Journal of Visceral Surgery (2019) 156, 197—208

Available online at ScienceDirect www.sciencedirect.com

Elsevier Masson France EM|consulte www.em-consulte.com/en

ORIGINAL ARTICLE

Surgical management of obstructive left colon cancer at a national level: Results of a multicentre study of the French Surgical Association in 1500 patients

D. Mege[a,1], G. Manceau[b,1], V. Bridoux[c], T. Voron[d], C. Sabbagh[e], Z. Lakkis[f], A. Venara[g], M. Ouaissi[h], Q. Denost[i], V. Kepenekian[j], I. Sielezneff[a], M. Karoui[b,*], AFC (French Surgical Association) Working Group[2]

[a] *Department of Digestive Surgery, Timone University Hospital, 264, rue Saint-Pierre, 13005 Marseille 05 Provence-Alpes-Côte d'Azur, France*
[b] *Department of Digestive Surgery, Médecine Sorbonne University, Pitié Salpêtrière University Hospital, Assistance publique des hôpitaux de Paris (AP—HP), 43—84, boulevard de l'Hôpital, 75013 Paris, France*
[c] *Department of Digestive Surgery, Charles-Nicolle University Hospital, 37, boulevard Gambetta, 76000 Rouen, Haute Normandie Rouen, France*
[d] *Department of Digestive Surgery, Médecine Sorbonne University, Saint-Antoine University Hospital, 184, rue du Faubourg Saint-Antoine, 75012 Paris, France*
[e] *Department of Digestive Surgery, Amiens University Hospital, 2, place Victor-Pauchet, 80054 Amiens cedex, France*

Available online 1 April 2019

* Corresponding author.
E-mail addresses: dianemege@hotmail.fr (D. Mege), gilles.manceau@aphp.fr (G. Manceau), valerie.bridoux@chu-rouen.fr (V. Bridoux), thibault.voron@gmail.com (T. Voron), sabbagh.charles@chu-amiens.fr (C. Sabbagh), zaher.lakkis@gmail.com (Z. Lakkis), auvenara@chu-angers.fr (A. Venara), ouaissi_mehdi@hotmail.com (M. Ouaissi), quentin.denost@chu-bordeaux.fr (Q. Denost), vahankep@yahoo.fr (V. Kepenekian), igor.sielezneff@ap-hm.fr (I. Sielezneff), mehdi.karoui@aphp.fr (M. Karoui).

[1] The first two authors contributed equally to the present work.

[2] Collaborator list from the AFC working group: Tatiana Codjia, Marie Dazza, Guillaume Gagnat, Servane Hamel, Laure Mallet, Paul Martre, Guillaume Philouze, Edouard Roussel, Pauline Tortajada, Anne Stéphanie Dumaine, Bruno Heyd, Brice Paquette, Nicola de' Angelis, Francesco Esposito, Vincenzo Lizzi, Nicolas Michot, Christophe Tresallet, Oriana Tetard, Elie Fayssal, Maxime Collard, David Moszkowicz, Frederique Peschaud, Jean Charles Etienne, Ludovic loge, Laura Beyer, Thierry Bege, Hélène Corte, Elsa D'Annunzio, Marine Humeau, Julien Issard, Nicolas Munoz, Julio Abba, Yaqoub Jafar, Laurence Lacaze, Pierre Yves Sage, Lilija Susoko, Bertrand Trilling, Catherine Arvieux, François Mauvais, Béatrice Ulloa Severino, Sophie Pitel, Arthus Vauchaussade de Chaumont, Bogdan Badic, Benjamin Blanc, Marine Bert, Paul Rat, Pablo Ortega-Deballon, Amélie Chau, Clémentine Dejeante, Christophe Mariette, Guillaume Piessen, Emilie Grégoire, Abdallah Alfarai, Jérémie H Lefèvre, Magali Cabau, Anaelle David, Deborah Kadoche, Fanny Dufour, Géraldine Goin, Yvain Goudard, Ghislain Pauleau, Philippe Sockeel, Bruno De la Villeon, Karine Pautrat, Clarisse Eveno, Antoine Brouquet, Anne Cécile Couchard, Gregoire Balbo, Jean Yves Mabrut, Justine Bellinger, Martin Bertrand, Aurélie Aumont, Emilie Duchalais, Anne-Sophie Messière, Adrien Tranchart, Jean-Baptiste Cazauran, Virginie Pichot-Delahaye, Vincent Dubuisson, Leon Maggiori, Bilem Djawad Boumediene, David Fuks, Xavier Kahn, Eve Huart, Jean Marc Catheline, Grégory Lailler, Oussama Baraket, Patrick Baque, Jean Marie Diaz de Cerio, Philippe Mariol, Bernard Maes, Philippe Fernoux, Philippe Guillem, Eric Chatelain, Charlotte de Saint-Roman, Kévin Fixot.

https://doi.org/10.1016/j.jviscsurg.2018.11.008

[f] Department of Digestive Surgery, Besançon University Hospital, 3, boulevard Alexandre-Fleming, 25000 Besançon, France
[g] Department of Digestive Surgery, Angers University Hospital, 4, rue Larrey, 49100 Angers, France
[h] Department of Digestive Surgery, Tours University Hospital, 2, allée Gaston-Pages, 37081 Tours, France
[i] Department of Digestive Surgery, Haut-Lévèque University Hospital, avenue Magellan, 33600 Pessac, France
[j] Department of Digestive Surgery, Lyon Sud University Hospital, 165, chemin du Grand-Revoyet, 69310 Pierre-Bénit, France

KEYWORDS
Colon cancer;
Obstruction;
Surgery;
Morbidity;
oncological outcomes

Summary
Purpose: Surgical management of obstructive left colon cancer (OLCC) is controversial. The objective is to report on postoperative and oncological outcomes of the different surgical options in patients operated on for OLCC.
Methods: From 2000—2015, 1500 patients were treated for OLCC in centers members of the French Surgical Association. Colonic stent ($n = 271$), supportive care ($n = 5$), palliative derivation ($n = 4$) were excluded. Among 1220 remaining patients, 456 had primary diverting colostomy (PDC), 329 a segmental colectomy (SC), 246 a Hartmann's procedure (HP) and 189 a subtotal colectomy (STC) as first-stage surgery. Perioperative data and oncological outcomes were compared retrospectively.
Results: There was no difference between the 4 groups regarding gender, age, BMI and comorbidities. Postoperative mortality and morbidity were 4—27% (PDC), 6—47% (SC), 9—55% (HP), 13—60% (STC), respectively ($P = 0.005$). Among the 431 living patients after PDC, 321 (70%) patients had their primary tumour removed. Cumulative mortality and morbidity favoured PDC (7—39%) and SC (6—40%) compared to HP (1—47%) and STC (13—50%) ($P = 0.04$). At the end of follow-up definitive stoma rates were 39% (HP), 24% (PDC), 10% (SC), and 8% (STC) ($P < 0.0001$). Five-year overall and disease-free survival was: SC (67—55%), PDC (54—48%), HP (54—37%) and STC (48—49%). After multivariate analysis, SC and PDC were associated with better prognosis compared to HP and STC.
Conclusion: In OLCC, SC and PDC are the two preferred options in patients with good medical conditions. For patients with severe comorbidities PDC should be recommended, reserving HP and STC for patients with colonic ischaemia or perforation complicating malignant obstruction.

