International Journal of Colorectal Disease (2019) 34:329–336
https://doi.org/10.1007/s00384-018-3200-x

ORIGINAL ARTICLE

Long-term hospital mortality due to small bowel obstruction after major colorectal surgery in a national cohort database

Nicolas Michot[1] · Jérémy Pasco[2] · Urs Giger-Pabst[3] · Guillaume Piessen[4] · Jean Jacques Duron[5] · Ephrem Salamé[1] · Leslie Grammatico-Guillon[2] · Mehdi Ouaïssi[1]

Accepted: 14 November 2018 / Published online: 26 November 2018

Abstract

Purpose Adhesions following major colorectal surgery can be responsible for bowel obstruction, mostly occurring in the small intestine. Published data for long-term survival following major colorectal surgery complicated with intestinal obstruction are limited. The aim of this study was to identify the mortality rates and mortality risk factors in patients with primary colorectal surgery (PMCS) complicated with surgical small bowel obstruction (SBO).

Methods This was a retrospective analysis of a prospective national registry of patients who underwent PMCS in 2008.

Results Of 15,640 patients who underwent PMCS, 2900 required further surgery for SBO with a median follow-up of 42 months (until the end of 2014). Re-hospitalization mortality rate was 10.1%, and 65% of deaths were obstruction-related. No differences were found in SBO incidence between patients who had undergone laparoscopic or open procedures. Hospital mortality was significantly higher in patients who underwent open PMCS compared with those who underwent a laparoscopic procedure (11% vs. 2%, $p = 0.0006$). Overall 1- and 5-year survival rates in patients who underwent surgical SBO treatment were significantly lower when the initial surgery was an open procedure compared with a laparoscopy (96.8% vs. 99.4% and 86.6% vs. 95.1%, respectively, $p = 0.0016$). Multivariate analysis revealed that age, sex, a history of diabetes, cancer, and heart disease were mortality risk factors.

Conclusions The surgical incidence and mortality rate of PMCS complicated with SBO were elevated. Laparoscopy clearly reduced long-term postoperative mortality in patients with and without abdominal adhesions.

Keywords Small bowel obstruction · Major colorectal surgery · Hospital mortality

Introduction

Postoperative adhesions secondary to upper and lower gastrointestinal (GI) surgery are commonly encountered by surgeons [1] and can lead to bowel obstruction, which occurs in the small intestine in nearly half of all patients [2]. Small bowel obstruction (SBO) is a common pathology that accounts for 4% of all emergency department admissions and for 20% of all emergency surgical procedures [3]. Elevated mortality rates ranging between 5 and 10% were reported in patients surgically treated for SBO. Previous data indicate that the mortality rate correlates with comorbidities of patients (ASA score) and time interval between SBO onset and surgery [4–7]. However, few studies take into account long-term follow-up following SBO surgery, as well as the characteristics of previous surgical procedure (i.e., upper and lower GI surgery, laparoscopy, or laparotomy). Moreover, impact of mortality rate's of postoperative SBO complicating laparoscopy compared to laparotomy specially

Nicolas Michot and Jérémy Pasco have equivalent contributions.

✉ Mehdi Ouaïssi
m.ouaissi@chu-tours.fr

[1] Department of Digestive, Oncological, Endocrine, and Hepatic Surgery and Hepatic Transplantation, Trousseau Hospital, CHRU, Avenue de la République, Chambray les Tours, France

[2] Regional Unit of Hospital Epidemiology, Data Center, Department of Medical Information for Epidemiology and Health Economics, François Rabelais University, Tours, France

[3] Department of General-, Visceral, and Transplant Surgery, University of Münster, Munster, Germany

[4] Universty Lille, Department of Digestive and Oncological Surgery, Claude Huriez University Hospital, F-59000 Lille, France

[5] Department of Digestive Surgery, Pitié Salpetrière Hospital, Paris, France

in major colorectal surgery was not reported in a large cohort data base [7]. Although postoperative mortality risk factors have been clearly identified, the available evidence are drawn from retrospective studies that analyzed postoperative mortality (at 30 days) but did not always account for the initial surgical approach, did not focus specifically on patients who underwent colorectal surgery, and did not report the long-term postoperative outcome [7–9]. In particular, very few studies have analyzed the long-term survival of patients undergoing surgery for SBO consecutive to primary major colorectal surgery (PMCS). The aim of this study was to analyze the long-term outcome and mortality risk factors in patients who underwent PMCS and who presented with postoperative small bowel obstruction (SBO) during a 6-year follow-up. The study cohort was selected using the French Hospital Discharge Database (PMSI, *Programme de Médicalisation des Systèmes d'Information*).

Materials and methods

Study design A national cohort study was conducted using data from the PMSI database from 2008. The PMSI is based on the mandatory notification of each in-hospital stay, in all French public or private hospitals, through a coded summary using the International Classification of Diseases, Tenth Revision (ICD-10). This database contains hospitalization dates, DRG codes (*Groupement Homogène d'Hospitalisation*; diagnostic-related group), ICD-10 diagnostic codes, CCAM codes (French Common Classification for Clinical Procedures), and the route of discharge for each hospitalization. This study was approved by the National Committee of Informatics and Liberty (CNIL) (no. 1813209v1).

