Techniques in Coloproctology (2020) 24:41–48
https://doi.org/10.1007/s10151-019-02126-3

ORIGINAL ARTICLE

Laparoscopic segmental left colectomy for splenic flexure carcinoma: a single institution experience

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Received: 27 January 2019 / Accepted: 21 November 2019 / Published online: 13 December 2019

Abstract

Background There is ongoing debate regarding surgical treatment of splenic flexure cancer. The main points of controversy include the appropriate extent of colon resection, either to the right or to the left, and the appropriate extent of lymph-node dissection. The aim of this study was to review our experience in laparoscopic treatment of splenic flexure cancer cases and to compare our data to the recent literature.

Methods Consecutive patients, operated on for splenic flexure colon carcinoma at a single institution between April 2005 and January 2013, were included in the study. Exclusion criteria were a previous history of colorectal cancer, recurrent colonic cancer, emergency cases with an obstructive tumor or a perforated tumor with peritonitis, synchronous cancer, palliative surgery, and a past history of colorectal resection. Patients underwent laparoscopic segmental left colectomy with ligation of the left branch of the middle colic and of the left colic artery. Patient characteristics, operative and postoperative outcomes, and long-term technical, functional, and oncological results from a prospectively maintained database were retrospectively analyzed. After hospital discharge, standardized follow-up was performed at 1 month postoperatively, then every 3 months during the first 2 years, and every 6 months thereafter, for a total of 5 years.

Results A total of 28 consecutive patients (16 males) with a median age of 71.8 years (range 42.5–88.8 years) were included. Ninety-day mortality was 3.5% and surgical morbidity was 21.5% with anastomotic leak rate of 10.7%. All survivors experienced good or very good functional results. During a median follow-up period of 50.9 months, eight patients (28.5%) presented with a recurrence. The 5-year overall and disease-free survival rates were 46.3% and 39.2%, respectively.

Conclusions Segmental left colectomy for splenic flexure carcinoma is associated with reasonably low morbidity and very good functional results. However, survival rates are low.

Keywords Splenic flexure colon cancer · Laparoscopy · Subtotal colectomy · Segmental left colectomy · Morbidity · Oncologic results

Introduction

Splenic flexure cancer is a rare condition, representing approximately 2–8% of all colorectal cancers [1–3]. It is associated with a high risk of colonic obstruction and poor prognosis [4, 5]. There is ongoing debate regarding the surgical treatment of splenic flexure cancer. The main points of controversy include the appropriate extent of colon resection, either to the right or to the left, and the appropriate extent of lymph-node dissection. The three main procedures available are segmental splenic flexure colectomy, extended right colectomy, and left hemicolectomy. Each has advantages and drawbacks in terms of lymph-node harvesting, procedural difficulty, emergency management, technical results, and functional outcomes. In a recent systematic review and

Preliminary results presented at the French Meeting of Surgery, Paris, France, from September 19 to September 21, 2018.

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meta-analysis on the surgical treatment of splenic flexure carcinomas that included 12 retrospective studies and 569 patients, Martinez-Perez et al. concluded that the whether the optimal extent of splenic flexure cancer surgical resection is, extended right colectomy, segmental splenic flexure resection, or left hemicolectomy remains under debate [6]. The elective surgical procedure for splenic flexure carcinoma has long been standardized in our institution, which is a 2200-bed tertiary referral center and university hospital serving a predominantly urban population of 675,000 inhabitants in France. All patients presenting with a splenic flexure carcinoma were treated with a segmental colectomy at our institution. The aim of this study was to review our experience in laparoscopic treatment of splenic flexure cancer and to compare our data to the recent literature. The primary endpoint was 90-day mortality and morbidity.