Introduction

About 20% of patients with CRC are diagnosed with acute colonic obstruction, which is located in the left colon in two thirds of them [1,2]. Urgent surgery for obstructive colon cancer is associated with increased risk of postoperative morbidity, mortality and permanent stoma rates as it usually occurs in elderly patients with poor medical condition or in those with high comorbidities [3—5]. Furthermore, 40 to 60% of obstructive colon cancers are locally advanced or metastatic at diagnosis and, at equal tumour stage, obstruction itself impaires oncological outcomes in colon cancer patients [2,6—9].

Surgical management of obstructive left colon cancer (OLCC) is still a matter of debate and several options may be discussed including primary diverting colostomy (PDC) as a bridge to elective colectomy, Hartmann's procedure (HP), segmental colectomy with primary anastomosis with or without intraoperative colonic irrigation (SC) and total or subtotal colectomy with anastomosis (STC) [10—12]. Only two randomised controlled trials have compared the different surgical options in the treatment of OLCC. Kronborg and colleagues [13] demonstrated that PDC followed by resection and anastomosis in second instance significantly decreases the rates of permanent colostomy, blood transfusion and wound infection compared to HP followed by restoration of continuity in second instance. No difference in cancer-specific survival was observed in this trial. The SCOTIA trial [14] showed that STC impairs functional results and increases the risk of permanent stoma compared to SC with intraoperative colonic irrigation with no difference in operative time, anastomotic leak, mortality and length of hospital stay. Despite numerous studies published since these two randomised trials [4,6,15—19], it is still hard to draw any conclusion on the best surgical strategy of patients with OLCC as the included population is heterogeneous, patients in these studies were often recruited over a long time period and surgical management included patients operated on after colonic stent insertion [20]. Finally, not all published series reporting on postoperative outcomes for OLCC yielded a global long-term picture of the different surgical options as they focussed on the first-stage urgent operation without any details on the second or third surgery when performed [19]. The aim of our multicentre French cohort study was therefore to provide an overview of the different surgical options and related mortality and morbidity in patients operated on for OLCC with a special interest in cumulative postoperative morbidity, long-term stoma rate and oncological outcomes.

Materials and methods

Study population

Data from all consecutive patients who were managed for OCC between January 2000 and December 2015 in surgical centers members of the French National Surgical Association (Association Française de Chirurgie) were retrospectively analyzed. The collected data were provided by the surgeons of each centre after institutional approval. The diagnosis of colonic obstruction was established in patients with clinical symptoms of intestinal obstruction and confirmed by abdominal X-ray, as performed in the early 2000s, and/or abdominal computed tomography (CT). OLCC was defined as a colonic tumour located between splenic flexure and rectum. Patients who had colonic stent insertion, those treated only with palliative supportive care because of poor medical condition and patients who had internal derivation as a palliative surgical procedure were excluded from the study.

Study endpoints

The primary endpoint of the study was to report the postoperative outcomes (mortality and morbidity) of surgery for OLCC with a particular focus on cumulative postoperative morbidity. Secondary endpoints included: definitive stoma rate, as well as overall and disease-free survival.

Variables and outcomes measures

Data were collected from the French National Surgical Association database. Postoperative morbidity was defined as any complication occurring during the hospital stay or within 30 days after surgery. Complications were classified according to Clavien-Dindo [21]. Overall survival was defined as the period of time between the date of surgery and the date of death, whatever the cause. For patients with non-metastatic disease, disease-free survival was defined as the period of time between the date of surgery and the date of the first relapse of the disease (locoregional or distant) or death. Living patients with no evidence of disease at last follow-up were censored.

Statistical analysis

Quantitative data were reported as median and range or mean and standard deviation, and categorical data were reported as absolute numbers and percentages (percentages were calculated with available data). Normally distributed quantitative data were analysed with Student's t test, Mann-Whitney test or Kruskal-Wallis test, as appropriate. Qualitative data were compared using Pearson's χ^2 test or Fisher's exact test, as appropriate. Survival curves were plotted according to the method of Kaplan and Meier and differences between survival distributions were assessed by log-rank test. Multivariate analysis for survival analysis was computed using Cox proportional hazards regression. All the variables that were significant in univariate analysis were included in the multivariate model. All tests were 2-sided, with a level of significance set at $P < 0.05$. Statistical analyses were performed using GraphPad Prism (version 5.0; California, USA) and JPM (version 12.1.0; SAS Institute, Cary, North Carolina, USA) software. This study was conducted according to the ethical standards of the Committee

