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Original Article

Antecolic vs retrocolic gastrojejunostomy after laparoscopic gastrectomy for cancer. A multicenter propensity matched analysis

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ABSTRACT

Background: Intracorporeal Roux-en-Y reconstruction has been shown to be the most effective reconstruction method after minimally invasive distal gastrectomy. The aim of this study is to compare postoperative complications and early outcomes after antecolic and retrocolic gastro-jejunal anastomoses reconstructions.

Methods: A multicentric retrospective cohort study was designed to compare only laparoscopic Roux-en-Y procedures with intracorporeal antecolic and retrocolic reconstruction of gastro-jejunal anastomoses performed on posterior wall of the stomach from January 2009 to December 2019. After performing propensity score matching analysis (PSM), data from 258 patients were analysed. Intraoperative data included fashion of gastro-jejunal anastomosis; length and type of cartridge used; total operative time. To evaluate safety and efficacy of anastomoses, early postoperative complications and recovery outcomes were examined.

Results: Operative time was statistically significant lower for the antecolic group (192,88 ± 42,60 min vs. 227,09 ± 81,26 min; $p < 0{,}001$). No differences between the two groups were identified in the incidence of postoperative complications neither in recovery outcomes.

Conclusions: Both antecolic and retrocolic techniques are reliable and effective to perform, since the route of the alimentary limb does not affect the incidence of postoperative complications and gastric

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emptying function. Considering its safety and efficacy and the shorter operative time, the antecolic approach with a large stapled anastomosis could be recommended.

1. Introduction

In the last few years laparoscopic gastrectomy has been widely applied in treatment of gastric cancer.[1] Compared to open procedures, laparoscopic gastrectomy (LG) offers better short-term postoperative outcomes[2,3] and similar overall and cancer-specific survival rates[4–7] for both early and advanced gastric cancer.

Laparoscopic gastrectomy (LG) has shown several advantages compared with conventional open gastrectomy and it is now considered safe and effective for the treatment of gastric cancer.[8]

According to current literature, intracorporeal anastomosis after minimally invasive gastrectomy is considered safe and feasible.[9]

Despite technical complexity, the Roux-en-Y reconstruction has been shown to be the most effective reconstruction method after distal gastrectomy[10–12] and it can be performed via either an antecolic or a retrocolic route.

The aim of this study is to compare postoperative outcomes and complications after antecolic and retrocolic gastro-jejunal anastomoses among patients with Roux-en-Y reconstruction.

2. Patients and methods

2.1. Study design and population

Utilizing prospectively maintained gastric cancer databases, all consecutive patients from January 2009 to December 2019 who underwent curative minimally invasive surgical resection for gastric cancer at thirteen high-volume institutions for gastric surgery were identified.

Tumour staging and classification were performed using thoracoabdominal CT scan and according to the American Joint Committee on Cancer (AJCC 8th edition).[13]

Patients with contraindications for minimally invasive surgery as severe systemic disease or inability to sustain pneumoperitoneum were treated by open approach. All the other patients were considered eligible for minimally invasive surgery.

A total of 579 patients underwent partial gastrectomy by laparoscopic or robotic approach performed according to standardized criteria of distal gastrectomy and D2 lymphadenectomy for gastric cancer. [10,11]

After excluding emergency surgery and robotic procedures, 497 patients were analysed. To minimize the bias related to different surgical techniques, patients with Billroth II reconstruction were excluded from this multicentric study.

The left sample of 463 patients who underwent laparoscopic partial gastrectomy with totally intracorporeal anastomoses and Roux-en-Y reconstruction comprised 30 patients with gastro-jejunal anastomosis performed on the anterior wall of the stomach and 433 patients with gastro-jejunal anastomosis performed on the posterior wall of the stomach.

After excluding gastro-jejunal anastomoses performed on the anterior wall of the stomach, 131 antecolic and 302 retrocolic gastro-jejunal anastomoses were examined.

Data were collected on specific data sheets and stored in a prospectively maintained database using Microsoft Excel software.

Written informed consent was obtained by all patients.