Materials and methods

Patient selection

All consecutive patients who underwent elective colonic resection for splenic flexure adenocarcinoma in our institution between April 2005 and January 2013 were included in the study. A database of all patients was prospectively compiled. Diagnosis was made with colonoscopy and biopsies in all patients. Cancer staging was based on computed tomography (CT) scans of the chest, abdomen and pelvis, and evaluation of tumor markers, including carcinoembryonic antigen (CEA) and cancer antigen (CA) 19.9. Patients were classified according to the Union for International Cancer Control (UICC) guidelines. The American Society of Anesthesiology (ASA) grading system was used for preanesthesia evaluation.

Surgical technique

No patient received mechanical bowel preparation. Antibiotic prophylaxis (intravenous cefoxitin 2 g) was given at the induction of anesthesia. A urinary catheter was placed at the beginning of the procedure. The patient was placed in the Lloyd–Davies position with the arms along the trunk, the shoulders protected by shoulder pads covered with gel to avoid neurovascular compression, and the lower limbs slightly bent in abduction with specific boots. The first access port (10 mm) for the 0° optical system was placed in the umbilicus with an open technique and pneumoperitoneum was created. Then, three other ports were inserted: 1 (12 mm) in the right iliac fossa for the thermofusion device and the main operative instruments, 1 (5 mm) in the right upper quadrant, and 1 (5 mm) in the left iliac fossa for exposure. An abdominal incision was made according to the site of specimen removal. The precise location of the tumor was confirmed. Any liver, peritoneal, or ovarian metastasis and any invasion of adjacent organs were reported.

The operation started with mobilization of the left colon, beginning with an incision on the right side of the peritoneum, just medial to the inferior mesenteric vein. The left Toldt's fascia was dissected until the left colonic gutter was reached. The inferior mesenteric artery, left colic artery, and inferior mesenteric vein were identified, and the left ureter was located before any division of vessels with the thermofusion device. A 10-cm-wide gauze was systematically introduced at this time to clear the operative field, avoid suction, aid in dissection, and serve as a marker for subsequent steps. The left transverse mesocolon was opened against the inferior border of the pancreas, which was usually easily visualized, and the gauze was passed through the hole thus created. The greater omentum was freed from the transverse colon, except when tumor invasion was suspected; in this case, the left part of the greater omentum was removed en bloc with the splenic flexure. The gauze was seen at this time, confirming that the surgeon was in the right plane. The splenic flexure was detached from its natural adhesions and the peritoneum of the left colonic gutter was sectioned from top to bottom. The inferior mesenteric vein was then divided at the inferior border of the pancreas. The transverse mesocolon was divided from left to right along the inferior pancreatic edge. Using the thermofusion device, the left branch of the middle colic artery was then systematically divided at its origin against the mesentery, and the left colic artery was also divided at its origin, leaving free the root of the inferior mesenteric artery. The colon was extracted through a transverse mini-laparotomy covered by an abdominal wall protection device at the most suitable site in the left upper quadrant and an extracorporeal side-to-side anastomosis was fashioned using a double-stapling technique. The mesocolic window was left wide open.

Study design

All consecutive patients included in the study had splenic flexure adenocarcinoma. According to Steffen et al., splenic flexure cancer was defined as a tumor located in the distal third of the transverse colon, the left colonic angle, or the proximal descending colon within 10 cm of the flexure [1].

Exclusion criteria were a previous history of colorectal cancer, recurrent colonic cancer, emergency cases with an obstructive tumor or a perforated tumor with peritonitis, synchronous cancer, palliative surgery, and a past history of colorectal resection.

For this study, postoperative surveillance included rigorous clinical monitoring every morning and afternoon until discharge. Monitoring included assessment of the usual parameters (pulse, blood pressure, temperature, and pain), food intake, intestinal transit, and general

condition. Laboratory findings included C-reactive protein levels, white blood cell counts, and electrolytes on postoperative days 1 and 3, and then as needed. Any patient with a C-reactive protein level above 140 mg/L underwent an abdominal CT scan to rule out septic complications. After hospital discharge, standardized follow-up was performed at 1 month postoperatively, then every 3 months during the first 2 years, and every 6 months thereafter, for a total of 5 years. This included clinical examination, abdominal ultrasound examination, and CEA and CA 19.9 levels. CT of the chest, abdomen, and pelvis was performed annually for 5 years. Colonoscopy was performed regularly every 3 years throughout life.

