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ORIGINAL ARTICLE

Splenic flexure mobilization in rectal cancer surgery: do we always need it?

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Abstract
Splenic flexure (SFM) in rectal cancer surgery is a crucial step which may increase the difficulty of the operation. The aim of this retrospective single-center study is to demonstrate if the selective omission of SFM during anterior rectal resection can reduce the complexity of the operation, without affecting post-operative and oncologic outcomes. Data of 112 consecutive rectal resections for cancer from March 2010 to March 2017 were analyzed and divided into two groups: SFM and No-SFM. A sub-analysis was then performed for laparoscopy and traditional cases. Post-operative and oncologic outcomes, including overall (OS) and cancer-related survival (CRS), were analyzed and compared. SFM was performed in 42% of cases and laparoscopy was used in 73.2%. Operative time resulted significantly lower in the No-SFM group (190 vs. 225 min, $p=0.01$). In laparoscopy in the No-SFM group, operative time and post-operative stay were significantly lower (205.5 vs. 222.5 min, $p=0.04$; 9 vs. 10 days, $p=0.01$). Most of the open resections were performed without SFM (35.4% vs. 14.9%, $p=0.02$). No statistical significant differences were found in OS and CRS in the two groups. We support the hypothesis that every surgeon should carry out an accurate intra-operative evaluation to perform a selective SFM. When possible, SFM can be safely avoided with no additional risks in terms of post-operative and oncologic outcomes.

Keywords Splenic flexure mobilization · Rectal cancer · Colorectal · Surgery · Laparoscopy

Introduction

Mobilization of the splenic flexure in rectal cancer surgery may be a demanding step, especially in minimally invasive surgery and its routine use for anterior rectal resection is still debated [1]. Some authors have stated that splenic flexure mobilization (SFM) is not necessary in every procedure, particularly in obese patients where it may be technically difficult, with no advantages in terms of post-operative and oncologic outcomes [1–5]. Other authors believe that this procedure is mandatory, to ensure an optimal blood supply to the residual colon and a tension-free anastomosis [6, 7]. In effect, SFM is mainly performed in patients with a short left mesentery [8]. However, SFM is not free from intra-operative complications, like spleen injury, and it increases the complexity of an already demanding operation such as rectal resection [9–11]. Actually, this step can be particularly challenging in case of anatomically high position of the splenic flexure and adhesions of the greater omentum [12, 13]. Often SFM, both in open and in minimally invasive surgery, may require longer operative times, patient repositioning, a wider incision or additional port insertion, significantly increasing the difficulty of the whole procedure [14]. Moreover, despite some surgeons advocate the use of SFM to ensure a proper radical resection, this procedure is not always necessary if adequate oncologic clearance is achieved by proximal and distal resection margins of 5 cm and by a correct lymphadenectomy with high ligation of the inferior mesenteric artery at its origin from aorta [1, 9, 10, 15–20]. No randomized clinical trial still exists about the use of SFM in anterior rectal resection for cancer. Some retrospective series have shown no differences in terms of post-operative complications and oncologic adequacy in the selective use of SFM [3–5]. The aim of the present study is to demonstrate if the selective omission of SFM during both conventional and laparoscopic anterior rectal resection can

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reduce the complexity of the operation, without affecting post-operative and oncologic outcomes in terms of survival and recurrence rates.

