in Morrison's space.

Resumption of oral intake and patients' mobilization was provided on the first postoperative day. Nasogastric tube and urinary catheter were removed at the end of the surgical procedure. In case of fever, leukocytosis, abdominal pain or prolonged ileus abdominal CT scan was performed. Primary endpoint of the study was to compare rates of AL between the different surgical approaches and bowel continuity restoration techniques. We classified AL that needed surgical interventions as Major AL. The reintervention consisted in a laparotomic approach with resection of the anastomotic complex and ileocolic anastomosis or, in case of diffuse peritonitis, anastomotic resection with terminal ileostomy and mucosal colonic fistula.

The cases of AL that were treated conservatively (parental nutrition, antibiotic therapy) or with percutaneous drainage were classified as Minor AL.

Results

A total 161 patients were submitted for right colectomy for colon cancer, 95 were male and 66 were female. Median age was 72.9 years, and mean BMI was 25.7 kg/m^2. Patient's characteristics are shown in (Table I).

We performed 91 Laparoscopic Right Colectomy (LRC) and 70 Open Right Colectomy (ORC). We observed that the laparoscopic group median age was lowest (70.27 years vs 76.41 years), but we observed little difference of the mean BMI (LRC 25.23 kg/m^2 vs ORC 26.31 kg/m2).

The majority (89.5%) of the 161 patients was classified as ASA II or III. More than half of the population in the LRC group was classified as ASA score II or lowest, whilst in the ORC group we observed a higher number of patients with an ASA score of III or higher. We also observed in the ORC group a higher number of comorbidities (95.7% vs 75.8% in LRC), especially type II diabetes, and a significantly higher number of previous abdominal surgeries (64.3% vs 31.8% of the LRC). The majority of the patients had pTMN staging as T3 or higher (65.8%), while only a small portion of the population examined had metastases (7.4%). Tumor staging details are shown in (Table II).

TABLE I - *Patient's Characteristics*

		OPEN (70)	LAP (91)	Tot. (161)
Age (Mean)		76.41	70.27	72.94
BMI (Mean)		26.31	25.23	25.7
Sex (M:F)		43-27	52-39	95-66
Asa Score				
	I	1 (1.4%)	2 (2.2%)	3 (1.8%)
	II	17 (24.3%)	50 (55%)	67 (41.6%)
	III	42 (60%)	35 (38.4%)	77 (47.8%)
	IV	10 (14.3%)	4 (4.4%)	14 (8.6%)
Comorbidities		67 (95.7%)	69 (75.8)	136 (84.5)
	CV (IAS; FA)	56 (80%)	47 (51.6)	103 (64%)
	DMII	17 (24.3%)	4 (4.4%)	21 (13%)
Previous Abd. Surgery		45 (64.3%)	29 (31.8%)	74 (46%)
Tumor Site				
	Cecum	44 (62.8%)	44 (48.3%)	88 (54.6%)
	Ascending	13 (18.6%)	29 (31.8%)	42 (26.1%)
	Hepatic Flexure	8 (11.4%)	11 (12.1%)	19 (11.8%)
	Transverse	5 (7.1%)	7 (7.7%)	12 (7.4%)

TABLE II - *Tumor Staging*

		OPEN (70)	LAP (91)	Tot. (161)
T				
	HGD/Tis	7 (10%)	18 (19.8%)	25 (15.5%)
	T1-2	8 (11.4%)	22 (24.2%)	30 (18.6%)
	T3-4	55 (78.8%)	51 (56%)	106 (65.8%)
N				
	N0	39 (55.7%)	69 (75.8%)	108 (67.1%)
	N1a-b-c	17 (24.3%)	16 (17.6%)	33 (20.5%)
	N2a-b	14 (20%)	6 (6.6%%)	20 (12.4%)
M				
	M0	63 (90%)	86 (94.5%)	149 (92.5%)
	M1	7 (10%)	5 (5.5%)	12 (7.4%)
Stage				
	0	7 (10%)	18 (19.8%)	25 (15.5%)
	I	7 (10%)	17 (18.7%)	24 (14.9%)
	II	22 (31.4%)	33 (36.3%)	55 (34.2%)
	III	27 (38.6%)	18 (19.8%)	45 (27.9%)
	IV	7 (10%)	5 (5.5%)	12 (7.4%)

Operative and Post-Operative findings are shown in (Table III).