All patients who underwent PMCS in 2008 were identified from this national database, with a follow-up period from 2008 to 2014. All emergency procedures were excluded. Every patient with a DRG code in 2008 for PMCS (CMD6 or CMD13 and then GHM-06C04V or GHM-06C04W) was included. We then analyzed all further hospitalizations of these patients between 2008 and 2014. We filtered the PMSI database for patients treated for small bowel obstruction (SBO) by surgery after PMCS.

Study population The technique used for the initial surgery (laparoscopy or open procedure) was determined using the following algorithm:

a. Open procedure: registration of at least one laparotomy procedure according to the CCAM code during the initial hospitalization
b. Laparoscopy: registration of at least one laparoscopic procedure with no open procedures according to the CCAM code during the initial hospitalization

The hospital stays were then used to form the hospital-stay database. Every hospital stay was linked to the patient by a unique, encrypted anonymized number, which provided the patient-care trajectory. Thus, the patient database was based on these encrypted, anonymized numbers.

Outcomes During the follow-up period, hospitalization for bowel obstruction was defined as a hospitalization with a DRG code relating to peritoneal adhesion release (GMH 06C131 to 06C134) or if the hospital summary included at least one primary diagnosis related to intestinal obstruction according to the following ICD-10 codes:

a. K56.2: volvulus
b. K56.4: other impaction of the intestine
c. K56.5: intestinal adhesions (bands) with obstruction
d. K56.6: other and unspecified intestinal obstruction
e. K66.0: peritoneal adhesions
f. K91.3: postprocedural intestinal obstruction, unspecified
g. N73.6: female pelvic peritoneal adhesions

During hospitalization for intestinal obstruction, a laparoscopic procedure was defined as the presence of at least one of the following CCAM codes:

a. HGPC 015: extensive small bowel release (extensive enterolysis) due to acute obstruction, by laparoscopy
b. HPPC 001: release of pelvic peritoneal adhesions (adhesiolysis) that are neither extensive nor dense, due to female infertility, by laparoscopy
c. HPPC 002: release of extensive and/or dense pelvic peritoneal adhesions (adhesiolysis) due to female infertility, by laparoscopy
d. HPPC 003: resection of peritoneal adhesions and/or bands due to acute bowel obstruction, by laparoscopy

The laparotomy treatment for bowel obstruction was defined as the presence of at least one of the following CCAM codes:

a. HGFA 005: single segment resection of small bowel obstruction, by laparotomy
b. HGPA 004: extensive small bowel release (extensive enterolysis), due to acute obstruction, by laparotomy
c. HPPA 001: release of pelvic peritoneal adhesions (adhesiolysis) that are neither extensive nor dense, due to female infertility, by laparotomy
d. HPPA 002: resection of peritoneal adhesions and/or bands due to acute bowel obstruction, by laparotomy
e. HPPA 003: release of extensive and/or dense pelvic peritoneal adhesions (adhesiolysis) due to female infertility, by laparotomy