Materials and methods

We retrospectively analyzed clinical data of 112 consecutive patients affected by histologically proven rectal adenocarcinoma submitted to elective surgical resection from March 2010 to March 2017, at the Department of Surgery, San Carlo Borromeo Hospital, Milan, Italy. Data were registered from the medical records of each patient, collected in a database and then extracted for statistical analysis. The following data were considered: demographic data, discharge paper, surgical operation descriptions (tumor location, type of operation, splenic flexure mobilization, drains number, stoma, perioperative morbidity, operative time and conversion to open surgery for laparoscopic cases), and the histopathologic report (tumor grading and staging, number of lymph nodes harvested and involved, resection margins analysis). Preoperative workup included in all cases digestive flexible endoscopy with tumor biopsy, blood samples, ECG, thoracic and abdominal CT scan and pelvic MRI or endoscopic ultrasound (EUS). Inclusion criteria: rectal tumors with distal extension to ≤ 15 cm from the anal verge (as measured by flexible endoscopy). They were categorized as extra- or intra-peritoneal on the basis of CT scan, MRI (when available) and intraoperative findings. Exclusion criteria: cases with incomplete intraoperative data, in particular when the information about SFM could not be obtained. Tumor staging was classified according to Union for International Cancer Control-American Joint Committee on Cancer (UICC-AJCC) TNM 7th edition classification system [21]. As by protocol in use, according to clinical staging and patient's health conditions, neoadjuvant chemoradiotherapy (CRT) was performed. Surgical operations were characterized by radical rectal resections, including Total Mesorectal Excision (TME) and adequate margin resections with primary anastomosis in all cases and loop ileostomy or loop colostomy when necessary. They were classified as high, low and ultra-low anterior resection. All procedures were performed by different surgeons of our department with adequate expertise in laparoscopy and open surgery (≥ 10 years). No preoperative selection criteria were used to allocate patients to laparoscopic or open surgery. Conversion from laparoscopic to open surgery was necessary in some cases to safely complete the operation. Surgeons decided to perform or not SFM on the basis of intraoperative findings. Splenic flexure was mobilized when the residual colon quality was considered not adequate for a well-vascularized and tension-free anastomosis, independently from the extension of resection. Patients were divided into two groups, SFM and No-SFM. Morbidity was registered during the postoperative stay and classified by Clavien–Dindo classification [22]. Major complications were defined as Clavien–Dindo grade III and IV. Anastomotic leakages were always submitted to reoperation and included in Clavien–Dindo grade III. Post-operative mortality was defined as the number of deaths within 30 days from the surgical operation. Follow-up was assessed by clinical investigation or by telephone interview. After a general analysis of the whole population, the two groups of patients were compared according to age, gender, American Society of Anesthesiology (ASA) score, Body Mass Index (BMI), previous abdominal surgery, tumor site, neoadjuvant CRT, operation type, operation time, presence of stoma, radicality, associated procedures, number of drains, conversion from laparoscopic to open surgery, pTNM staging, grading, number of lymph nodes harvested, margins infiltration, postoperative complications, mortality, post-operative stay and recurrence rate. Then, the groups were compared separately for laparoscopic and open procedures. Finally survival in the two groups was evaluated and compared. For statistical analysis, nominal data were expressed as frequencies and compared using Pearson's Chi-squared test and Fisher's exact test. Numerical data were expressed as medians, and they were compared using Mann–Whitney *U* test. Overall and cancer-related survivals were calculated by the life table method of Kaplan and Meier, and their differences were evaluated by the log-rank test. In view of the small size of some subgroups, multiple confounders which have not been adjusted for, a sample size calculation not being appropriate and hence a possible lack of power, we decided that statistical significance would only be reached if the p value was < 0.05. However, a lack of statistical significance does not mean that there is no difference in some results, because the lack of significance could be due solely to a lack of power. SPSS software v. 22 (IBM SPSS, Chicago, IL, USA) was used for statistical analysis.

Results

From March 2010 to March 2017, 112 consecutive anterior rectal resections for rectal cancer with available complete operative records were performed in our Institution in elective setting. The whole population was composed by 55.4% of men and 44.6% of women, with a median age of 73 years (range 39–94) and a median BMI of 24.22 kg/m^2. Most of the patients were classified as ASA 2 (49.1%) and less than a half had previously undergone abdominal operation (43.8%). Tumor location was more often in the extra-peritoneal space (62.5%) and 24.1% of cases underwent to pre-operative CRT. Only, 9.8% of patients presented distant liver metastases at diagnosis. The most performed operation was high anterior resection (63.4%) and SFM was performed in 42% of cases.