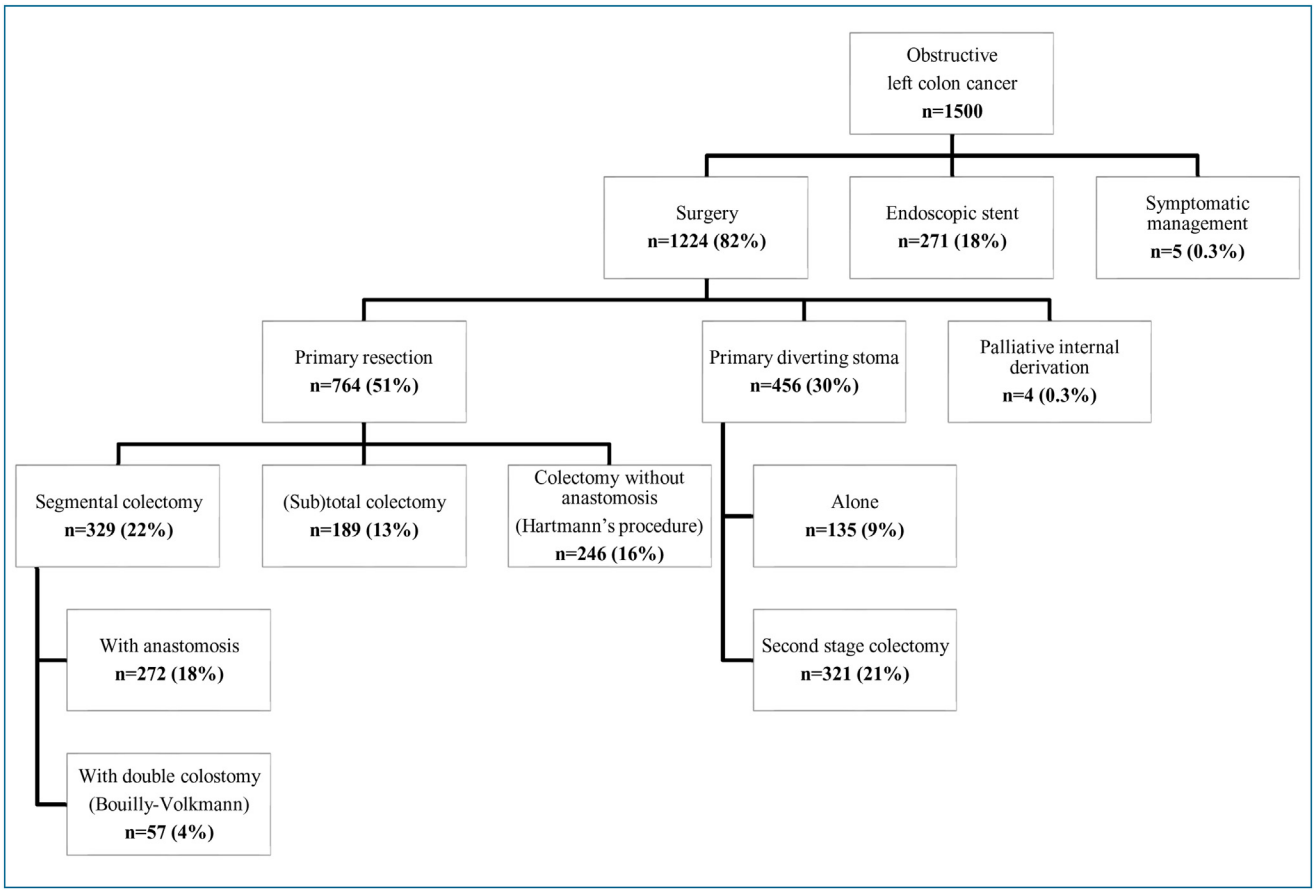

Figure 1. Flow chart of patients admitted with Obstructive Left Colon Cancer.

on Human Experimentation of our institution and reported according to the Strengthening the Reporting of Observational Studies in Epidemiology guidelines [22].

Results

Patient characteristics

Between 2000 and 2015, 1500 patients with OLCC were identified. Patients who had colonic stent insertion ($n = 271$), those who received supportive care because of poor medical condition ($n = 5$) and those who had palliative internal derivation ($n = 4$) were excluded from the study. The 1220 remaining patients were divided into four groups: PDC ($n = 456$), SC ($n = 329$), HP ($n = 246$) and STC ($n = 189$) (Fig. 1, Table 1). The obstruction was confirmed by imaging in 1139 patients (93%). There was no difference between the four groups regarding gender, age, BMI and comorbidities. Patients who had SC were in better medical condition (ASA score, $P = 0.008$, and performance status, $P < 0.0001$) than the other groups. On preoperative CT scan, synchronous metastatic disease was more frequently suspected in patients who had PDC (32%) than in other groups (SC 23%, HP 26% and STC 21%, respectively, $P = 0.01$). The following CT scan features of colonic obstruction related complications were more frequently reported in patients who had HP and STC than those who had PDC or SC: pneumoperitoneum (16 and 10% vs. 2 and 5%, $P < 0.0001$), bowel parietal pneumatosis (8 and 26% vs. 4 and 4%, $P < 0.0001$), and absence of vascular bowel wall enhancement (9 and 12% vs. 2 and 2%, $P < 0.0001$).

Intraoperative data

In the PDC group, the primary tumour was more frequently reported as locally advanced and unresectable than in the other groups (Table 2). HP and STC were more frequently

Table 1 Demographic characteristics of the 1220 patients operated on for OLCC according to the first-step surgical management.

	Primary diverting colostomy (PDC)	Segmental colectomy (SC)	Hartmann's procedure (HP)	(Sub)total colectomy (STC)	*P*-value
n	456	329	246	189	
Gender					0.7
Male	250 (55)[a]	178 (54)	144 (59)	109 (58)	
Female	206 (45)	151 (46)	102 (41)	80 (42)	
Age (years)	72 [26–102][b]	70 [30–100]	75 [24–104]	75 [23–100]	0.09
	70 ± 14[c]	69 ± 14	72 ± 14	71 ± 15	
BMI (kg/m²)	23 [16–43]	24 [15–38]	24 [14–52]	23 [15–41]	0.6
	24 ± 5	24 ± 4	25 ± 6	25 ± 5	
ASA score					**<0.0001**
1	101 (24)	79 (29)	34 (16)	25 (14)	
2	198 (47)	117 (43)	86 (40)	73 (42)	
3	109 (26)	71 (26)	84 (39)	65 (37)	
4	16 (4)	8 (3)	12 (6)	11 (6)	
NA	32	54	30	15	
ECOG performance status					**<0.0001**
0	119 (33)	115 (44)	57 (29)	39 (29)	
1	126 (35)	84 (32)	52 (26)	44 (33)	
2	74 (21)	43 (17)	52 (26)	35 (27)	
3	34 (10)	15 (6)	26 (13)	13 (10)	
4	5 (1)	2 (1)	11 (6)	1 (1)	
NA	98	70	48	57	
Comorbidities					
Vascular	184 (44)	145 (50)	120 (54)	89 (55)	0.05
Respiratory deficiency	65 (16)	31 (11)	31 (14)	32 (20)	0.06
Neurologic deficiency	63 (15)	30 (10)	36 (16)	26 (16)	0.2
Renal deficiency	29 (7)	16 (6)	13 (6)	8 (5)	0.8
Hepatic deficiency	14 (3)	5 (2)	6 (3)	6 (4)	0.5
Malnutrition	73 (18)	33 (11)	33 (15)	23 (14)	0.15
NA	41	39	23	26	
Other cancer	54 (13)	48 (15)	28 (12)	15 (9)	0.2
NA	26	18	17	19	

BMI: body mass index; ASA: American Society of Anesthesiologists; ECOG: Eastern Cooperative Oncology Group; NA: not available; $P < 0.05$ was considered as significant (in bold).
[a] Number (percentage).
[b] Median [range].
[c] Mean (standard deviation).

Table 2 Intraoperative data of the 1220 patients operated on for OLCC according to the first-step surgical management.