In the LRC 60/91 (65.9%) patients had extracorporeal anastomosis, of which 36/60 (60%) were hand sewn and 24/60 (40%) were made in a mechanical fashion. In 31 of the 91 patients in the LRC (34% of the entire laparoscopic group) an intracorporeal mechanical anastomosis was performed.

In the ORC group, 52 on 70 (74.3%) had a manual ileocolic anastomosis and 18 on 70 (25.7%) was performed a mechanical anastomosis.

The ORC had 16 associated intraoperative surgical procedures, whilst in the LRC the number of associated surgical procedures was 6 cases.

Conversion to traditional open surgery occurred in 10/91 (10.9%) of the LRC group: 4 cases for peritoneal adhesions, 2 cases per intraoperative bleeding and 2 cases for anesthesiologic related difficulties. In no case we performed conversion to open surgery due to difficulties during ileocolic anastomosis.

Postoperative complications were higher in the laparoscopic group with 14 cases (15.38%) in the LRC and 9 (12.85%) in the ORC.

The main postoperative complication in both patient populations was anastomotic leakage (AL). Anastomotic fistula occurred in 15 patients (9.3%), of which 10/15 (66.6%) occurred in LRC and 5/15 (33.3%) occurred in ORC. Only one patient had AL after conversion to open surgery and needed reintervention (major AL). We reported 2 cases of bowel obstruction in the LRC group, both needing surgical therapy (adhesiolisis).

Stratifying the populations for the method of anastomosis (Table IV), of the 10 AL of the LRC group, 6 fistulas (10%) were in extracorporeal anastomosis, of which 5 (13.8%) were manual and 1 (4.2%) mechanical, while 4 AL occurred in the intracorporeal anastomosis subgroup (12.9%).

In the ORC group we had 5 (7.1%) fistulas: 3 (5.7%) were performed manually and 2 (11.1%) mechanically. Major fistulae occurred in 7 of the LRC group, of which 3 in the intracorporeal and 4 in the extracorporeal subgroup.

The cases of Major Fistulae in the ORC were 4. Of all the extracorporeal mechanical anastomosis (both extracorporeal laparoscopic mechanical and open mechanical anastomoses), 100% of the AL needed surgical intervention.

TABLE III - *Operative and Postoperative variables*

TYPE (N)		OPEN (70)	LAP (91) Total	Intra (31)	Extra (60)
Laparotomic Conversion		0 (0%)	10 (10.9%)	-	10 (10.9%)
	Adhesions		5 (5.5%)		
	Bleeding		2 (2.2%)		
	Difficulty		2 (2.2%)		
	Anesthesiology		1 (1.1%)		
Anastomosis					
	Mechanical	18 (25.7%)	55 (60.4%)	31 (100%)	24 (40%)
	Hand Sewn	52 (74.3%)	36 (39.6%)	0	36 (60%)
No. of Lymph Nodes (Mean)		16.5	17.16		
Other Procedures		16 (22.8%)	6 (6.6%)		
	Cholecystectomy	1 (1.4%)	1 (1.1%)		
	Hepatic Resection	3 (4.3%)	0 (0%)		
	Hernia Repair	7 (10%)	1 (1.1%)		
	Multiple Colic Resection	2 (2.8%)	0 (0%)		
	Other	4 (5.7%)	4 (4.4%)		
Postop. Complications (%)		9 (12.85%)	14 (15.38%)	5 (16.1%)	9 (15%)
	Anastomotic leakage	5 (7.1%)	10 (11%)	4 (12.9%)	6 (10%)
	Intestinal Obstruction	–	2 (2.1%)	1 (3.22%)	1 (1.6%)
	Hemorrhage	1 (1.42%)	0	–	–
	Others	3 (4.28%)	2 (2.1%)	–	2 (3.3%)

TABLE IV - *Anastomotic Leakage in detail*

Variables			Total AL (15)	Major AL* (11)	Minor AL* (4)	No AL (151)
Laparoscopic Approach (91)						
	Extracorporeal (60)		6 (10%)			54 (90%)
		Mechanical (24)	1 (4.2%)	1 (4.2%)	-	23 (95.8%)
		Handsewn (36)	5 (13.8%)	3 (8.3%)	2 (5.5%)	31 (86.1%)
	Intracorporeal					
		Mechanical (31)	4 (12.9%)	3 (9.6%)	1 (3.2%)	27 (87.1%)
Open Approach (60)						
		Mechanical (18)	2 (11.1%)	2 (11.1%)	-	16 (88.9%)
		Handsewn (52)	3 (5.7%)	2 (3.8%)	1 (1.9%)	49 (92.3%)