The primary endpoint was 90-day mortality and morbidity. Postoperative surgical morbidity was defined as significant morbidity grades III, IV, and V, as recommended by Dindo et al. [7]. Secondary endpoints were functional and oncologic results. To evaluate functional results, we use the mean number of stools per day and urgency (patient unable to wait more than 15 min before using the toilet) and by the presence or absence of de novo or worsening of anal incontinence or constipation at 6 months and the end of follow-up. The patients who have had surgery for colorectal cancer in our department are routinely asked about the number of stools per day, urgency, and anal continence disorders. Oncological results included TNM classification, quality of resection (R0, R1, or R2), and overall and disease-free survival (OS and DFS, respectively). Patients who had positive lymph nodes and/or developed metastasis were discussed at a specific multidisciplinary meeting and received chemotherapy, usually leucovorin calcium (folinic acid), fluorouracil, and oxaliplatin (FOLFOX).

The study was conducted in accordance with the principles of the Declaration of Helsinki. Based on recommendations for the steps and means to be used for evaluation and reporting of techniques in surgery published by an international panel of methodologists and surgeons, this was a phase 1 study of splenic flexure colonic resection for consecutive patients [8]. Therefore, submission to a Committee for the Protection of Individuals was not necessary.

Statistical analysis

Quantitative variables were presented with median and extreme values, or mean and standard deviation. Qualitative variables were presented using counts and percentages. OS and DFS were calculated using the Kaplan–Meier method.

Results

Population characteristics

Between April 2005 and January 2013, 28 patients (16 males) with a median age of 71.8 years (range 42.5–88.8 years) underwent elective colonic resection for splenic flexure adenocarcinoma in our institution. Patient characteristics and intraoperative data are summarized in Table 1.

The median body mass index (BMI) was 23.6 kg/m^2 (range 16.4–37.5 kg/m^2). The ASA score was 1 in 13 patients, 2 in 5, 3 in 9, and 4 in 1. The median length of hospital stay was 11 days (range 4–61 days). The median duration of follow-up was 50.9 months (range 7–138 months). All patients underwent laparoscopic segmental splenic flexure resection as explained above. A 46-year-old patient who had a perforated tumor and metastatic disease did not undergo anastomosis after resection.

Conversion to an open procedure was required in two cases, due to splenic tears with difficulty controlling bleeding. No splenectomy was performed. During the same period, no patient underwent extended right colectomy or true left hemicolectomy in an elective setting.

Mortality and morbidity

The 90-day postoperative mortality rate was 3.5%: the death of the above-mentioned 46-year-old patient died of respiratory failure from pulmonary embolism on day 61. This patient was preoperatively classified as ASA 4 and had an unfavorable tumor prognosis (pT4a N1b M1 R0). The death was not related to surgical complication.

The 90-day morbidity rate was 32.1% and included nine patients who developed ≥ 1 surgical and/or medical complications (Table 2). Six patients (21.4%) including the patient who died, developed a Dindo Clavien grade III, IV or V surgical complication within the first 90 days. Three patients (10.7%) developed an anastomotic leak that was treated surgically in two cases (one stoma and one lavage drainage) and conservatively with radiological drainage under general anesthesia in the third one. A fourth patient presented with an evisceration that necessitated emergent reoperation for repair. The fifth patient presented with a pleural effusion that was radiologically drained under local anesthesia. Seven patients had one or more medical complications (Table 2). A 82-year-old woman preoperatively classified as ASA 3 died from jejunal recurrence on day 126. She had an unfavorable prognosis, a 12-cm-wide tumor, pT4b N1b M0 R0, with invasion of the jejunum, that was resected *en bloc*.