	Primary diverting colostomy (PDC)	Segmental colectomy (SC)	Hartmann's procedure (HP)	(Sub)total colectomy (STC)	*P*-value
n	456	329	246	189	
Tumor characteristics					
Perforated tumour	7 (2)[a]	16 (5)	34 (14)	13 (7)	**<0.0001**
NA	90	12	15	6	
Contact with organs	40 (12)	45 (14)	45 (20)	29 (18)	**0.03**
Small bowel/wound	9/17	17/7	12/7	12/4	
Omentum/duodenum	2/-	3/1	3/-	3/1	
Bladder/genital organs	3/4	11/8	5/12	3/2	
Others	5	10	10	6	
NA	112	16	24	23	
Unresectable tumour	39 (12)	3 (1)	7 (3)	4 (2)	**<0.0001**
NA	139	14	25	24	
Suspected involved lymph nodes	37 (13)	50 (18)	43 (24)	24 (18)	**0.02**
NA	164	53	64	55	
Metastases	97 (29)	78 (25)	72 (32)	55 (30)	0.3
Carcinosis	50	24	20	23	
Liver	52	59	58	44	
Others	3	3	4	1	
NA	117	11	18	7	
Severity of obstruction					
Ischaemic lesion	13 (4)	22 (7)	36 (16)	86 (51)	**<0.0001**
Cecum alone	7	14	21	45	
Cecum and right colon	—	3	5	15	
Whole colon	6	5	10	26	
NA	100	15	27	20	
Cecal perforation	4 (1)	8 (3)	20 (9)	53 (29)	**<0.0001**
NA	92	15	15	5	
Peritonitis	14 (4)	17 (5)	52 (22)	26 (14)	**<0.0001**
NA	87	14	14	6	

[a] Number (percentage); $P < 0.05$ was considered as significant (in bold).

performed in patients with perforated tumour, ischaemic lesions of the distended colon, caecal perforation or peritonitis. PDC was performed by median laparotomy in 41% of patients, by an elective incision in 46% and laparoscopically in 13% of patients, respectively. Among the 272 patients who had SC with primary anastomosis, 84 (31%) had intraoperative colonic irrigation and 42 (15%) had a defunctioning ileostomy. In patients who had HP, an extended colectomy with closing of the distal colonic stump and confection of an end-ileostomy was necessary in 35 patients (14%). Resection of neighbouring organs (i.e, small bowel, wound, bladder or ovary) due to locally advanced primary tumour was reported in 15%, 13% and 13% of patients who had SC, HP and STC, respectively ($P = 0.7$). Per-operative complications consisting mainly of iatrogenic tumour opening, ureteral, bowel or splenic injuries were reported in 39 (3%) patients; they occurred more frequently during STC (7%) than in the other groups (PDC 1%, SC 4% and HP 5%, $P = 0.006$).

Postoperative outcomes

Postoperative mortality rate was significantly higher in patients with STC and HP than in patients with SC or PDC (Table 3). Overall, surgical and medical morbidity rates were higher after STC and HP than after SC or PDC. Anastomotic complications were similar between patients who had SC (36/272, 13%) and STC (26/189, 14%, $P = 0.4$) with primary anastomosis. Median length of hospital stay was significantly lower after SC than after PDC, HP and STC. Patients who had SC or STC were more likely to have redo surgery for postoperative complications than patients who had PDC or HP. At multivariate analysis, age >70 years, ASA score ≥ 3, pulmonary and neurological comorbidities and haemodynamic instability at admission were independent predictors of postoperative mortality after first-stage surgery (Table 4).

Five hundred and twenty-two patients had a planned second surgical stage. Among the 431 living patients after PDC, 321 (74%) had resection of the primary tumour, with anastomosis in 268 of them. In the other three groups, the second surgical stage consisted of restoration of intestinal continuity. The postoperative results of second surgical stage procedures are summarised in Table 5. Postoperative mortality and morbidity after resection of the primary tumour in the PDC group was 3% and 35% respectively with a 7% rate of anastomotic leak. Overall 19 patients had a third surgical stage for stoma closure, 15 in the PDC group and 4 in the HP Group. Cumulative postoperative outcomes, including all surgical stages are given in Table 6. Cumulative overall and major morbidity and mortality favoured the PDC and SC groups.

At the end of follow-up (16 months, range: 0.03—179 months), the rate of living patients with permanent stoma

Table 3 Postoperative data of the 1220 patients operated on for OLCC according to the first-stage surgical management.

	Primary diverting colostomy (PDC)	Segmental colectomy (SC)	Hartmann's procedure (HP)	(Sub)total colectomy (STC)	*P*-value
n	456	329	246	189	
Length of hospital stay (days)	15 [0—203][a] 19 ± 20[b]	13 [0—86] 15 ± 10	15 [0—214] 19 ± 18	15 [0—185] 21 ± 21	**0.01**
Overall morbidity	103 (23)[c]	137 (42)	112 (46)	90 (48)	**<0.0001**
Surgical morbidity	56 (12)	89 (27)	69 (28)	63 (33)	**<0.0001**
Anastomotic complication	—	36[d] (13)	5 (2)[e]	26 (14)	**<0.0001**
Wound complication	16 (4)	29 (9)	34 (14)	19 (10)	**<0.0001**
Stoma-related complication	31 (7)	6 (2)	18 (7)	5 (3)	**0.001**
Haemorrhage	4 (1)	8 (2)	9 (4)	8 (4)	**0.03**
Prolonged ileus	6 (1)	16 (5)	9 (4)	12 (6)	**0.005**
Medical morbidity	74 (16)	96 (29)	96 (39)	76 (40)	**<0.0001**
Mortality	19 (4)	19 (6)	23 (9)	24 (13)	**0.005**
Dindo classification					0.5
I—II	67 (15)	86 (26)	73 (30)	58 (31)	
III—IV	36 (8)	51 (16)	39 (16)	32 (17)	
Unplanned reoperation	20 (4)	38 (12)	23 (9)	29 (15)	**<0.0001**
Radiological drainage	0	4 (1)	5 (2)	6 (3)	**0.005**

[a] Median [range].
[b] Mean ± standard deviation.
[c] Number (percentage).
[d] Among the 272 patients who underwent anastomosis.
[e] From an ileo-ileal anastomosis following an associated small bowel resection; $P < 0.05$ was considered as significant (in bold).

was significantly higher after HP than after PDC, SC or STC ($P < 0.0001$). Systemic chemotherapy, as adjuvant or metastatic treatment, was given after resection of the primary tumour, in 230 (50%) patients from the PDC group, 190 (58%) from the SC group, 107 (43%) from the HP group and 90 (48%) from the STC group ($P = 0.006$).

Pathology results

At admission, 25% of patients had metastatic disease, with no difference between the four groups. At pathological examination, among patients who had resection of the primary tumour ($n = 1089$), 34% were found stage III. There was no difference between the four groups regarding tumour size, TNM stage, positive lymph nodes, lymphatic, vascular and perineural invasion (Table 7). Tumour perforation was more frequently observed after HP than after PDC, SC and STC. The median number of harvested lymph nodes was lower after HP than after PDC, and STC.

Long-term outcomes

Median overall survival was 24.5 months for the entire cohort. Five-year overall survival (Fig. 2A) was significantly higher after SC (67%) than after PDC (54%), HP (54%) and STC (48%) ($P = 0.0002$). Similarly, 5-year disease-free and cancer-specific survival (Fig. 2B and C) was higher after SC (55% and 73%, respectively) than after PDC (48% and 63%, respectively), HP (37 and 69%, respectively) and STC (49% and 55%, respectively). At multivariate analysis, nine independent factors were associated with the risk of death (Table 8): ASA grade, performance status, pulmonary comorbidity, neurological comorbidity, renal comorbidity, per-operative macroscopic invasion of a neighbouring organ, type of surgical management, stage IV disease and postoperative chemotherapy. In our series, SC and PDC were associated with better prognosis than the two other procedures. No difference was found between SC and PDC (OR: 0.83; 95% CI: 0.47—1.49; $P = 0.53$).