*We considered Major AL the anastomotic leakage that needed reintervention. All Minor AL were treated conservatively with percutaneous drainage

Discussion

In this retrospective single center study, we aimed to determine which surgical approach for right sided colon cancer leads to fewer findings of anastomotic leakage.
We observed patients affected by right colonic adenocarcinoma that were submitted to open right hemicolectomy or laparoscopic right hemicolectomy with extracorporeal anastomosis or intracorporeal anastomosis. In both approaches, we differentiated the anastomosis technique in manual (hand-sewn) and mechanical. In the laparoscopic group, all intracorporeal anastomoses were performed mechanically with an automatic suture device. Anastomotic leakage is one of the most severe complications in patients submitted to colic resection [5,7,8]. Many factors contribute to an increased risk of anastomotic leakage, such as age, vascular disease, smoking habit, diabetes, nutritional status and pulmonary diseases [9-11]. Based on patient's characteristics, the treatment of anastomotic leakage can be different, varying from an observational approach, a conservative approach including feast, antibiotics and proper site drainage, and reintervention with re-resection of the anastomotic complex and re-anastomosis [8].
The population of the study showed to be demographically homogeneous regarding age, BMI, tumor location and tumor staging. The main factor leading to an open approach was a history of past abdominal surgery and tumors staged T4b with duodenal and ureteral infiltration.
Similar studies recently tried to determine which technique is preferable for ileocolic anastomosis. The rate of

leakage after ileocolic anastomosis varies in the literature, as studied by a metanalysis by Hajibandeh et al [12], reporting a rate of 5.5% in the ICA and 4% in the ECA group, but also referring to similar studies reporting an even lowest rate of leaks. Strong evidence suggests that stapled anastomosis is safer than hand-sewn, leading to a faster recovery and reduced anastomotic leaks [13,14]. A recent study from Malerba et al compared the cost effectiveness of both ICA and ECA anastomoses, showing that although the intracorporeal anastomosis requires a higher expense for surgical instruments and the prolonged surgical time, the overall cost between the 2 techniques is similar when considering the longer recovery needed in ECA [15]. An updated Chochrane review (2011) analyzed a pool of 825 cancer patients from 1970 to 2010 patients showing that stapled anastomosis led to fewer leaks [16]. A recent study by Allaix et al [17] compared operative results in 140 patients with right colon neoplasm randomized to receive either ICA vs ECA stapled anastomosis. Based on their results, ICA led to a better postoperative stay with faster recovery but showed an increased rate of AL in the ICA group (8.6% IC vs 2.9% EC), even if not statistically significant.

According to the study by Allaix et. Al, our study showed an increased rate of anastomotic fistulae in the laparoscopic intracorporeal group.

We observed a higher rate of leaks (12.9%) compared to other studies [12] in literature. This could be addressed to the complexity of the surgical act when performed by surgeons with different levels of training in laparoscopic surgery. Indeed, laparoscopic right hemicolectomy with intracorporeal anastomosis is considered one of the most difficult surgical procedures, due to the necessity to have a high surgical skill in laparoscopic sutures to perform enterotomy closure [18].

In the laparoscopic extracorporeal anastomosis group, although the overall rate of AL was less than in the intracorporeal group, when the anastomosis was performed manually the leakage was even more frequent than when performed intracorporeally (13.5% manual extracorporeal vs 12.9% intracorporeal).

Differently from the laparoscopic procedures, we observed that AL was less frequent in the ORC when the anastomosis was performed manually (5.7% vs 11.1%). Indeed, we observed a significant difference in anastomotic success rate between extracorporeal hand-sewn anastomosis whether performed during a laparoscopic (13.5%) or open (5.7%) procedure.

This could be addressed to the longer time needed to perform an handsewn anastomosis during laparoscopic surgery through a minilaparotomy, causing a longer time of mesenteric traction and manipulation of the bowels. A recent metanalysis by Aiolfi et al (2020) confronting intracorporeal and extracorporeal laparoscopic right colectomy showed an increased rate of postoperative complications after extracorporeal bowel manipulation but didn't show a significantly different rate of AL [19]. Another recent study (2022) from Provenzano et al compared perioperative outcomes between ECA and ICA anastomoses, showing a significant association between ECA and increased hospital stay, delayed bower recovery and increased complications, but without showing the rates of AL between the techniques [20]. In our opinion, mesenteric traction during extracorporeal anastomosis could lead to a prolonged ileus and reduced vascularity of the exposed bowel, leading to anastomosis distention that could cause leakage [21].