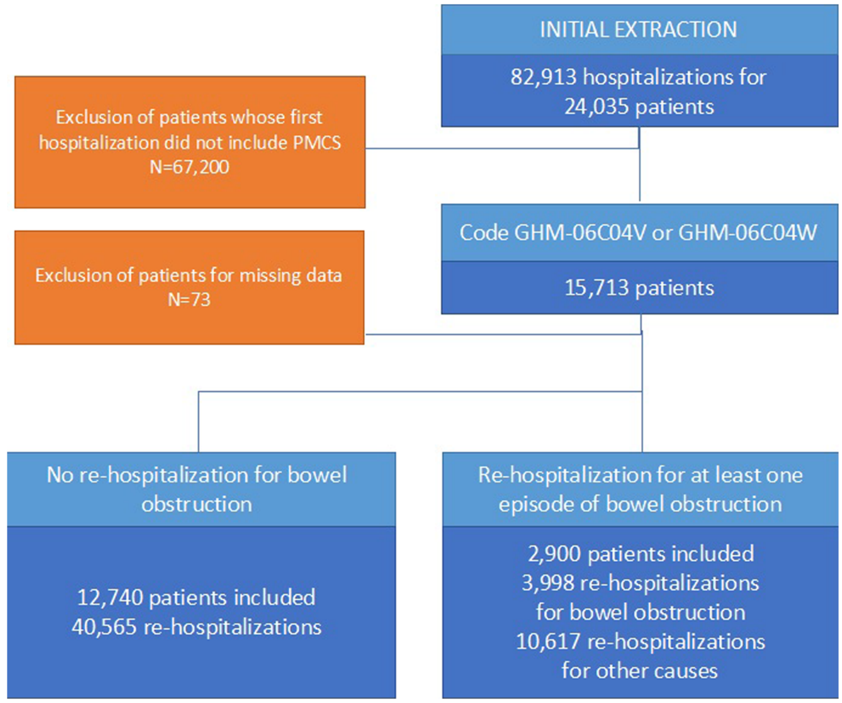

Fig. 1 Population flowchart. PMCS primary major colorectal surgery

Table 1 Population description

	Number (%)
Median age (years)	66 (53–77)
Male/female	1234 (42.6)/1666 (57.4)
Laparotomy/laparoscopy	2734 (94.3)/166 (5.7)
Immunosuppression	18 (0.6)
Drug abuse	14 (0.5)
Alcohol abuse	107 (3.7)
Rheumatoid arthritis	51 (1.8)
Anemia/coagulopathy	413 (14.7)
Under nutrition	563 (19.4)
Diabetes	332 (11.4)
Hypothyroidism	152 (5.2)
Renal impairment	164 (5.7)
Hepatic impairment	82 (2.8)
Obesity	282 (9.7)
Vascular disease	138 (4.8)
Pulmonary disease	309 (10.7)
Fluid and electrolyte imbalance	0
Digestive disorder	27 (0.9)
Neurological disorder	172 (5.9)
Cutaneous disorder	99 (3.4)
Cancer	1036 (35.7)
Arterial hypertension	1092 (37.7)
Psychiatric disorder	307 (10.6)
Digestive/hepatic/alcohol	185 (6.4)
Endocrine disorder	1086 (37.4)
Cardiovascular disease	1361 (46.9)

The PMSI does not permit a patient with SBO to be treated only medically. The quality of information encoded was not specific, and the population was heterogeneous with respect to postoperative complications, without absolute certainty of adherence SBO diagnosis. In-hospital mortality was determined at the discharge from the last recorded hospitalization, which revealed the patient's status (deceased = discharge code 9). The number of comorbidities was identified by the presence of an ICD-10 code for either the main diagnosis or a related diagnosis during one of the hospitalizations.

Statistical analysis

Proportions were compared using the chi-squared test, and numerical values were compared using the non-parametric Wilcoxon test. For the survival analysis, hospital mortality was the statistical unit. The variable time (T) was the time between the date of the first obstruction and the hospital mortality. A survival curve was produced for the surgical technique (laparoscopy vs. laparotomy) using Kaplan–Meier analysis, and the log-rank test was used to assess significant differences. Cox univariate analysis and subsequent multivariate analysis were used to analyze the factors associated with hospital mortality following major digestive surgery and obstruction. All analysis was performed using the software package R v.3.4.0.

Table 2 Univariate and multivariate analysis of risk factors for all-cause of mortality

	$N = 295$ (%) Deceased	$N = 2605$ (%) Alive	*P* univariate	HR multivariate	HR 95% CI multivariate	*P* multivariate
Mean age (years)	72 ± 14.6	62.4 ± 17.9	*< 0.0001*	1.04	[1.03; 1.05]	*< 0.001*
Male	127 (43)	1107 (42)	0.85	0.86	[0.67; 1.09]	0.21
Initial laparotomy	291 (99)	2443 (94)	*< 0.0001*	3.20	[1.18; 8.64]	*0.02*
Mean number of hospitalizations	4.4 ± 7.7	5.1 ± 4.9	*< 0.0001*			
Laparotomy (number)				0.85	[0.72; 1.00]	0.05
Laparoscopy (number)				0.52	[0.37; 0.74]	*< 0.001*
Comorbidities						
Immunosuppression	3 (1)	15 (1)	0.75	1.39	[0.44; 4.40]	0.58
Drug abuse	3 (1)	11(0.5)	0.38	2.22	[0.67; 7.38]	0.19
Alcohol abuse	13(4)	94 (4)	0.63	0.91	[0.49; 1.67]	0.75
Rheumatoid arthritis	7 (2)	44 (2)	0.51	1.12	[0.49; 2.56]	0.79
Anemia/coagulopathy	70 (24)	343 (13)	*< 0.0001*	1.33	[1.01; 1.76]	0.05
Under nutrition	80 (27)	483 (19)	*0.02*	1.16	[0.87; 1.54]	0.31
Diabetes	33 (11)	299 (11)	0.46	0.72	[0.49; 1.06]	0.09
Hypothyroidism	11 (5)	141 (5)	0.14	0.54	[0.29; 0.99]	0.05
Renal impairment	34 (12)	130 (5)	*< 0.0001*	1.39	[0.94; 2.03]	0.10
Hepatic impairment	21 (7)	61 (2)	*< 0.0001*	2.51	[1.54; 4.10]	*< 0.001*
Obesity	21 (10)	261 (10)	*0.03*	0.74	[0.47; 1.18]	0.21
Vascular disease	28 (9)	110 (4)	*< 0.0001*	1.37	[0.91; 2.06]	0.13
Pulmonary disease	48 (16)	261 (10)	*0.0037*	1.33	[0.96; 1.84]	0.08
Digestive disorder	4 (1)	23 (1)	0.33	1.49	[0.54; 4.10]	0.44
Neurological disorder	31 (11)	141 (5)	*0.0086*	1.12	[0.76; 1.66]	0.55
Cutaneous disorder	21 (7)	78 (3)	*< 0.0001*	1.22	[0.77; 1.94]	0.39
Cancer	162 (55)	874 (34)	*< 0.0001*	1.72	[1.36; 2.18]	*< 0.001*
Arterial hypertension	142 (48)	950 (36)	*0.0017*	0.84	[0.65; 1.08]	0.17
Heart disease	122(41)	505 (19)	*< 0.0001*	1.94	[1.51; 2.51]	*< 0.001*
Psychiatric disorder	35 (12)	272 (10)	0.98	0.71	[0.49; 1.04]	0.08
Digestive/hepatic/OH	32 (11)	153 (6)	*0.0049*			
Endocrine disorder	121 (41)	965 (37)	0.96			
Cardiovascular disease	187 (63)	1174(45)	*< 0.0001*			