The Institutional Review Board approval was obtained before review of any patient material. This article was written according to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines for reporting observational studies.[14]

In details, a cohort study was designed to compare only procedures with intracorporeal antecolic and retrocolic reconstruction of gastro-jejunal anastomoses performed on posterior wall of the stomach.

The two groups were compared in terms of demographic and clinicopathological characteristics, surgical procedures, postoperative complications and recovery outcomes.

Patients' characteristics included were age, gender, Body Mass Index (BMI), American Society of Anaesthesiologists risk class (ASA score), tumour staging according to AJCC.

A propensity score matching analysis (PSM) was needed to reduce confounding bias in comparing outcomes between interventions.[15–17] The covariates supposed to be determinants of selection bias included in the logistic regression were age, BMI, AJCC tumour staging, history of previous abdominal surgery. Surgical aspects were not included in PSM because this multicentric study aimed to compare two different surgical techniques.

Ultimately, data from 258 patients were analysed as showed in Fig. 1.

2.2. Operative technique

All patients undergoing surgery with intended anastomosis went on fasting the day before surgery. Urinary catheter and nasogastric tube were placed before surgery. Standard perioperative antibiotic prophylaxis was administered intravenously before incision.

All surgeons involved in this study had extensive practice in laparoscopic gastric surgery.

The intervention was performed according to the standard steps of laparoscopic distal gastrectomy with D2 lymphadenectomy[18,19] and intracorporeal anastomosis followed by Roux-en-Y reconstruction.

The ascending route of the alimentary limb was brought up to the remnant gastric pouch in two ways: anterior or posterior to the transverse colon.

If a retrocolic technique was used, the Roux limb was passed through a window in the transverse mesocolon into the lesser sac, and mesenteric defects were closed. In cases of antecolic technique, the Roux limb was passed through a small opening created in the omentum.

2.3. Intraoperative data and postoperative outcomes

Intraoperative data included the characteristics of surgical procedures such as fashion of gastro-jejunal anastomosis, length and type of cartridge used and total operative time.

The outcome used to evaluate safety and efficacy of anastomoses was the occurrence of early postoperative complications including nausea or vomiting, pain, delayed gastric emptying,