Discussion

For patients admitted for OLCC, surgery was the preferred strategy during the study period in France and most of them (62%) had up-front resection of the primary tumour. In our series, the mortality rate after acute resection ranged from 6 to 13%, as reported by other large series of resected patients for OLCC (7—18%) [2,4,15,23]. Several risk factors have been demonstrated to be correlated with mortality after surgery for OLCC. In a recent multicentre retrospective series of 1816 patients operated on for OLCC in the Netherlands, increasing age, high ASA score, respiratory and neurological comorbidities were independent predictors of postoperative mortality [4]. In a study conducted in Great Britain and Ireland in a population of 989 patients who had resection for obstructive colonic cancer, age, ASA score, tumour stage and urgency of surgery were found to be independent predictors of postoperative mortality [15]. In our series, after multivariate analysis, age >70 years, ASA score ≥ 3, patients' comorbidities (pulmonary and neurological) and haemodynamic failure at admission were found to be predictors of postoperative mortality. Some authors emphasise the fact that surgeons' high colorectal expertise may decrease mortality after surgery for OLCC by allowing the right choice of procedures, avoiding contamination of the operative field during surgery or decreasing operative time [9]. In our series we were not able to evaluate this specific point but at multivariate analysis, the type of hospital where patients were managed (academic vs.

Table 4 Predictive factors for postoperative mortality after the first-step surgery in 1220 patients operated on for OLCC.

Variables	Univariate analysis			Multivariate analysis		
	No postoperative death	Postoperative death	*P*-value	Odds Ratio	95% CI	*P*-value
Gender			0.35			
Male	620 (92%)	55 (8%)				
Female	500 (93%)	36 (7%)				
Age, years			**<0.0001**			**0.008**
>70	585 (89%)	72 (11%)		2.45	1.27—4.87	
≤70	529 (97%)	19 (3%)		1		
BMI, kg/m²			0.41			
≥25	289 (93%)	22 (7%)				
<25	453 (94%)	27 (6%)				
ASA score			**<0.0001**			**0.01**
≥3	320 (86%)	53 (14%)		2.18	1.19—3.98	
<3	680 (96%)	30 (4%)		1		
Vascular comorbidity			0.079			0.35
Yes	487 (91%)	47 (9%)		0.76	0.42—1.36	
No	516 (94%)	33 (6%)		1		
Pulmonary comorbidity			**<0.0001**			**0.04**
Yes	135 (85%)	24 (15%)		2.00	1.05—3.81	
No	868 (94%)	56 (6%)		1		
Neurological comorbidity			**0.004**			**0.049**
Yes	133 (87%)	20 (13%)		1.89	1.00—3.56	
No	870 (94%)	60 (6%)		1		
Renal comorbidity			0.33			
Yes	59 (89%)	7 (11%)				
No	944 (93%)	73 (7%)				
Liver comorbidity			0.072			0.45
Yes	26 (84%)	5 (16%)		1.71	0.42—6.94	
No	977 (93%)	75 (7%)		1		
Malnutrition			0.10			
Yes	145 (90%)	17 (10%)				
No	857 (93%)	63 (7%)				
Hemodynamic failure			**<0.0001**			**0.0007**
Yes	41 (75%)	14 (25%)		4.51	1.89—10.77	
No	924 (94%)	63 (6%)		1		
Colon ischemia			**0.04**			0.41
Yes	63 (77%)	19 (23%)		0.72	0.33—1.57	
No	802 (85%)	139 (15%)		1		
Peritonitis			**0.04**			0.81
Yes	96 (87%)	14 (13%)		0.90	0.38—2.13	
No	916 (93%)	70 (7%)		1		
Type of procedure			**0.006**			
HP	220 (91%)	23 (9%)		1.56	0.66—3.68	0.31
STC	165 (87%)	24 (13%)		1.86	0.75—4.66	0.18
PDC	427 (94%)	25 (6%)		1.07	0.47—2.44	0.87
SC	308 (94%)	19 (6%)		1		
Per-operative complication: complication			0.21			
Yes	34 (87%)	5 (13%)				
No	1086 (93%)	86 (7%)				
Academic hospital			0.87			
Yes	1402 (91%)	133 (9%)				
No	413 (92%)	38 (8%)				

BMI: body mass index; ASA: American Society of Anesthesiologists; PDC: primary diverting colostomy; HP: Hartmann's procedure: SC: segmental colectomy; STC: (sub)total colectomy. $P < 0.05$ was considered as significant (in bold).

non-academic) and the type of urgent surgery (acute resection or PDC) did not influence postoperative mortality. These results suggest that a surgeon's decision should be tailored to patient-related factors and per-operative findings. In our series, patients who had HP or STC were found to have locally advanced or perforated primary tumour, ischaemic lesions of the dilated colon or caecal diastatic perforation. Similarly, HP and STC were more frequently performed in

Table 5 Postoperative outcomes of 522 patients who underwent a planned second surgical stage.

	Primary diverting colostomy (PDC)	Segmental colectomy (SC)	Hartmann's procedure (HP)	(Sub)total colectomy (STC)	*P*-value
n/alive patients after the first-stage	321/431 (74)[a]	99/310 (32)	78/223 (35)	24/165 (14)	
Time interval, days[d]	16 [1–362][b] 47 ± 67[c]	117 [1–421] 159 ± 104	190 [34–854] 225 ± 150	195 [41–374] 190 ± 93	**<0.0001**
Length of hospital stay (days)	11 [1–153] 15 ± 13	6.5 [2–28] 9 ± 6	9 [4–26] 11 ± 6	13 [6–41] 18 ± 13	**<0.0001**
Overall morbidity	111 (35)	18 (18)	11 (14)	9 (38)	**<0.0001**
Surgical morbidity	90 (28)	7 (7)	9 (12)	7 (29)	**<0.0001**
Anastomotic complication	22 (7)	5 (5)	2 (3)	3 (13)	0.3
Wound complication	39 (12)	4 (4)	5 (6)	3 (13)	0.07
Stoma-related complication	8 (2)	–	1 (1)	–	1.00
Haemorrhage	14 (4)	3 (3)	1 (1)	1 (4)	0.6
Prolonged ileus	22 (7)	1 (1)	1 (1)	2 (8)	**0.04**
Medical morbidity	67 (21)	6 (6)	6 (8)	5 (21)	**0.0006**
Mortality	14 (3)	1 (1)	2 (3)	0	0.25
Dindo classification					0.34
I–II	71 (22)	9 (9)	5 (6)	4 (17)	
III–IV	40 (12)	9 (9)	6 (8)	5 (21)	
Unplanned reoperation	12 (4)	6 (6)	3 (4)	4 (17)	**0.03**
Radiological drainage	2 (1)	0	0	0	–

[a] Number (percentage).
[b] Median [range].
[c] Mean ± standard deviation.
[d] After the 1st surgical stage; $P < 0.05$ was considered as significant (in bold).