The significant *p* values are in italic

Results

Study population

In 2008, 15,729 patients underwent elective PMCS. Between 2008 and 2014, these patients accounted for 55,708 re-hospitalizations. Of these, 2900 patients (18.5%) were readmitted to the hospital at least once for SBO (Fig. 1). Sixteen of these patients were excluded because information about the initial procedure was not recorded in the database. Of the 2900 remaining patients, there were 3998 re-hospitalizations for SBO. During the 6-year follow-up, 2900 patients (18.4% of the 15,640) underwent surgery for SBO. Median age was 66 years (53–77), and 42.6% of the patients were male. The medical history of the patients is shown in Table 1. The PMCS was performed by open procedure in 94% of patients ($n = 2734$) and by laparoscopic procedure in 5.7% ($n = 166$). The most common comorbidities were cancer (35.7%), arterial hypertension (37.7%), cardiovascular disease (21.6%), undernutrition (19.4%), and diabetes mellitus (11.4%). The proportion of patients with at least one SBO episode was not significantly different between the open and laparoscopic PMCS [18.4% ($n = 2734/14,853$) vs. 21.1% ($n = 166/787$), $p = 0.0654$].

Re-hospitalizations according to surgical technique (Tables 2 and 3)

Median follow-up period was 42 months (18–62). The number of re-hospitalizations for SBO was higher among patients who had an initial open PMCS compared with those who had an initial laparoscopic PMCS (median = 4 (min = 1; max = 118) vs. median = 3 (min = 1; max = 25).

Table 3 Univariate and multivariate analysis of risk factors for mortality due solely to bowel obstruction

	N = 191 Death secondary to bowel obstruction	*N* = 2709 Alive or other-cause death	*P* univariate	HR multivariate	HR 95% CI multivariate	*P* multivariate
Mean age (years)	74.92 ± 14.02	62.62 ± 17.79	*< 0.001*	1.05	[1.04; 1.06]	*< 0.001*
Male	75 (39)	1159 (43)	0.31	0.74	[0.54; 1.00]	*0.05*
Initial laparotomy	188 (98)	2546 (94)	*0.01*	2.57	[0.82; 8.10]	0.11
Mean number of hospitalizations	2.87 ± 2.35	5.19 ± 5.39	*< 0.001*			
Laparotomy (number)				1.00	[0.81; 1.23]	0.98
Laparoscopy (number)				0.41	[0.23; 0.71]	*0.0014*
Comorbidities						
Immunosuppression	1 (1)	17 (1)	0.80	0.98	[0.13; 7.07]	0.98
Drug abuse	2 (1)	12 (0)	0.29	3.55	[0.83; 15.21]	0.09
Alcohol abuse	9 (5)	98 (4)	0.47	1.26	[0.60; 2.66]	0.54
Rheumatoid arthritis	6 (3)	45 (2)	0.14	1.65	[0.67; 4.07]	0.28
Anemia and coagulopathy	43 (23)	370 (14)	*0.0013*	1.39	[0.98; 1.98]	0.07
Under nutrition	40 (21)	523 (19)	0.71	1.01	[0.70; 1.47]	0.95
Diabetes	15 (8)	317 (12)	0.09	0.56	[0.33; 0.97]	*0.04*
Hypothyroidism	6 (3)	146 (5)	0.16	0.48	[0.21; 1.10]	0.08
Renal impairment	20 (10)	144 (5)	*0.0037*	1.36	[0.83; 2.21]	0.22
Liver impairment	14 (7)	68 (3)	*< 0.001*	3.06	[1.67; 5.61]	*< 0.001*
Obesity	8 (4)	274 (10)	*0.0055*	0.51	[0.25; 1.05]	0.07
Vascular disease	18 (9)	120 (4)	*0.0022*	1.60	[0.96; 2.66]	0.07
Pulmonary disease	28 (15)	281 (10)	0.08	1.19	[0.78; 1.81]	0.42
Digestive disorder	3 (2)	24 (1)	0.32	1.60	[0.50; 5.14]	0.43
Neurological disorder	15 (8)	157 (6)	0.31	0.94	[0.55; 1.61]	0.83
Cutaneous disorder	9 (5)	90 (3)	0.33	0.86	[0.43; 1.70]	0.66
Cancer	90 (47)	946 (35)	*0.001*	1.38	[1.03; 1.85]	*0.03*
Arterial hypertension	85 (45)	1007 (37)	0.06	0.75	[0.55; 1.02]	0.07
Heart disease	83 (43)	544 (20)	*< 0.001*	2.06	[1.50; 2.82]	*< 0.001*
Psychiatric disorder	18 (9)	289 (11)	0.51	0.61	[0.36; 1.01]	0.06
Digestive/hepatic/OH condition	22 (12)	163 (6)	*0.0038*			
Endocrine disorder	61 (32)	1025 (38)	0.06			
Cardiovascular disease	118 (62)	1243 (46)	*< 0.001*			