Laparoscopic approach was used in 73.2% of cases, requiring in 35.4% conversion to open surgery. In 58% of patients, a stoma was also performed and in 17.9% of cases, another procedure was associated with the rectal resection. Associated procedures included resection of adjacent organs infiltrated by the tumor when necessary (i.e., histero-adnexectomy, bladder resection), hepatic resection or radiofrequency thermoablation in case of hepatic metastasis. R0 surgery was achieved in 91.1% of patients. Regarding post-operative and oncologic outcomes, patients were mostly classified as pT3 (52.7%) and pN0 (58.9%) with a median of 13 lymph nodes harvested (range 0–37). Major morbidity (Clavien–Dindo III–IV) was observed in 15.2% of cases and included intestinal occlusion, ureteral lesions, bleeding and anastomotic leakage. The latter was registered in 5 cases (4.5%). Post-operative mortality was 3.6%. Recurrence (local and/or distant) was detected in 23.2% of patients during follow-up. Additional clinico-pathological data are shown in Table 1. After dividing the population into two groups, on the basis of SFM, no differences were found in terms of age, gender, BMI, ASA score, previous abdominal surgery, tumor site, neoadjuvant CRT, type of operation, the presence of stoma, radicality, associated procedures, conversion from laparoscopic to open surgery, pTNM staging, grading, number of lymph nodes harvested, margins infiltration, length of hospital stay, postoperative complications and mortality, recurrence rates. Operative time resulted significantly lower in the No-SFM group (190 vs. 225 min, $p=0.01$). Laparoscopic cases were characterized by an equal distribution in the two groups (42 vs. 40 patients for No-SFM and SFM, respectively); whereas, in open resections, the most were performed without SFM and this difference was statistically significant ($p=0.02$). One drain was used in the 83.1% of No-SFM group vs. the 57.4% of SFM group; whereas, 2 or more drains were used in the SFM group compared to the No-SFM group (42.5% vs. 16.9%, $p=0.01$). Despite no differences were found in terms of stoma creation, after analyzing the type of stomas, ileostomy was significantly more common in the SFM group (40.4% vs. 16.9%) whereas colostomy was preferred in the No-SFM group (35.4% vs. 25.5%, $p=0.02$) (Table 2). In laparoscopic procedures, no significant differences were found between the two groups, except for the presence and type of stoma, number of drains, operative time and post-operative stay (Table 3), like in the whole group. In particular, in this analysis, a stoma was mostly preferred in the SFM group (65% vs. 38.1%, $p=0.02$) and, when performed, ileostomy was used in most of cases (42.5% vs. 14.3%, $p=0.01$). In the No-SFM group, operative time and post-operative stay were significantly lower (205.5 vs. 222.5 min, $p=0.04$; 9 vs. 10 days, $p=0.01$). In open procedures, no significant differences were found between the two groups (maybe due to the small sample size), but a lower operation time (180 vs. 225 min, $p=0.39$), a higher lymph node count (13 vs. 11, $p=0.88$) and a lower post-operative stay (13 vs. 18 days, $p=0.85$) were registered in the No-SFM vs. SFM group. The 3-, 5- and 7-year overall survival (OS) of the whole population was 70.9, 61.2 and 52.5%, respectively. The 3-, 5- and 7-year overall survival was 65.5, 62 and 62% in No-SFM and 77.8, 73.9 and 52.8% in SFM, respectively ($p=0.24$) (Fig. 1). The 3-, 5- and 7-year

Table 1 Clinico-pathological characteristics of the population

Variables	Values	Total N. = 112
Sex	M	62 (55.4%)
	F	50 (44.6%)
ASA	1	6 (5.4%)
	2	55 (49.1%)
	3	26 (23.2%)
	4	3 (2.7%)
Operation type	High ant. resection	71 (63.4%)
	Low ant. resection	10 (8.9%)
	Ultralow ant. res.	31 (27.7%)
Stoma	No	47 (42%)
	Colostomy	35 (31.2%)
	Ileostomy	30 (26.8%)
N. drains	1	81 (72.3%)
	≥ 2	31 (27.7%)
Approach	Open	30 (26.8%)
	Laparoscopy	82 (73.2%)
Operation time	Minutes (median)	210 (range 70–390)
pT	0	3 (2.7%)
	1	8 (7.1%)
	2	25 (22.3%)
	3	59 (52.7%)
	4	4 (3.6%)
pN	0	66 (58.9%)
	1	22 (19.7%)
	2	11 (9.8%)
pM	0	93 (83%)
	1	10 (8.9%)
Stage	0	3 (2.7%)
	I	27 (24.1%)
	II	33 (29.5%)
	III	27 (24.1%)
	IV	9 (8%)
Grading	G2	58 (51.7%)
	G3	32 (28.6%)
	N.G.	22 (19.7%)
Margins infiltration	No	87 (77.7%)
	Yes	3 (2.7%)
Post-operative stay	Days (median)	10 (range 5–77)
Clavien–Dindo	0	65 (58%)
	I	14 (12.5%)
	II	10 (8.9%)
	III	16 (14.3%)
	IV	1 (0.9%)