Table 1 Population characteristics and intraoperative data (28 patients)

Data	Value	Range
Age at surgery in years, mean (median)	70.7 (71.8)	42.5–88.8
Sex ratio (male–female): *n*	16–12	
BMI (kg/m^2): mean (median)	24.1 (23.6)	16.4–37.5
ASA class [1, 2]: *n*	13–5–9–1	
Previous laparotomy: *n* (%)	7 (25)	
ACE level		
< 5 µg/L: *n*	17	
> 5 µg/L: *n*	6	
Laparoscopy: *n*	28	
Conversion to laparotomy[a]: *n*	2	
Neighboring organ invaded: *n*	13	
Manual anastomosis: *n*	15	
Mechanical anastomosis: *n*	12	
Stoma: *n*	1	
Peroperative complication[a]: *n*	2	
Abdominal drainage: *n*	12	
Duration of the procedure in minutes: mean (median)	158 (150)	64–297
Length of hospital stay in days: mean (median)	16.4 (11)	4–61
Duration of follow-up in months: mean (median)	52.4 (50.9)	7–138

BMI body mass index, *ASA* American society of anesthesiologists, *ACE* angiotensin converting enzyme
[a]See text

Table 2 Mortality and morbidity in 9 out of 28 patients

Data	*N*	%
90-day surgical complication (Clavien–Dindo ≥ 3)[a]	6 patients	21.4
Death	1	3.5
Anastomotic leak (reoperation in 2; drainage in 2)	3	10.7
Pleural effusion	1	3.5
Evisceration	1	3.5
90-day medical complications	7 patients[b]	25
Respiratory failure	3	
Anemia requiring blood transfusion[c]	3	
Confusion	2	
Pneumonia	2	
Pulmonary embolism	1	
Myocardial infarction	1	
Bilateral parotitis	1	
Temporary heart failure	1	

[a]See text
[b]Total over seven patients, because some developed more than one complication
[c]Two patients presented with postoperative gastrointestinal bleeding

Functional results

Of the 26 patients still alive at 6 months, 4 had no functional evaluation, either because data were missing ($n = 1$) or because they had a stoma at the time of evaluation ($n = 3$). The median number of stools per day was 1 (range 1–3 stools). No patient complained of urgency, de novo or worsening anal incontinence, or constipation at 6 months. The functional result was considered very good in 19 patients and good in 3. No patient had a poor result. At the end of follow-up, all survivors had a very satisfactory functional evaluation with a median of 1 stool per day (range 0–3 stools).

Oncological results

Pathological data are summarized in Table 3.

Mean specimen length in this series of splenic flexure segmental colectomy was 23.6 cm (range 7–46 cm). With regard to the length of colonic resection, 5 cm on both sides of the tumor is usually considered adequate to ensure local curative resection. In our series, this length was less than 5 cm in 6 cases (0.5 cm in 1, 3.5 cm in 3, 4 cm in 1, and 4.5 cm in 1).

Assessment of recurrence and survival was performed during a median follow-up of 50.9 months (range 7–138 months; mean 52.4 months). Three patients were lost to follow-up at 60 months. During the follow-up period, 8 (28.5%) presented with recurrence: 1 (3.5%) developed local recurrence, 6 had distant metastasis (21.4%), and 1 (3.5%) had both local and distant recurrence. The OS rate was 46.3% at 5 years (Fig. 1) and the DFS rate was 39.2% at 5 years (Fig. 2). Nineteen