The significant *p* values are in italic

Mortality risk factors

Among the patients who were re-hospitalized ($n = 2900$), the overall in-hospital mortality rate was 10.2% ($n = 295$) with 65% ($n = 191$) occurring during a hospitalization specifically for SBO (i.e., 6.6% of all-cause mortalities). At the end of the follow-up period, the overall in-hospital mortality rate was significantly higher within the open PMCS group compared with the laparoscopic PMCS group (11% vs. 2%, $p = 0.0006$). Among the re-hospitalizations for obstruction, a significant difference was also found (7.6% vs. 1.8%; $p = 0.0058$).

In the univariate analysis (Tables 2 and 3), age, initial surgical technique, number of re-hospitalizations, number of new surgical procedures for SBO, and comorbidities were all associated with an increased hospital mortality rate, irrespective of whether the death was due to SBO or not. Only pulmonary, neurological and cutaneous pathologies as well as arterial hypertension were associated with an increased death rate; these variables were also found to be risk factors of increased all-cause mortality.

In the multivariate analysis, age, male sex, initial technique, liver disease, cancer, and cardiovascular disease were independent factors associated with in-hospital mortality. When we focused on obstruction-related mortality, age, liver disease, cardiovascular disease, and cancer were risk factors for in-hospital mortality.

Survival analysis

One-year overall survival among the 15,640 patients undergoing PMCS was 96.3% [96.0; 96.7] if no SBO occurred vs.