Table 2 Comparison between patients without and with splenic flexure mobilization (SFM)

Variable	No-SFM (n = 65–58%)	SFM (n = 47–42%)	p value
Sex			0.99
M	36 (55.4%)	26 (55.3%)	
F	29 (44.6%)	21 (44.7%)	
Age (years)	72	76	0.76
BMI (kg/m^2)	24.45	24.22	0.91
ASA score			0.92
1	4 (8%)	2 (5%)	
2	30 (60%)	25 (62.5%)	
3	14 (28%)	12 (30%)	
4	2 (4.5%)	1 (2%)	
Previous abdominal surgery			0.83
No	36 (55.4%)	27 (57.4%)	
Yes	29 (44.6%)	20 (42.6%)	
Tumor site			0.35
Intra-peritoneal	22 (33.8%)	20 (42.6%)	
Extra-peritoneal	43 (66.2%)	27 (57.4%)	
Neoadjuvant CRT			0.94
No	47 (72.3%)	35 (74.5%)	
Yes	16 (24.6%)	11 (23.4%)	
Operation type			0.25
High ant. resection	37 (56.9%)	34 (72.3%)	
Low ant. resection	7 (10.7%)	3 (6.4%)	
Ultra-low ant. resection	21 (32.3%)	10 (21.3%)	
Stoma			0.15
No	31 (47.7%)	16 (34%)	
Yes	34 (52.3%)	31 (66%)	
Stoma type			0.02
Ileostomy	11 (16.9%)	19 (40.4%)	
Colostomy	23 (35.4%)	12 (25.5%)	
Radicality			0.09
R0	56 (86.2%)	46 (97.9%)	
R+	7 (10.8%)	1 (2.1%)	
Associated procedures			0.42
No	55 (84.6%)	37 (78.7%)	
Yes	10 (15.4%)	10 (21.3%)	
N. drains			0.01
1	54 (83.1%)	27 (57.4%)	
≥ 2	11 (16.9%)	20 (42.5%)	
Approach			0.02
Open	23 (35.4%)	7 (14.9%)	
Laparoscopy	42 (64.6%)	40 (85.1%)	
Operation time (min)	190	225	0.01
pT			0.63
0	1 (1.5%)	2 (4.3%)	
1	3 (4.6%)	5 (10.6%)	
2	15 (23.1%)	10 (21.3%)	
3	34 (52.3%)	25 (53.2%)	
4	3 (4.6%)	1 (2.1%)	
pN			0.23
0	36 (55.4%)	30 (63.8%)	
1	11 (16.9%)	11 (23.4%)	

Table 2 (continued)

Variable	No-SFM ($n=65$–58%)	SFM ($n=47$–42%)	p value
2	9 (13.8%)	2 (4.3%)	
pM			0.42
0	51 (78.5%)	42 (89.4%)	
1	8 (12.3%)	2 (4.3%)	
Stage			0.63
0	1 (1.5%)	2 (4.3%)	
I	14 (21.5%)	13 (27.7%)	
II	18 (27.7%)	15 (31.9%)	
III	16 (24.6%)	11 (23.4%)	
IV	7 (10.8%)	2 (4.3%)	
Grading			0.56
G2	34 (52.3%)	24 (51.1%)	
G3	17 (26.2%)	15 (31.9%)	
N.G.	14 (21.5%)	8 (17%)	
Lymph nodes count	13	14	0.73
Margin infiltration			0.17
No	47 (94%)	40 (100%)	
Yes	3 (6%)	0	
Clavien–Dindo			0.35
0	39 (62.9%)	26 (59.1%)	
1	5 (8.1%)	9 (20.5%)	
2	7 (11.3%)	3 (6.8%)	
3	10 (16.1%)	6 (13.6%)	
4	1 (1.6%)	0	
Major complications			0.57
No	51 (82.3%)	38 (86.4%)	
Yes	11 (17.7%)	6 (13.6%)	
P.O. mortality			0.73
No	59 (90.8%)	43 (91.5%)	
Yes	3 (4.6%)	1 (2.1%)	
P.O. stay (days)	10	11	0.19
Recurrence			0.18
No	35 (67.3%)	35 (79.5%)	
Yes	17 (32.7%)	9 (20.5%)	