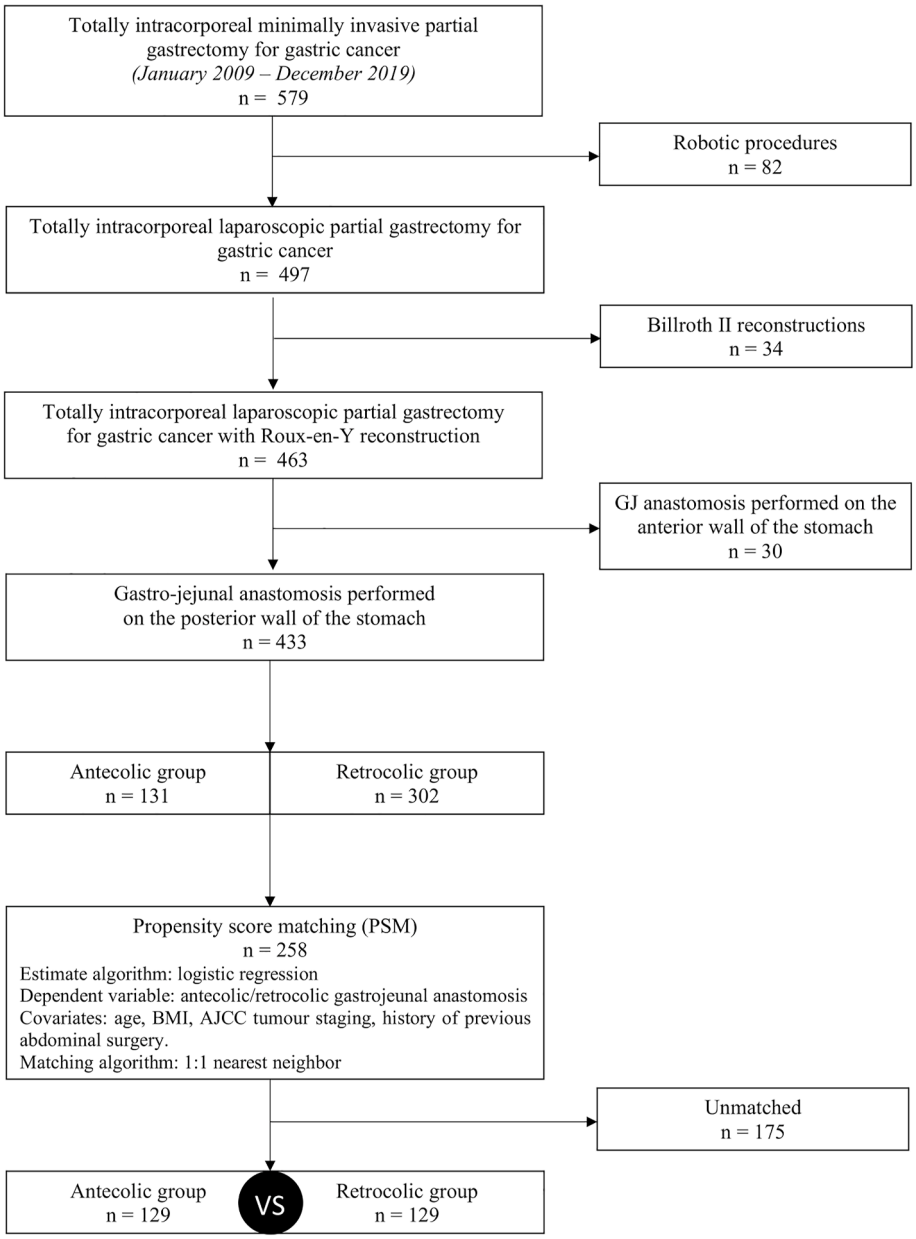

Fig. 1. Flow chart of patients' selection.

wound infection, bleeding from gastro-jejunal anastomosis, extraluminal bleeding, stenosis of anastomosis, leakage from anastomosis within 30 days after surgery.

Delayed gastric emptying was defined as the requirement or re-insertion of a nasogastric tube (NGT) after POD 3 or failure to start oral diet by POD 7. Any endoluminal or extraluminal bleeding was considered if blood transfusion or surgical revision was required. Anastomotic stenosis was defined clinically, endoscopically or radiologically as a passage disturbance of the anastomotic site. The term anastomotic leakage defines all conditions of clinical or radiological anastomotic dehiscence needing radiological drainage or surgical revision.

Need of Intensive Care Unit (ICU) recovery and death were also reported.

Clavien-Dindo classification was used to categorize early postoperative complications.[20]

Recovery outcomes including first flatus, tolerance to liquid and solid diet and length of hospital stay were also analysed.

2.4. Statistical analysis

All statistical analyses were performed using the IBM SPSS® Statistics 26 system (SPSS Inc., Chicago, IL, USA). Continuous variables were tested for normality of distribution and expressed as a mean ± standard deviation (SD) or medians and ranges and compared between groups using the *t*-test or Mann–Whitney *U* test as appropriate.

Categorical variables were expressed as percentages and compared between groups using the Pearson $\chi 2$ test or Fisher's exact test as appropriate.

All results were presented as two-tailed values with statistical significance set at p values < 0,05. Propensity score matching analysis (PSM) was obtained by a logistic regression model including the type of anastomosis (antecolic/retrocolic) as the

dependent variable. Covariates chosen for the logistic regression were age, BMI, AJCC tumour staging, history of previous abdominal surgery. Matching of the propensity score was obtained with the "1:1 nearest neighbor" matching method.

3. Results

3.1. Prematching study population

We retrospectively analysed data from 433 patients with diagnosis of gastric cancer who underwent totally intracorporeal laparoscopic partial gastrectomy followed by Roux-en-Y reconstruction.

Gastro-jejunal anastomoses were performed on the posterior wall of the stomach according to the clinical advice of each surgeon, so we examined 131 antecolic and 302 retrocolic gastro-jejunal anastomoses.