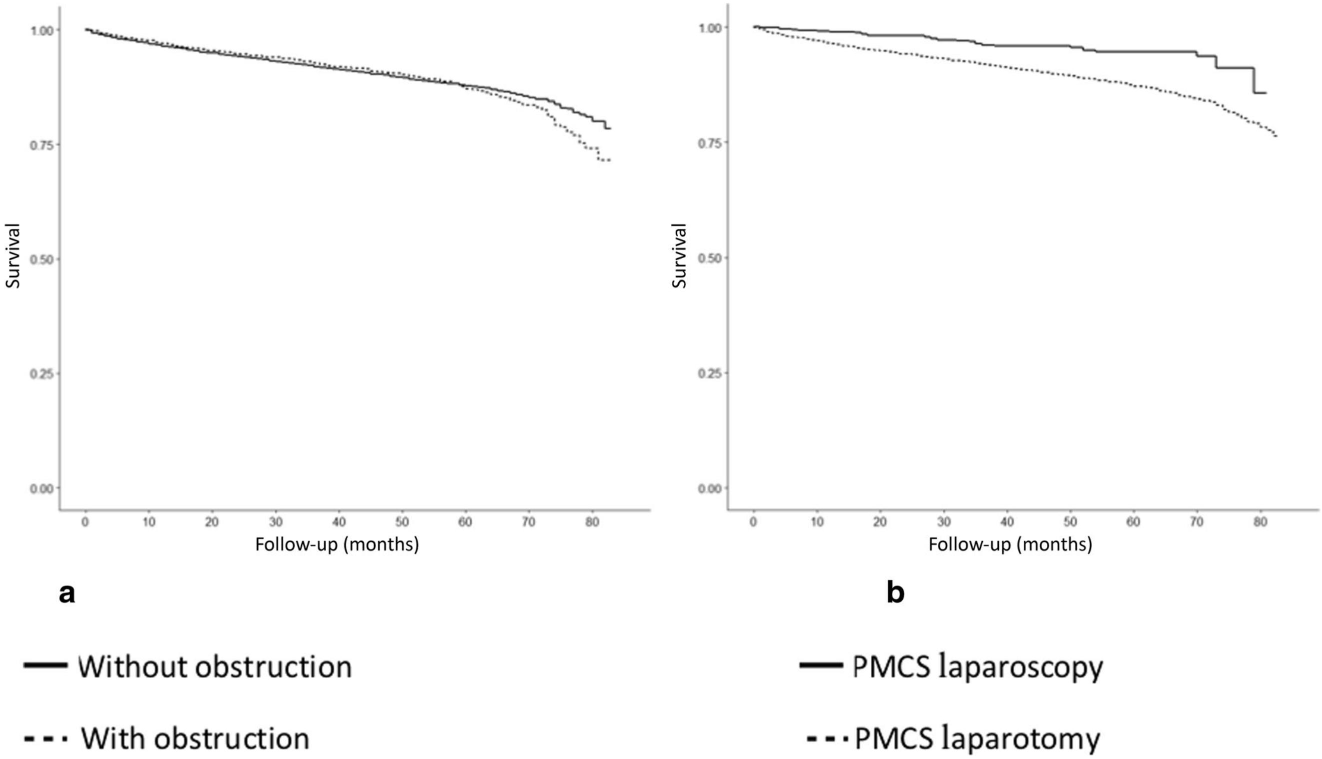

Fig. 2 **a** Overall survival of the populations with and without bowel obstruction after PMCS. **b** Overall survival of the populations operated for bowel obstruction after PMCS with laparotomy and laparoscopy

96.9% [96.3; 97.6] in patients who presented with at least one SBO episode. The corresponding 5-year overall survival rates were 87.6% [86.8; 88.4] and 87.1% [85.5; 88.7], respectively ($p = 0.474$) (Fig. 2a). One and 5-year overall survivals

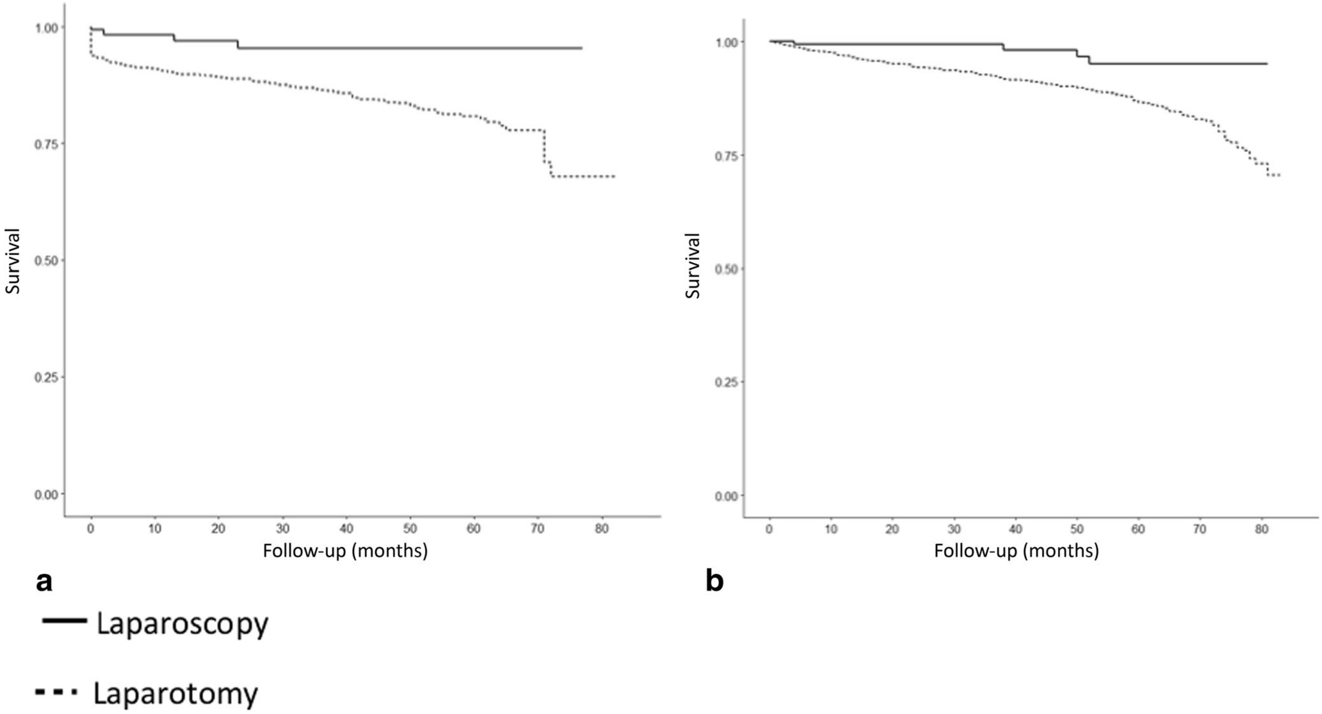

Fig. 3 **a** Overall survival (death related only to small bowel obstruction) of the populations with and without bowel obstruction after PMCS. **b** Overall survival (death related only to small bowel obstruction) of the populations with and without bowel obstruction after PMCS after the first small bowel obstruction

following open PMCS were significantly lower compared with patients who underwent laparoscopic PMCS: 96.3% [96.0; 96.6] vs. 98.9% [98.1; 99.6] and 87.1% [86.4; 87.9] vs. 94.5% [92.4; 96.6], respectively ($p < 0.0001$) (Fig. 2b).