cancer-related survival (CRS) was 79.3, 75.2, 75.2 and 91.6%, 91.6%, 76.3% ($p=0.06$) for No-SFM and SFM groups, respectively (Fig. 2). In laparoscopy, the 3-, 5- and 7-year OS was 78.8, 73.9 and 73.9% vs. 82.3, 77.8 and 55.5% (No-SFM vs. SFM, $p=0.86$) and CRS was 84.3, 84.3, 79 and 96.2%, 96.2%, 80.1% (No-SFM vs. SFM, $p=0.06$), respectively. In open surgery, survival was not considered due to the small number of patients.

Discussion

Traditionally, the mobilization of splenic flexure has been considered mandatory in rectal cancer surgery in order to achieve good post-operative and oncologic results [23]. In literature, there are conflicting reports about the need of performing SFM. Undoubtedly, it is a demanding procedure which increases the difficulty of the operation. For this reason, some authors suggest that SFM should be performed only in selected cases to avoid tension at the colorectal anastomosis [1–5]. Currently, no consensus exists about the standardization of this procedure neither any randomized trial comparing routine to selective SFM in anterior resection [8]. However, it would be quite complicated to arrange a trial in which the randomization requires an accurate and objective intra-operative evaluation to justify the choice of submitting some patients to SFM even if not needed. Therefore, the only available current references are non-randomized studies. Moreover, not all studies are focused on rectal resections only, but often they also include left

Table 3 Comparison between patients without and with splenic flexure mobilization (SFM) by laparoscopic approach

Variable	No SFM ($n=42$–51.2%)	SFM ($n=40$–48.8%)	p value
Sex			0.85
M	24 (57.1%)	22 (55%)	
F	18 (42.9%)	18 (45%)	
Age	68.5	73.5	0.29
BMI	24.22	24.22	0.71
Previous abd. surg			0.49
No	22 (52.4%)	24 (60%)	
Yes	20 (47.6%)	16 (40%)	
Tumor site			0.39
Intra-peritoneal	14 (33.3%)	17 (42.5%)	
Extra-peritoneal	28 (66.7%)	23 (57.5%)	
Neoadjuvant CRT			0.44
No	28 (66.7%)	29 (72.5%)	
Yes	14 (33.3%)	10 (25%)	
Operation type			0.4
High ant. resection	27 (64.3%)	29 (72.5%)	
Low ant. resection	2 (4.8%)	2 (5%)	
Ultra-low ant. resection	13 (30.9%)	9 (22.5%)	
Stoma			0.02
No	26 (61.9%)	14 (35%)	
Yes	16 (38.1%)	26 (65%)	
Stoma type			0.01
Ileostomy	6 (14.3%)	17 (42.5%)	
Colostomy	10 (23.8%)	9 (22.5%)	
Associated procedures			0.15
No	38 (90.5%)	32 (80%)	
Yes	4 (9.5%)	8 (20%)	
N. drains			0.01
1	37 (88.1%)	24 (60%)	
≥2	5 (11.9%)	16 (40%)	
Conversion			0.08
No	31 (73.8%)	22 (55%)	
Yes	11 (26.2%)	18 (45%)	
Operation time (min)	205.5	222.5	0.04
Lymph nodes count	13	14	0.65
Major complications			0.85
No	36 (87.8%)	33 (89.2%)	
Yes	5 (12.2%)	4 (10.8%)	
P.O. mortality			0.56
No	40 (95.2%)	36 (90%)	
Yes	1 (2.4%)	1 (2.5%)	
P.O. stay (days)	9	10	0.01
Recurrence			0.41
No	27 (73%)	30 (81.1%)	
Yes	10 (27%)	7 (18.9%)	