Table 3 Oncologic results in 28 patients

Data	Value (%)	Range
Pathology results		
Largest diameter of tumor (cm)	5.4	1.8–12
Median number of harvested nodes	14	3–32
Median number of positive nodes	1.7	0–13
Surgical distal margin in cm	6.2	0.5–15
Surgical distal margin < 5 cm	6 (21.4)	
Tumor perforation	2 (7.1)	
Blood vessel invasion	15 (53.5)	
Lymphatic vessel invasion	16 (57.1)	
Perineural invasion	6 (21.4)	
Tis	2 (7.1)	
T1	2 (7.1)	
T2	3 (10.7)	
T3	9 (32.1)	
T4a	5 (17.8)	
T4b	7 (25)	
N0	14 (50)	
N1	10 (35)	
N2	4 (14.2)	
Recurrence		
Local or metastatic recurrence	8 (28.5)	
Local recurrence only	1 (3.5)	
Metastatic recurrence only	6 (21.4)	
Local and metastatic recurrence	1 (3.5)	
Mortality at the end of follow-up	19 (67.8)	
Death attributed to cancer	11 (39.3)	
Death attributed to another cause	8 (28.6)	

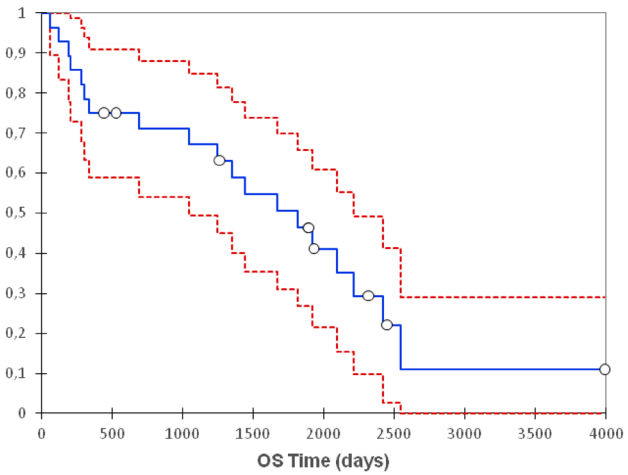

Fig. 1 Kaplan–Meier overall survival curve (continuous blue line). Horizontal axis is time (in days) and vertical axis is survival rate

patients died during follow-up. Death was attributed to the cancer in 11 cases and to another cause in 8.

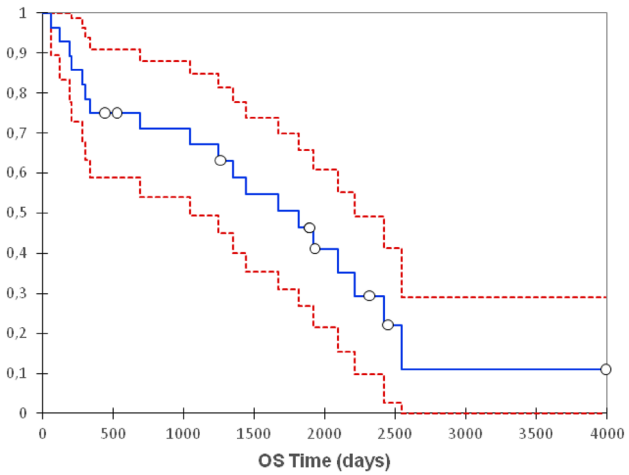

Fig. 2 Kaplan–Meier disease-free survival curve (continuous blue line). Horizontal axis is time (in days) and vertical axis is survival rate

Discussion

Splenic flexure cancer is defined as a tumor located in the distal third of the transverse colon, the left colonic angle, or the proximal descending colon within 10 cm of the flexure [1]. When managing colonic carcinoma cases, five factors should be considered for surgical treatment: the extent of colonic resection, extent of lymph-node dissection, procedural difficulty, functional results, and oncological results.