In patients who had at least one SBO episode, 1 and 5-year disease-specific survival following open PMCS was significantly lower compared with laparoscopic PMCS (96.8% [96.1; 97.5] vs. 99.4 [98.1; 100.0] and 86.6% [85.0; 88.3] vs. 95.1% [90.3; 100.0], respectively ($p = 0.0016$)) (Fig. 3a). When considering 1 and 5-year survival rates following the first SBO episode, this difference increased (98.3% [95.9; 100.0] vs. 90.2 [88.9; 91.5] and 95.3% [90.7; 100.0] vs. 80.8% [78.0; 83.7], respectively ($p = 0.0006$)) (Fig. 3b).

Discussion

This national hospital cohort study is the first to assess the risk factors of long-term mortality after surgically treated SBO. The study population was a large cohort of 15,640 patients who underwent PMCS in 2008 and were followed until 2014. The estimated incidence of SBO, irrespective of whether the initial surgery was performed by laparoscopic or open procedures, was higher than that found in two recent meta-analyses by Yamada and Ha, (5% vs. 8%, 5.3% vs. 8.2% respectively) [10, 11]. However, one recent study by Smolarek indicated not only an abdominal adhesion rate of 9.8–11.2% but also the absence of any significant difference in the incidence of SBO, irrespective of the initial surgical technique (i.e., laparoscopy or open) [12]. These conflicting results are likely due to the heterogeneity of the populations, both in terms of surgical approach (laparoscopy or midline/transverse laparotomy) and surgery type (upper or lower GI). In contrast, the data in our present study are observed in a highly selected group of patients that only underwent PMCS (CMD6 or CMD13 and then GHM-06C04V or GHM-06C04W). Within these selected patients, those who presented with SBO requiring hospitalization were analyzed. Our study was restricted to major colorectal surgery, comprising only lower GI surgical procedures. Data analyses, as well as all drawn conclusions clearly, depend on the quality of coding performed by surgeons. However, the important population size allows to limit bias associated with this retrospective study. Most SBO etiologies are related to adherences; however, there were some reported SBO episodes that did not have a clear etiology. This represents a weakness in this type of studies.

Published mortality rates after SBO following surgery vary from 3 to 13% in short-term follow-up analyses and 7 to 10% in the long-term follow-up analyses [13–15]. According to a previously published review, the mortality rate [4] in our present study reported the same comorbidity factor as an independent risk for increased mortality rate (i.e., age, heart disease, liver impairment). Limited data collection inherent to national database analyses could not allow for intraoperative mortality risk factors analyses (such as time interval between SBO onset and surgical treatment and the exact type of surgical procedure performed to release SBO). However, intestinal resection requirement does not appear to be a risk factor for mortality [4]. To our knowledge, no study has yet analyzed the impact of surgical approach on mortality rate for lower GI surgical procedures (i.e., open vs. laparoscopy). The impact of the initial surgical approach is extremely important, not only for the incidence of bowel obstruction but also for long-term mortality. The impact of laparoscopy has already been demonstrated in a study by Panis et al. of over 84,000 patients, which revealed increased mortality in the laparotomy group compared with the laparoscopy group, although the authors only analyzed mortality after 30 days [16]. Long-term outcome was significantly improved in patients presenting with SBO and who were initially operated on using a laparoscopic approach.

However, the results of our study should be interpreted with caution due to the retrospective nature of the study, and particularly because of the lack of any information about the patients' oncological history. Furthermore, there was often a lack of information about any history of laparotomy. In fact, we know that the incidence of abdominal adhesions and obstruction appears to differ depending on the choice of laparotomy approach (e.g., midline or transverse) [4]. Thus, the use of administrative hospital databases introduced an inherent bias that should be taken into consideration. The strengths and limitations of the use of healthcare databases for epidemiological purposes have previously been extensively discussed [17, 18]. However, our approach provides a different perspective on the public health issue represented by SBO with the advantages of long-term follow-up and a high number of patients.

This study revealed the incidence of bowel obstruction requiring surgery consequent to major colorectal surgery among the French hospital population. Our findings revealed a high mortality rate from such obstructions requiring surgery and highlight the impact of surgical approach on short-, medium-, and long-term postoperative survivals.

Compliance with ethical standards

This study was approved by the National Committee of Informatics and Liberty (CNIL) (no. 1813209v1).

Conflict of interest The authors declare that they have no conflict of interest.