Baseline characteristics of the two groups are described in Table 1. There were no statistically significant differences in terms of gender, age, BMI, ASA score and history of previous abdominal surgery. Otherwise, more patients of the retrocolic group had, according to AJCC, a stage III or IV cancer. Furthermore, there was a statistically significant difference regarding operative time which resulted to be lower for the antecolic group (192,34 ± 42,53 min vs. 230,14 ± 89,27 min; $p < 0{,}001$).

3.2. Postmatching study population

After propensity score analysis the study population was composed of 258 patients: 129 for each group. There were no statistically significant differences between the groups with regard to demographic and pathological characteristics of patients as described in Table 2.

3.3. Postmatching results

Operative time was statistically significant lower for the antecolic group (192,88 ± 42,60 min vs. 227,09 ± 81,26 min; $p < 0{,}001$).

Analysing postoperative complications, as shown in Table 3, no differences were found in the incidence of nausea and vomiting ($p = 0{,}866$), pain ($p = 0{,}117$), delayed gastric emptying ($p = 0{,}189$), wound infections ($p = 0{,}108$), bleeding from gastro-jejunal anastomosis ($p = 0{,}769$), extraluminal bleeding ($p = 1000$), stenosis of gastro-jejunal anastomosis ($p = 1000$) and leakage from gastro-jejunostomy ($p = 1000$).

Additionally, ten patients (7,8 %) for each group needed an ICU recovery and only three deaths were reported, one (0,8 %) for the antecolic group and two (1,6 %) for the retrocolic.

Characteristics of surgical procedures analysed included length and type of cartridge used.

A total of 246 gastrojejunal anastomoses were performed with a 60 mm stapler (121 for the antecolic and 125 for the retrocolic group), while the other 12 were performed with a 45 mm stapler (8 in the antecolic and 4 in the retrocolic group).

Early postoperative outcomes after surgery are described in Table 4. No differences were identified between the two groups in time to first flatus, oral fluid and solid intake and length of hospital stay.

4. Discussion

Gastrectomy with extensive lymphadenectomy is considered the gold standard in the treatment of gastric cancer.[21]

Thanks to the rapid development of techniques, minimally invasive surgery (MIS) has worldwide spread in the treatment of gastric cancer (GC). Laparoscopic gastrectomy (LG) has shown several advantages compared with conventional open gastrectomy and it is now considered safe and effective for the treatment of gastric cancer.[8,9]

Despite technical difficulties, intracorporeal anastomosis has been shown to be the most effective approach after distal gastrectomy and the Roux-en-Y reconstruction could be considered the most validated reconstructive method.[10–12,22–25]

A gastrojejunostomy in Roux-en-Y reconstruction can be performed through either the retrocolic or the antecolic route. Retrocolic reconstruction could be difficult to perform in minimally invasive surgery thus, on a clinical point of view, the antecolic route of reconstruction is the procedure of choice in most cases.[26]

On the other hand, retrocolic reconstructive route may be considered closer to anatomical structure and so with potential advantages on gastric emptying. Some patients, including obese patients, with short mesenterium in the proximal jejunum might benefit of a shorter route to reach the gastric remnant, thus the posterior route (transmesocolic).

According to current literature, only one study[27] previously compared antecolic and retrocolic Billroth II reconstructions after distal gastrectomy for gastric cancer analysing postoperative complications and oncological outcomes. Retrocolic Billroth II anastomosis were preferable to antecolic Billroth II reconstructions as there was lower risk of late gastric outlet obstruction and a greater 5-years survival rate among patients having the former procedure.

Limitation of this study is that data come from a too old series to be actual in the new technological era. Additionally functional recovery after a loop anastomosis (BII) was quite different from a roux-en-Y.

Route to perform gastrojejunostomy after distal gastrectomy has been studied also in bariatric surgery with different results.

Table 1
Prematching baseline characteristics.