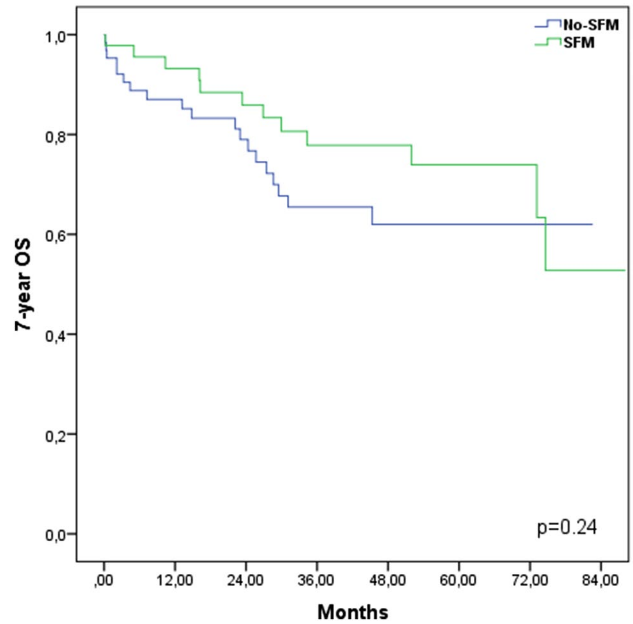

Fig. 1 7-year overall survival of patients of the two groups

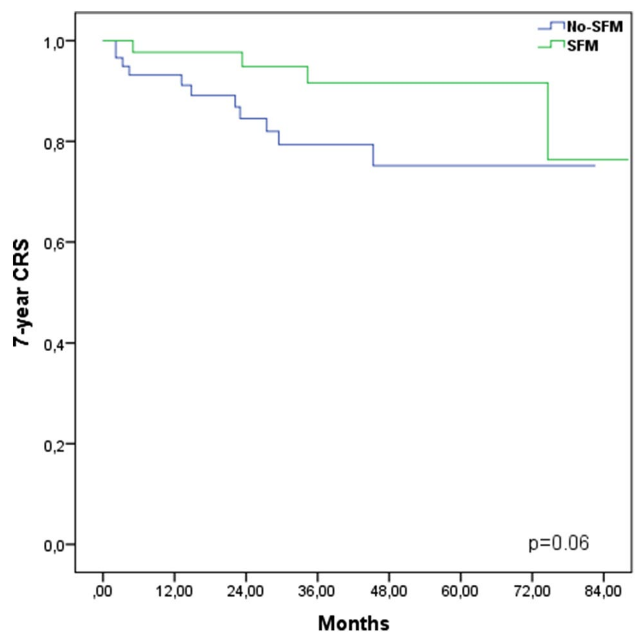

Fig. 2 7-year cancer related survival of patients of the two groups

colectomies [4, 24]. In our study, which analyzes only anterior rectal resections, SFM was performed in 42% of cases. This high rate, compared to other studies [1, 8], is probably explained by the significantly greater proportion of laparoscopic cases in the SFM group. In fact, during laparoscopy, the evaluation of blood supply to the residual colon may be more difficult without any additional tool, like fluorescence dye injection [25]. Moreover, even in case of good blood perfusion, the assessment of a tension-free anastomosis is often challenging and not easy to identify during laparoscopy. As a consequence, SFM is performed by default in most of the cases to minimize any risk of anastomotic leakage. For this reason, in our study, SFM was more frequently performed in laparoscopy than in open surgery. However, SFM may be not necessary in a great number of laparoscopic patients and the strict choice about mobilization or non-mobilization may be associated with an unacceptably high morbidity rate. Our results revealed also no difference in the choice of performing SFM according to tumor location and operation type. Surprisingly, SFM was more frequent in case of high anterior resection (72.3% vs. 56.9%, $p=0.16$); whereas for ultra-low resection, no particular differences were found in the two groups. These data demonstrate that SFM has been performed only when necessary for tension-free anastomosis without any signs of altered blood supply. No differences in the two groups were found about the presence of stoma, but when the type of stoma was analyzed, ileostomy resulted more frequent in the SFM group while colostomy was preferred in the No-SFM group ($p=0.02$). Currently there is no consensus on the best surgical procedure for constructing a defunctioning stoma in rectal cancer surgery and this lacking is confirmed also by some meta-analyses comparing ileostomy and colostomy which have failed to demonstrate the superiority of either methods [26–29]. A recent meta-analysis, focused on the complications of loop ileostomy and colostomy, has shown a lower incidence of complications for ileostomy with a lower prevalence of sepsis, prolapse, and parastomal hernias and less incidence of wound infection and incisional hernias in the closure of stomas [30]. Regarding intra-operative data, SFM resulted in longer operative times (225 vs. 190 min, $p=0.01$), confirming the results reported by other studies and the hypothesis that SFM is a time-consuming procedure which increases the complexity of the operation [8]. Another intra-operative finding was the higher number of drains positioned in case of SFM. This result reflects the wider dissection performed in case of SFM, including the mobilization of the whole descending colon until the transverse colon with a higher risk of post-operative collections which were prevented by the positioning of an additional drain in the left paracolic space. Postoperative results showed no difference in terms of morbidity and oncologic outcomes. In particular, major complications including anastomotic leakage, post-operative stay and lymph nodes harvest were not affected by the omission of SFM, confirming that this procedure can be safely avoided when unnecessary. When we compared the two groups about the extent of resection, no statistically significant difference was shown. This result confirmed that the study was not affected by the potential bias of the type of resection, in which SFM may be more often performed in the group of low and ultra-low resections. A remarkable result in the laparoscopic group