With regard to the length of colonic resection, 5 cm on both sides of the tumor is usually and internationally considered adequate to ensure local curative resection and avoid intraluminal implantation of cancerous cells leading to anastomotic recurrence [9, 10]. In our series, this length was less than 5 cm in 6 cases and more than 3 cm in 5 cases. Two patients out of 6 who had a distal margin of less than 5 cm presented with a recurrence, vs 6 patients out of 22 who had a distal margin over 5 cm. We cannot draw any conclusions owing to the small number of patients, but at least in our series, it seems that a distal margin < 5 cm did not affect survival. The mean length of colonic resection in this series ranged from 7 to 46 cm, and seems adequate. More extensive resections, such as extended right colectomy and true left hemicolectomy, were not performed in our series. True left hemicolectomy from the mid-transverse colon to the rectum to treat splenic flexure carcinoma has rarely been reported in the literature. To our knowledge, only one randomized trial compared limited segmental colectomy including a few splenic flexure colectomies to left hemicolectomy in 260 patients with left colonic carcinoma [11]. This study showed a significant difference in colonic specimen length, but failed to demonstrate any difference in pathology findings (size of tumor, degree of differentiation, Dukes stage, and extent

of lymph-node invasion) between groups. True left hemicolectomy involves a colorectal anastomosis between the middle part of the transverse colon and the upper part of the rectum; this operation is technically demanding and involves a transmesenteric pull-through or even right colonic inversion following a Deloyers procedure to ensure a safe, low-tension anastomosis [11]. We never chose this strategy in our institution.

The appropriate extent of lymph-node dissection is more controversial. We always chose a strategy of limited splenic flexure resection with ligation of the left branch of the middle colic artery and left colonic artery at their origin, using the thermofusion device. Sadler et al. reported the case of an 83-year-old woman with an obstructive splenic flexure carcinoma, who, on laparotomy, was found to have a positive lymph node along the ileocecal vascular pedicle among a total of eight nodes in an extended right colectomy specimen [12]. However, no other case of lymph-node invasion within the right mesocolon has been reported in extended right colectomy for carcinoma of the splenic flexure [6]. Moreover, Perrakis et al. showed that nearly 20% of patients with splenic flexure carcinoma had extramesocolic lymph-node invasion, with no mention of lymph-node metastasis to the ileocolic artery [13]. Therefore, extended right colectomy without extended peripancreatic and perigastric lymphadenectomy may be inadequate to avoid recurrence. In a study evaluating the distribution of the left branch of the middle colic artery and the left colic artery using CT angiography and colonography in 191 patients, Fukuoka et al. classified the blood supply to the splenic flexure into six types, and concluded that lymph-node dissection should be performed according to the type of blood supply, using ligation of the left branch of the middle colic artery and the left colic artery at their origin [14]. We performed such a lymph-node dissection routinely in our department. However, 12 patients out of 28 (43%) in our series had less than 12 retrieved nodes. Four from these patients had positive lymph nodes and two received adjuvant FOLFOX. These procedures could be considered as oncologically inadequate according to the National Comprehensive Cancer Network (NCCN) and UICC. However, from 12 patients who had less than 12 nodes retrieved, 1 (8.3%) presented with a recurrence: this patient had 9 retrieved nodes 7 of which were positive. Despite FOLFOX regimen, liver and renal metastases developed. Out of 16 patients who had more than 12 nodes harvested, 2 died within 6 months with no evidence of metastasis, leaving 14 patients for oncological analysis: 7 patients (50%) developed metastasis. Again, comparison (8.3% versus 50%) is not valuable, owing to the small number of patients and confounding data.

The most difficult part of all three operations proposed for splenic flexure carcinoma involves takedown of the splenic flexure, which has been described as technically demanding [15] and associated with greater intraoperative blood loss and complications [16, 17]. In our experience, we had to convert laparoscopy into open laparotomy to insure hemostasis of the spleen in two cases. The main difference between procedures is, therefore, the advantage of resecting more length of colon with the splenic flexure. However, extra length was shown to be unnecessary in a retrospective series of left colectomies [18]. As far as the laparoscopic vs open approach, based on a consecutive series of 23 patients with splenic flexure carcinoma, Pisani Ceretti et al. concluded that laparoscopic resection with intracorporeal anastomosis appeared feasible and safe, with no conversion and two major postoperative complications, including one case of acute pancreatitis and one case of postoperative bleeding from the anastomotic suture line [19]. Even with 2 conversions among 28 cases, like, we still consider laparoscopic surgery for splenic flexure cancer to be feasible and safe, compared with open colectomy, as do Nakashima et al. and Okuda et al. [20, 21].