Characteristics	Antecolic (n = 131)	Retrocolic (n = 302)	*p* value
Male (n, %)	73 (55,7 %)	164 (54,3 %)	0,834
Age (mean ± SD)	67,12 ± 12,31	69,32 ± 11,46	0,074
BMI (mean ± SD)	24,55 ± 3,44	24,41 ± 3,73	0,705
ASA score (mean ± SD)	2,07 ± 0,75	2,15 ± 0,74	0,301
AJCC stage 0 (n, %)	14 (10,7 %)	55 (18,2 %)	0,009
AJCC stage 1 (n, %)	39 (29,8 %)	75 (24,8 %)	
AJCC stage 2 (n, %)	43 (32,8 %)	60 (19,9 %)	
AJCC stage 3 (n, %)	26 (19,8 %)	80 (26,5 %)	
AJCC stage 4 (n, %)			
Previous Abdominal Surgery (n, %)	9 (6,9 %)	32 (10,6 %)	0,100
Yes	38 (29 %)	114 (37,7 %)	
No	93 (71 %)	188 (62,3 %)	

Table 2
Postmatching baseline characteristics.

Characteristics	Antecolic (n = 129)	Retrocolic (n = 129)	*p* value
Male (n, %)	73 (56,6 %)	72 (55,8 %)	1000
Age (mean ± SD)	67,42 ± 11,99	68,37 ± 11,72	0,519
BMI (mean ± SD)	24,51 ± 3,37	24,70 ± 3,70	0,673
ASA score (mean ± SD)	2,07 ± 0,75	2,18 ± 0,75	0,248
AJCC staging (n, %)			0,630
AJCC stage 0 (n, %)	14 (10,9 %)	15 (11,6 %)	
AJCC stage 1 (n, %)	39 (30,2 %)	45 (34,9 %)	
AJCC stage 2 (n, %)	41 (31,8 %)	42 (32,6 %)	
AJCC stage 3 (n, %)	26 (20,2 %)	23 (17,8 %)	
AJCC stage 4 (n, %)	9 (7 %)	4 (3,1 %)	
Previous Abdominal Surgery (n, %)			0,424
Yes (n, %)	38 (29,5 %)	45 (34,9 %)	
No (n, %)	91 (70,5 %)	84 (65,1 %)	

Table 3
Complications of postmatched antecolic and retrocolic groups according to Clavien-Dindo classification.

Clavien-Dindo	Complications	Antecolic (n = 129)	Retrocolic (n = 129)	*p* value
0	Nausea and vomiting (n, %)	22 (17,1 %)	20 (15,5 %)	0,866
	Pain (n, %)	31 (24,0 %)	20 (15,5 %)	0,117
1	Paralytic ileus (n, %)	15 (11,6 %)	8 (6,2 %)	0,189
	Wound infection (n, %)	11 (8,5 %)	4 (3,1 %)	0,108
	Bleeding from gastro-jejunal anastomosis (n, %)	5 (3,9 %)	7 (5,4 %)	0,769
	Extraluminal bleeding (n, %)	7 (5,4 %)	7 (5,4 %)	1000
	Stenosis of gastro-jejunal anastomosis (n, %)	3 (2,3 %)	4 (3,1 %)	1000
	Leakage of gastro-jejunal anastomosis (n, %)	6 (4,7 %)	5 (3,9 %)	1000
4	ICU recovery (n, %)	10 (7,8 %)	10 (7,8 %)	1000
5	Death (n, %)	1 (0,8 %)	2 (1,6 %)	1000

Table 4
Postoperative outcomes of postmatched antecolic and retrocolic groups.

Postoperative outcomes	Antecolic (n = 129)	Retrocolic (n = 129)	*p* value
First flatus (hours, mean ± SD)	76,65 ± 37,60	75,16 ± 40,62	0,760
Oral fluid intake (hours, mean ± SD)	93,21 ± 41,93	97,86 ± 51,23	0,426
Oral solid intake (hours, mean ± SD)	126,09 ± 52,60	124,85 ± 58,67	0,858
Length of hospital stay (days, mean ± SD)	10,09 ± 10,09	10,50 ± 6,10	0,693

Retrocolic jejunal limb placement after laparoscopic gastric bypass for morbid obesity has been shown to be associated to higher incidence of bowel obstruction.[28–39]

One additional reason could be, as reported, that, whereas the retrocolic technique creates three mesenteric defects, the antecolic positioning of the Roux limb produces only two (Petersen's defect and the jejunojejunostomy), eliminating one of the most common sites of obstruction: the mesocolonic window.