Table 6 Cumulative postoperative results of 1220 patients with left colonic malignant obstruction.

	Primary diverting colostomy (PDC)	Segmental colectomy (SC)	Hartmann's procedure (HP)	(Sub)total colectomy (STC)	*P*-value
n	456	329	246	189	
Length of hospital stay (days)	24 [1–176][a] 27 ± 26[b]	14 [1–86] 16 ± 12	17 [1–214] 19 ± 20	15 [1–185] 19 ± 22	**<0.0001**
Mortality	34 (7)[c]	20 (6)	25 (10)	24 (13)	**0.04**
Overall morbidity	176 (39)	133 (40)	116 (47)	92 (50)	**0.04**
Dindo classification					0.9
I–II	115 (25)	81 (25)	74 (30)	57 (30)	
III–IV	61 (13)	52 (16)	42 (17)	35 (19)	
Unplanned reoperation	46 (10)	37 (11)	25 (10)	28 (15)	0.3
Definitive stoma	108 (24)	32 (10)	96 (39)	15 (8)	**<0.0001**

[a] Median [range].
[b] Mean ± standard deviation.
[c] Number (percentage); $P < 0.05$ was considered as significant (in bold).

patients with higher ASA score compared to PDC or SC. Our results are in accordance with those reported in a retrospective multicentre German study of 743 patients who had resection for OLCC [17]. In this latter study, HP was the preferred surgical option in patients with more comorbidities or for those with peritonitis, tumour infiltration of neighbouring organs, and synchronous metastasis [17]. In the series reported by Chereau and colleagues [18], HP was limited to patients with perforation and peritoneal seeding or in severely ill patients for whom cure was not possible.

Keeping patients' selection biases in mind, postoperative morbidity was significantly higher after first-stage HP and STC than after SC and PDC in our series. Kronborg and colleagues [13] reported that blood transfusion (55% vs. 14%, $P < 0.01$) and wound infection (22% vs. 5%, $P = 0.01$) rates were significantly higher after HP compared to PDC. Likewise, Chereau and colleagues [18] have shown that PDC was associated with lower morbidity (9.8% vs. 54.5% vs. 45.5%) and 30-day mortality (4.9% vs. 27.3% vs. 9%) than HP and STC. The rates of overall (42%) and major (16%) morbidities observed after SC in our study are in accordance with previous published series [11], suggesting that SC is technically demanding in emergency settings compared to PDC. Some authors have argued that cumulative

Table 7 Pathological results of 1089 patients who underwent the resection of the OLCC.

	Primary diverting colostomy (PDC)	Segmental colectomy (SC)	Hartmann's procedure (HP)	(Sub)total colectomy (STC)	*P*-value
n	321	329	246	189	
Tumour size (cm)					0.52
≤2	30 (11)[a]	31 (11)	13 (6.5)	14 (10)	
>2 to ≤5	141 (51)	144 (51)	102 (51)	78 (54)	
>5 to ≤10	96 (34.5)	96 (34)	82 (41)	49 (34)	
>10	10 (3.5)	11 (4)	3 (1.5)	3 (2)	
NA	44	147	46	45	
Longitudinal resection margin (cm)	6 [1—30][b]	6.5 [1—30]	6 [0.5—48]	9 [1—58]	**<0.0001**
	7 ± 5[c]	8 ± 5	8 ± 7	12 ± 10	
Tumour perforation	22 (8)	25 (9)	37 (18)	21 (14)	**0.001**
NA	22	39	38	43	
TNM classification					0.29
Stage 0—II	101 (36)	123 (39)	75 (32)	62 (34)	
Stage III	121 (39)	102 (32)	79 (33)	58 (32)	
Stage IV	90 (29)	94 (29)	82 (35)	62 (34)	
NA	9	10	10	7	
Harvested lymph nodes	18 [2—79]	17 [1—58]	15 [0—76]	22 [3—160]	**<0.0001**
	21 ± 12	19 ± 10	17 ± 10	28 ± 21	
Involved lymph nodes	1 [0—32]	1 [0—20]	1 [0—26]	1 [0—28]	0.73
	2 ± 4	2 ± 3	2 ± 4	2 ± 4	
Vascular invasion	146 (51)	140 (49)	100 (51)	77 (47)	0.9
NA	33	44	48	26	
Lymphatic invasion	112 (45)	101 (42)	73 (44)	69 (50)	0.5
NA	73	88	78	50	
Perineural invasion	151 (53)	135 (49)	88 (45)	68 (44)	0.13
NA	35	53	51	36	

NA: not available; TNM: tumour node metastasis stage. $P < 0.05$ was considered as significant (in bold).
[a] Number (percentage of available data).
[b] Median [range].
[c] Mean ± standard deviation.

morbidity and mortality is so high after staged surgery for OLCC that less conservative surgery is justified [11,24]. In our series, the cumulative mortality, overall and major morbidities reported in the PDC group were similar to those observed after SC, although patients in the latter group had better medical condition (ASA score and performance status). Our results are in accordance with those reported in a recent meta-analysis [19].

The risk of permanent stoma formation is a major concern in patients with OLCC and operated on with multi-stage procedures. In the present series, 74% of patients managed by PDC had resection of the primary tumour during a second-stage, and 15 of them (5%) needed a third surgical procedure for stoma closure. The definitive stoma rate after PDC was thus 24% at the end of follow-up. In contrast, in the HP group, stoma reversal was achieved in only 35% of patients, in line with the literature [18]. In our series, 99 out of the 329 patients for whom SC was performed, had either a protective anastomosis ($n = 42$) or a double colostomy (Bouilly-Volkmann). These two procedures may represent an attractive option since postoperative morbidity after second-stage surgery and permanent stoma rates are low.

Little is known on long-term prognosis in patients operated on for OLCC since most studies emphasised surgical techniques and short-term outcomes in this setting. In our series, we show that five-year overall, disease-free and cancer-specific survival is significantly improved after SC or PDC compared to HP or STC. Jiang and colleagues [6] reported that PDC tended to be associated with higher overall survival than one-stage procedures (105 vs. 66 months, $P = 0.088$). Chereau and colleagues [18] reported that PDC was associated with better median overall survival (26 months) than HP (7 months) and STC (18 months). As reported by Chereau et al. [18], the number of harvested lymph nodes in our series was significantly lower after HP compared to the other procedures. In a recently published series, Öistämö and colleagues [25] showed that the number of harvested lymph nodes in the resected specimen was higher in the planned resection group ($n = 43$) compared with the acute resection group ($n = 57$) (21 vs. 8.7; $P = 0.001$). Added to the previously mentioned histological factor, the lower number of longitudinal resection margins and the greater number of perforated tumours reported in the HP group may explain the worse disease-free survival reported in patients with non-metastatic disease treated by HP. In addition, in our series, in line with others [25], a small proportion of patients in the HP group received postoperative chemotherapy which may also negatively impact prognosis.