Although, when considering the incidence of AL differentiating them in minor and major AL based on the treatment required, we observed that all the failed mechanical extracorporeal anastomosis, independently of the laparoscopic or open approach, needed re-intervention.

Based on our findings, in terms of rate of AL in laparoscopic right colectomy the extracorporeal mechanical anastomosis reported better results than intracorporeal laparoscopic anastomosis, even if when the leak occurred, it appeared to be more severe.

Anyhow, in our opinion, a complete learning curve for intracorporeal laparoscopic suture could guarantee safe and successful results. Indeed, this technique can avoid mesoileocolic traction, especially in obese patients and reduce the extra abdominal bowel exposition [22]. Both of those two factors are a key to the success of the anastomosis vascularization and functionality.

In the laparotomic right colectomy, instead, hand-sewn anastomosis led to fewer anastomotic fistulae when compared to the mechanical method.

The limitations to our study are linked to the small number of patients enrolled and the heterogeneity in the skill and learning curve of the surgeons. Indeed, studying the results from a larger pool of patients undergoing surgery for right colonic cancer practiced by a single surgeon or a surgical equipe of similarly trained surgeons could result in a precise outcome analysis without biases.

Conclusions

In our experience, in the surgical treatment of right colonic cancer, the lowest rate of anastomotic leakage was observed in the laparoscopic group with extracorporeal mechanical anastomosis. In terms of major and minor fistulae, worse results needing surgical intervention occurred in the extracorporeal mechanical groups, while a higher number of hand-sewn extracorporeal laparoscopic anastomosis were able to be treated conservatively. Of the laparotomic group, we observed better results when the anastomosis was performed manually. A higher number of patients is needed to increase statistical results. A more homogeneous surgical skill level could reduce bias of the results.

Riassunto

Negli ultimi anni, il ruolo dell'approccio laparoscopico nel trattamento chirurgico del cancro del colon destro è aumentato. I risultati che confrontano le diverse tecniche di anastomosi ileocolica sono controversi, con studi che riportano solo alcuni vantaggi della tecnica laparoscopica intracorporea. Lo scopo di questo studio è quello di confrontare i risultati tra emicolectomia destra laparoscopica ed emicolectomia "open" per il cancro del colon destro, concentrandosi sulle tecniche anastomotiche (intracorporee vs extracorporee nella procedura laparoscopica e manuale vs meccanica nella procedura laparotomica).

Questo è uno studio retrospettivo svolto nel nostro centro di chirurgia Generale ed Oncologica presso l'ospedale "San Filippo Neri" che ha arruolato pazienti affetti da neoplasia del colon destro nel periodo di tempo da gennaio 2016 a dicembre 2020. Lo scopo dello studio primario era di valutare la frequenza di fistola anastomotica (AL) nelle varie metodiche di confezionamento eseguite dai nostri chirurghi e confrontarle.

Sono stati arruolati un totale di 161 pazienti sottoposti a emicolectomia destra, di questi 91 sono stati eseguiti con tecnica laparoscopica e 70 con tecnica a cielo aperto. Complessivamente, AL si è verificato in 15 pazienti (9.3%). Dei 10 casi di AL nel gruppo laparoscopico (11%), abbiamo osservato 4 casi di AL nel gruppo intracorporeo (12.9%) e 6 nel gruppo delle anastomosi extracorporee (10%) rispettivamente. Nel gruppo laparotomico, 5 pazienti (7%) hanno sviluppato AL, di cui 3 (5.7%) confezionate in maniera manuale e 2 (11.1%) meccanicamente.

Sulla base dei risultati ottenuti nel nostro centro, l'emicolectomia laparoscopica ha una maggiore incidenza di perdite anastomotiche. Nel gruppo laparoscopico, nello specifico, abbiamo osservato una frequenza di AL più bassa quando l'anastomosi era confezionata in maniera meccanica extracorporea. Quando invece l'anastomosi era eseguita in extracorporea con tecnica "open", l'anastomosi confezionata manualmente ha mostrato risultati migliori rispetto a quella meccanica in termini di comparsa di AL.

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