Thus, we decided to draw up a multicentric retrospective study to compare postoperative complications and early outcomes of patients with gastric cancer who underwent laparoscopic partial gastrectomy followed by antecolic or retrocolic reconstruction of gastro-jejunal anastomoses performed on posterior wall of the stomach.

Propensity Score Matching analysis was needed to overcome the selection bias related to the retrospective nature of the study allowing better matching between the two treatment groups.

According to our results, one of the major findings is the reduction of operative time for the antecolic reconstruction which seems to confirm the antecolic approach as the most simple and reproducible way after minimally invasive gastrectomy for gastric cancer.

At the same time, we have demonstrated that the route of the alimentary limb does not affect the incidence of postoperative complications and gastric emptying function.

Particularly regarding gastric emptying functions, 22 (17,1 %) patients in the antecolic group and 20 (15,5 %) patients in the retrocolic group experienced nausea and/or vomiting ($p = 0,866$) while delayed gastric emptying occurred in 15 (11,6 %) patients of the antecolic group and 8 (6,2 %) patients of the retrocolic group ($p = 0,189$)

As it concerns overall complications, 7 (5,4 %) extraluminal bleedings were recorded both in the antecolic and retrocolic groups ($p = 1000$); 10 patients (7,8 %) needed for ICU recovery in both groups ($p = 1000$) and only 1 (0,8 %) patient died in the antecolic group versus 2 (1,6 %) patients in the retrocolic group ($p = 1000$).

In line with the aforementioned results and with current literature,[38,40] we can state that laparoscopic distal gastrectomy followed by intracorporeal Roux-en-Y reconstruction can be safely performed for the treatment of gastric cancer.

Both antecolic and retrocolic techniques are reliable and effective to perform, since the route of the alimentary limb does not affect the incidence of gastro-jejunostomy related complications.

In fact, 5 (3,9 %) bleedings from gastro-jejunal anastomosis were recorded in the antecolic group and 7 (5,4 %) in the retrocolic group ($p = 0,769$); only 3 (2,3 %) patients of the antecolic group and 4 (3,1 %) patients of the retrocolic group had anastomotic stenosis ($p = 1000$); ultimately 6 (4,7 %) and 5 (3,9 %) anastomotic

leakages were respectively recorded in the two groups ($p = 1000$).

Considering its safety and efficacy and the shorter operative time, the antecolic approach with a large stapled anastomosis could be recommended, following the current surgical trend. Although, it should be emphasized that retrocolic route is indicated in some situation, such as short mesenteric root.

Limitations of this study lie in its retrospective nature and subsequently the bias related to patients' selection which cannot be completely eliminated by the Propensity Score Matching. Further prospective randomized studies are needed to confirm our results.

Disclosures

Marco Milone, Sara Vertaldi, Michele Manigrasso, Anna D'Amore, Marie Sophie Alfano, Antonino Agrusa, Gabriele Anania, Gian Luca Baiocchi, Pietro Paolo Bianchi, Alberto Biondi, Umberto Bracale, Salvatore Buscemi, Matteo Chiozza, Francesco Corcione, Domenico D'Ugo, Maurizio Degiuli, Giuseppe De Simone, Ugo Elmore, Federica Galli, Giuseppe Giuliani, Carmine Iacovazzo, Pietro Maida, Francesco Maione, Alessia Chini, Giampaolo Marte, Stefano Olmi, Stefano Rausei, Rossella Reddavid, Riccardo Rosati, Giuseppe Servillo, Matteo Uccelli, Giovanni Domenico De Palma, Elisa Cassinotti, Luigi Boni have no conflict of interest or financial ties to disclose.

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