The present study has some limitations. It is retrospective series, the population was heterogeneous, some data are missing, functional results and quality of life could not be assessed, but these disadvantages are offset by the large sample of patients. In addition, the present study is the first

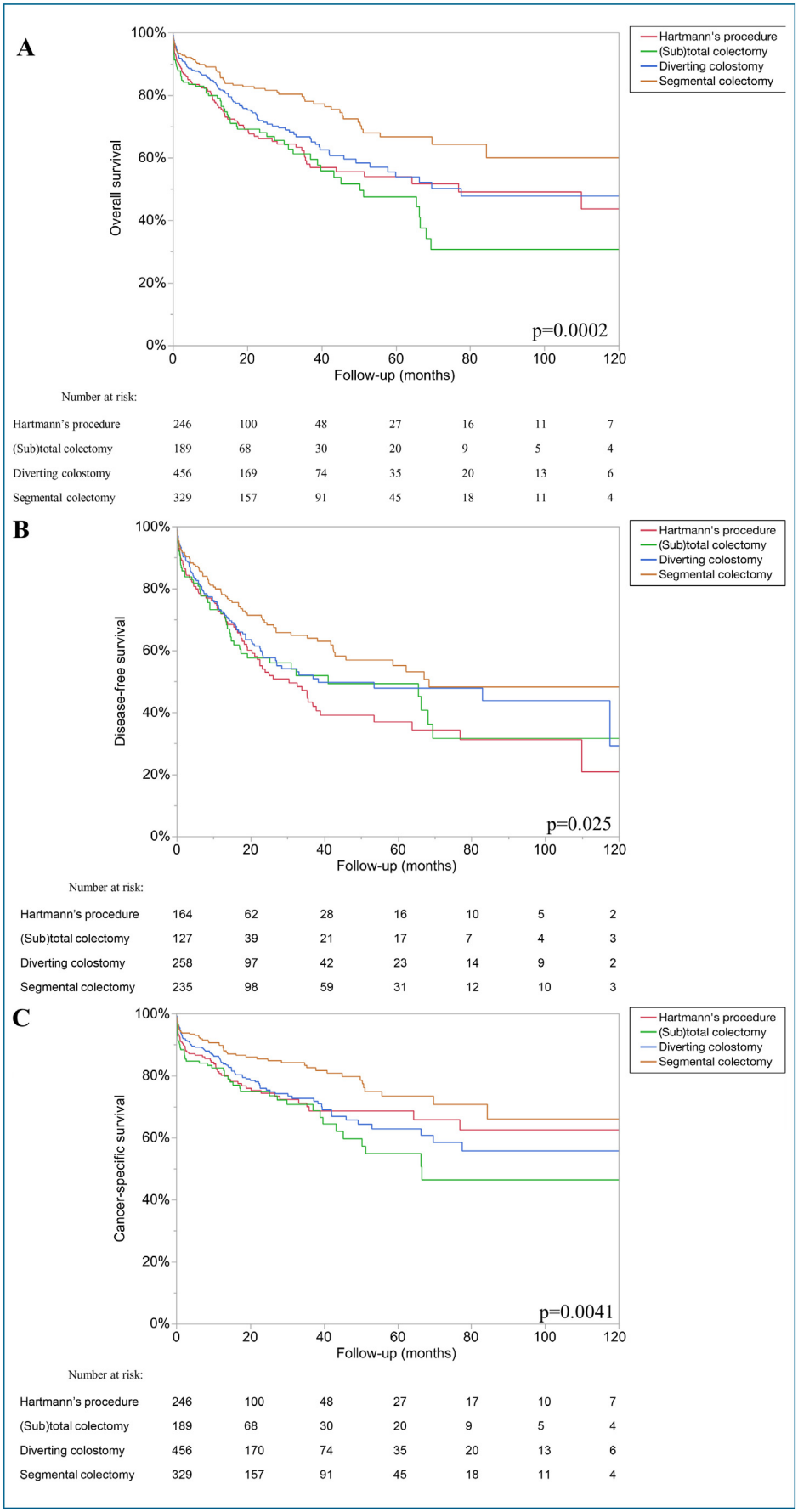

Figure 2. Overall (A), disease-free (B) and cancer-specific (C) survival according to the four main surgical managements of obstructive left colon cancer: Hartmann's procedure (red line), (sub)total colectomy (green line), primary diverting colostomy (blue line) and segmental colectomy (brown line).

Table 8 Predictive factors of overall survival after surgery for left malignant colonic obstruction at univariate and multivariate analysis.

Characteristics	Univariate analysis			Multivariate analysis			
	5-year overall survival		Log-rank *P*-value	*n*	Odds Ratio	95% CI	*P*-value
Sex				551			
Male/Female	55%	59%	0.59				
Age at operation, years							
≥75/ <75	48%	63%	**<0.0001**[a]		1.46	0.98—2.16	0.060
Body mass index, kg/m²							
≥30/ <30	64%	56%	0.48				
ASA grade							
≥3/ <3	42%	62%	**<0.0001**[a]		1.67	1.13—2.46	**0.0099**[a]
ECOG performance status							
≥3/ <3	46%	61%	**<0.0001**[a]		2.09	1.17—3.58	**0.014**[a]
Vascular comorbidity							
Yes/No	58%	57%	0.11				
Pulmonary comorbidity							
Yes/No	40%	60%	**<0.0001**[a]		1.82	1.14—2.81	**0.012**[a]
Neurological comorbidity							
Yes/No	53%	58%	**0.020**[a]		1.91	1.13—3.40	**0.016**[a]
Renal comorbidity							
Yes/No	35%	59%	**0.0004**[a]		2.22	1.22—3.79	**0.010**[a]
Liver comorbidity							
Yes/No	29%	58%	**0.014**[a]		2.79	0.82—7.18	0.093
Malnutrition							
Yes/No	44%	59%	**0.0004**[a]		1.08	0.63—1.74	0.78
Hemodynamic failure							
Yes/No	41%	61%	**<0.0001**[a]		1.25	0.59—2.44	0.54
Obstruction revealing colon cancer							
Yes/No	57%	40%	0.13				
Upstream ischemia of the colon							
Yes/No	56%	61%	0.12				
Peritonitis							
Yes/No	43%	60%	**0.0086**[a]		1.29	0.73—2.20	0.37
Macroscopic invasion of a neighboring organ							
Yes/No	48%	62%	**0.0018**[a]		2.22	1.40—3.43	**0.0010**[a]
Surgical procedure							
PDC/SC/HP/STC	54%/67%/54%/47%		**0.0002**[a]				
STC/HP					1.10	0.68—1.76	0.70
PDC/HP					0.58	0.33—0.98	**0.042**[a]
PDC/STC					0.53	0.29—0.93	**0.027**[a]
SC/HP					0.48	0.29—0.78	**0.0027**[a]
SC/STC					0.44	0.25—0.75	**0.0030**[a]
SC/PDC					0.83	0.47—1.49	0.53
Synchronous metastases							
Yes/No	28%	69%	**<0.0001**[a]		2.89	1.94—4.28	**<0.0001**[a]
Number of lymph nodes examined							
≥12/ <12	63%	61%	**0.029**[a]		0.86	0.55—1.37	0.51
Postoperative chemotherapy							
Yes/No	62%	51%	**<0.0001**[a]		0.44	0.29—0.68	**0.0002**[a]