Patients were very satisfied with functional results in this series. In a series of 187 patients, You et al. reported that segmental colectomy obtained significantly better functional results than subtotal colectomy with ileorectal anastomosis, in terms of number of stools per day, and thus, quality of life [22]. For these authors, keeping the ileocecal valve and a long and healthy right and transverse colonic segment favored a better water absorption, resulting in less liquid stools and better transit regulation. However, preserving at least 15 cm of sigmoid colon for the ileosigmoid anastomosis can lead to significant improvement in functional results, compared with keeping a shorter sigmoid segment [23].

Current guidelines for colonic cancer resection advise removal of 5 cm of tissue on both sides of the tumor and at least 12 lymph nodes [24]. Central mesocolic lymph-node metastases might explain why extended mesocolic lymph-node dissection seems to improve oncological outcomes, but the literature does not provide an explanation [24]. The meta-analysis by Martinez-Perez et al. included 12 studies, and compared left colectomies with extended right colectomies to treat splenic flexure cancer, but there was no statistical difference in the number of lymph nodes harvested or rate of R0 resection [6]. Moreover, three recent studies failed to demonstrate a difference in OS and DFS rates between the two procedures. In a retrospective study, Odermatt et al. compared 38 patients who underwent subtotal colectomy with 30 patients who underwent segmental splenic flexure colectomy and showed 5-year OS of 49% vs. 60% (non significant), and 5-year DFS of 41% vs. 54% (non significant), respectively [25]. In a matched case–control study, de'Angelis et al. compared outcomes for laparoscopic extended right colectomy versus laparoscopic left colectomy for splenic flexure carcinoma, and found no statistical difference between short- and

long-term perioperative and postoperative morbidity, and no statistical difference between 5-year cumulative survival rates (72.8% vs. 75.1%, respectively) and 5-year DFS rates (67.1% vs. 66.7%, respectively) [26]. In an observational multicenter study comparing subtotal colectomy ($n=68$) and left colectomy ($n=76$) in patients with splenic flexure carcinoma, Beisani et al. demonstrated that despite a significantly higher number of harvested nodes in the subtotal colectomy group than in the left colectomy group (26 vs. 18, $p=0.0001$), 5-year OS rates were similar between groups (85% vs. 84%, respectively, $p=0.98$) [27]. The review by Martinez-Perez et al. reported 5-year OS rates of 49–72% for extended right colectomies vs. 60–94.6% for left colectomies (non significant) [6].

This study has some limitations. Some data were collected retrospectively, the study was performed at a single center, and only involved a small number of patients, and quality of life evaluation and cost calculations are lacking.

Conclusions

Segmental left colectomy for splenic flexure carcinoma is associated with reasonably low morbidity and very good functional results. However, OS and DFS rates were low, since the optimal extent of surgical resection for splenic flexure carcinoma, i.e., extended right colectomy or segmental left colectomy, remains under debate. A randomized trial comparing these two options for splenic flexure carcinoma is needed.

Acknowledgements The authors thank Wolters Kluwer and Editage for language, grammar, and terminology checking.

Funding None.

Compliance with ethical standards

Conflict of interest Jean-Luc Faucheron has a consulting agreement with AMI, Covidien, Medtronic, Ethicon, MSD, Legrand, Janssen-Cilag, and Johnson & Johnson Beauté Santé France. This has had no impact with the results of this study. Quentin Chenevas-Paule, Bertrand Trilling, Pierre-Yves Sage, and Edouard Girard have no conflicts of interest or financial ties to disclose.

Ethical approval The study has been performed in accordance with the ethical standards as laid down in the 1964 Declaration of Helsinki and its later amendments.

Informed consent For this type of study, formal consent is not required.

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