References

1. Leung TT, Dixon E, Gill M, Mador BD, Moulton KM, Kaplan GG, MacLean AR (2009) Bowel obstruction following appendectomy:

what is the true incidence? Ann Surg 250(1):51–53. https://doi.org/10.1097/SLA.0b013e3181ad64a7

2. ten Broek RP, Issa Y, van Santbrink EJ, Bouvy ND, Kruitwagen RF, Jeekel J, Bakkum EA, Rovers MM, van Goor H (2013) Burden of adhesions in abdominal and pelvic surgery: systematic review and met-analysis. BMJ 347:f5588. https://doi.org/10.1136/bmj.f5588
3. Catena F, Di Saverio S, Coccolini F, Ansaloni L, De Simone B, Sartelli M, Van Goor H (2016) Adhesive small bowel adhesions obstruction: evolutions in diagnosis, management and prevention. World J Gastrointest Surg 8(3):222–231. https://doi.org/10.4240/wjgs.v8.i3.222
4. Ouaissi M, Gaujoux S, Veyrie N, Deneve E, Brigand C, Castel B, Duron JJ, Rault A, Slim K, Nocca D (2012) Post-operative adhesions after digestive surgery: their incidence and prevention: review of the literature. J Visc Surg 149(2):e104–e114. https://doi.org/10.1016/j.jviscsurg.2011.11.006
5. Keenan JE, Turley RS, McCoy CC, Migaly J, Shapiro ML, Scarborough JE (2014) Trials of nonoperative management exceeding 3 days are associated with increased morbidity in patients undergoing surgery for uncomplicated adhesive small bowel obstruction. J Trauma Acute Care Surg 76(6):1367–1372. https://doi.org/10.1097/TA.0000000000000246
6. Kothari AN, Liles JL, Holmes CJ, Zapf MA, Blackwell RH, Kliethermes S, Kuo PC, Luchette FA (2015) "Right place at the right time" impacts outcomes for acute intestinal obstruction. Surgery 158(4):1116–1125. https://doi.org/10.1016/j.surg.2015.06.032
7. Duron JJ, du Montcel ST, Berger A, Muscari F, Hennet H, Veyrieres M, Hay JM, French Federation for Surgical R (2008) Prevalence and risk factors of mortality and morbidity after operation for adhesive postoperative small bowel obstruction. Am J Surg 195(6):726–734. https://doi.org/10.1016/j.amjsurg.2007.04.019
8. Jeppesen MH, Tolstrup MB, Kehlet Watt S, Gogenur I (2016) Risk factors affecting morbidity and mortality following emergency laparotomy for small bowel obstruction: a retrospective cohort study. Int J Surg 28:63–68. https://doi.org/10.1016/j.ijsu.2016.02.059
9. Margenthaler JA, Longo WE, Virgo KS, Johnson FE, Grossmann EM, Schifftner TL, Henderson WG, Khuri SF (2006) Risk factors for adverse outcomes following surgery for small bowel obstruction. Ann Surg 243(4):456–464. https://doi.org/10.1097/01.sla.0000205668.58519.76
10. Yamada T, Okabayashi K, Hasegawa H, Tsuruta M, Yoo JH, Seishima R, Kitagawa Y (2016) Meta-analysis of the risk of small bowel obstruction following open or laparoscopic colorectal surgery. Br J Surg 103(5):493–503. https://doi.org/10.1002/bjs.10105
11. Ha GW, Lee MR, Kim JH (2016) Adhesive small bowel obstruction after laparoscopic and open colorectal surgery: a systematic review and meta-analysis. Am J Surg 212(3):527–536. https://doi.org/10.1016/j.amjsurg.2016.02.019
12. Smolarek S, Shalaby M, Paolo Angelucci G, Missori G, Capuano I, Franceschilli L, Quaresima S, Di Lorenzo N, Sileri P (2016) Small-bowel obstruction secondary to adhesions after open or laparoscopic colorectal surgery. JSLS, 20(4). https://doi.org/10.4293/JSLS.2016.00073
13. Menzies D, Parker M, Hoare R, Knight A (2001) Small bowel obstruction due to postoperative adhesions: treatment patterns and associated costs in 110 hospital admissions. Ann R Coll Surg Engl 83(1):40–46
14. van Goor H (2007) Consequences and complications of peritoneal adhesions. Color Dis 9(Suppl 2):25–34. https://doi.org/10.1111/j.1463-1318.2007.01358.x
15. Fevang BT, Fevang J, Lie SA, Soreide O, Svanes K, Viste A (2004) Long-term prognosis after operation for adhesive small bowel obstruction. Ann Surg 240(2):193201–193201. https://doi.org/10.1097/01.sla.0000132988.50122.de
16. Panis Y, Maggiori L, Caranhac G, Bretagnol F, Vicaut E (2011) Mortality after colorectal cancer surgery: a French survey of more than 84,000 patients. Ann Surg 254(5):738–743; discussion 743-4. https://doi.org/10.1097/SLA.0b013e31823604ac
17. Jouan Y, Grammatico-Guillon L, Espitalier F, Cazals X, Francois P, Guillon A (2015) Long-term outcome of severe herpes simplex encephalitis: a population-based observational study. Crit Care 19:345. https://doi.org/10.1186/s13054-015-1046-y
18. Sunder S, Grammatico-Guillon L, Baron S, Gaborit C, Bernard-Brunet A, Garot D, Legras A, Prazuck T, Dibon O, Boulain T, Tabone X, Guimard Y, Massot M, Valery A, Rusch E, Bernard L (2015) Clinical and economic outcomes of infective endocarditis. Infect Dis (Lond) 47(2):80–87. https://doi.org/10.3109/00365548.2014.968608