ASA: American Society of Anesthesiologists; DC: diverting colostomy; ECOG: Eastern Cooperative Oncology Group; HP: Hartmann's procedure; SC: segmental colectomy; STC: (sub)total colectomy.
[a] *P*-value significant at the 0.05 level (in bold).

to compare the four main surgical options for OLCC with detailed results in terms of postoperative outcomes including all surgical stages and long-term oncological outcomes.

In conclusion, patients who are considered for surgery for OLCC should be given information on cumulative morbidity, permanent stoma rate and oncological outcomes as a necessary part of their initial counselling. For those operated on, this is essential. Given these postoperative considerations, segmental colectomy (in experienced hands) and primary loop colostomy are the two preferred options in patients with good medical condition (ECOG 0 or 1) and no colonic ischaemic features above the obstruction.

For those with severe comorbidities, primary diverting colostomy should be recommended as the first-stage surgical procedure, reserving Hartmann's procedure and (sub)total colectomy for patients with colonic ischaemia or perforation complicating malignant obstruction.

Acknowledgements

We are grateful to Nikki Sabourin-Gibbs, Rouen University Hospital, for her help in editing the manuscript.

Disclosure of interest

The authors declare that they have no competing interest.

References

[1] Torre LA, Bray F, Siegel RL, et al. Global cancer statistics, 2012. CA Cancer J Clin 2015;65:87—108.
[2] McArdle CS, McMillan DC, Hole DJ. The impact of blood loss, obstruction and perforation on survival in patients undergoing curative resection for colon cancer. Br J Surg 2006;93:483—8.
[3] Sjo OH, Larsen S, Lunde OC, Nesbakken A. Short term outcome after emergency and elective surgery for colon cancer. Colorectal Dis 2009;11:733—9.
[4] Tanis PJ, Paulino Pereira NR, van Hooft JE, et al. Resection of obstructive left-sided colon cancer at a national level: a prospective analysis of short-term outcomes in 1816 patients. Dig Surg 2015;32:317—24.
[5] Awotar GK, Guan G, Sun W, et al. Reviewing the management of obstructive left colon cancer: assessing the feasibility of the one-stage resection and anastomosis after intraoperative colonic irrigation. Clin Colorectal Cancer 2017;16:e89—103.
[6] Jiang JK, Lan YT, Lin TC, et al. Primary vs. delayed resection for obstructive left-sided colorectal cancer: impact of surgery on patient outcome. Dis Colon Rectum 2008;51:306—11.
[7] Chin C-C, Wang J-Y, Changchien C-R, et al. Carcinoma obstruction of the proximal colon cancer and long-term prognosis — obstruction is a predictor of worse outcome in TNM stage II tumor. Int J Colorectal Dis 2010;25:817—22.
[8] Cortet M, Grimault A, Cheynel N, et al. Patterns of recurrence of obstructing colon cancers after surgery for cure: a population-based study. Colorectal Dis 2013;15:1100—6.
[9] Morita S, Ikeda K, Komori T, et al. Outcomes in colorectal surgeon-driven management of obstructing colorectal cancers. Dis Colon Rectum 2016;59:1028—33.
[10] Tiret E. Emergency management for colonic cancer. Gastroenterol Clin Biol 1998;22:S102—7.
[11] Ansaloni L, Andersson RE, Bazzoli F, et al. Guidelenines in the management of obstructing cancer of the left colon: consensus conference of the world society of emergency surgery (WSES) and peritoneum and surgery (PnS) society. World J Emerg Surg WJES 2010;5:29.
[12] Chang GJ, Kaiser AM, Mills S, et al. Practice parameters for the management of colon cancer. Dis Colon Rectum 2012;55:831—43.
[13] Kronborg O. Acute obstruction from tumour in the left colon without spread. A randomized trial of emergency colostomy versus resection. Int J Colorectal Dis 1995;10:1—5.
[14] Single-stage treatment for malignant left-sided colonic obstruction: a prospective randomized clinical trial comparing subtotal colectomy with segmental resection following intraoperative irrigation. The SCOTIA Study Group. Br J Surg 1995;82:1622—7.
[15] Tekkis PP, Purkayastha S, Lanitis S, et al. A comparison of segmental vs. subtotal/total colectomy for colonic Crohn's disease: a meta-analysis. Color Dis 2006;8:82—90.
[16] Villar JM, Martinez AP, Villegas MT, et al. Surgical options for malignant left-sided colonic obstruction. Surg Today 2005;35:275—81.
[17] Kube R, Granowski D, Stübs P, et al. Surgical practices for malignant left colonic obstruction in Germany. Eur J Surg Oncol 2010;36:65—71.
[18] Chéreau N, Lefevre JH, Lefrancois M, et al. Management of malignant left colonic obstruction: is an initial temporary colostomy followed by surgical resection a better option? Color Dis 2013;15:e646—53.
[19] Amelung FJ, Mulder CLJ, Verheijen PM, et al. Acute resection versus bridge to surgery with diverting colostomy for patients with acute malignant left sided colonic obstruction: systematic review and meta-analysis. Surg Oncol 2015;24:313—21.
[20] De Salvo GL, Gava C, Pucciarelli S, Lise M. Curative surgery for obstruction from primary left colorectal carcinoma: primary or staged resection? Cochrane Database Syst Rev 2004:CD002101.
[21] Dindo D, Demartines N, Clavien P-A. Classification of surgical complications: a new proposal with evaluation in a cohort of 6336 patients and results of a survey. Ann Surg 2004;240:205—13.
[22] von Elm E, Altman DG, Egger M, et al. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. Lancet 2007;370:1453—7.
[23] Frago R, Biondo S, Millan M, et al. Differences between proximal and distal obstructing colonic cancer after curative surgery. Color Dis 2011;13:e116—22.
[24] Hennekinne-Mucci S, Tuech J-J, Bréhant O, et al. Emergency subtotal/total colectomy in the management of obstructed left colon carcinoma. Int J Colorectal Dis 2006;21:538—41.
[25] Öistämö E, Hjern F, Blomqvist L, et al. Emergency management with resection versus proximal stoma or stent treatment and planned resection in malignant left-sided colon obstruction. World J Surg Oncol 2016;14:232.