was the conversion rate, which was higher in the SFM group (45% vs. 26.2%, $p=0.08$). This means that almost half of the laparoscopic procedures in which SFM was performed were converted to open surgery. Although not significant, we can suppose that SFM may be one important cause of conversion in laparoscopic surgery for rectal cancer, but this result needs to be validated by further investigation. The other results in the analysis of laparoscopic cases were similar to those of the whole population, whereas no statistical significance was registered in the open group, maybe due to the relatively small number of patients. However, similar trends resulted in the two groups, in particular a shorter operation time in laparoscopy and open surgery of, respectively, 17 and 45 min faster without SFM ($p=0.04$ and $p=0.39$). Although not statistically significant, the latter may demonstrate how SFM may be demanding even in open surgery. In open anterior resection, many surgeons prefer routine SFM at the beginning of the operation, particularly for low rectal cancers [31]. This step is often carried out together with the dissection of the inferior mesenteric artery, the inferior mesenteric vein and the colon before the pelvic dissection. If there is bleeding from the spleen, it can be packed and will probably stop during the time it takes to perform the rectal dissection [7]. However, our open results show how SFM can be safely avoided in 76.7% of open cases with a direct evaluation of the colon in terms of tension and blood supply. Therefore, routine SFM during open anterior resection should probably be abandoned to prefer a selective approach [1, 2, 5]. A similar consideration may be done about laparoscopy, but with this approach the evaluation of the real conditions of the residual colon is obviously more difficult, as discussed before. Therefore, we think that a selective approach, in which the eventual SFM is not performed at an early stage of the operation, should be the best. Nevertheless, it is true that the definition of SFM may vary from different surgeons, because there is not a universally accepted technique; so, this can be very heterogeneous in different series. Moreover, many other factors should be considered: height of the tumor and level of vascular ligation, length and quality of the descending/sigmoid colon, patient shape, surgeon's technical skills. Finally, the survival analysis, after a slight advantage in the first years for SFM group, revealed no statistical significant differences in the two groups in terms of OS and CRS. However, this result needs to be confirmed by further investigation with longer follow-up and more cases included. We have to mention the limit of our study related to the small number of patients and to the retrospective nature of data collection and study design. We demonstrated the homogeneity of the population according to the general clinico-pathological features and also the potential bias of the extent of resection.

In conclusion, SFM is a difficult technical step in rectal cancer resection and it can increase the complexity of the operation. Our study supports the hypothesis that SFM results in longer operative time both in laparoscopy and in open surgery, without any difference in terms of morbidity, oncologic outcomes and survival. SFM is not related to the extent of resection, and in our series, it has been performed according to intra-operative evaluation of the residual colon. A higher conversion rate may be related to the difficulty of carrying out SFM in laparoscopy. However, despite the presence of some limitations, we support the hypothesis that every surgeon should carry out an accurate intra-operative evaluation to perform a selective SFM. When possible, SFM can be safely avoided with no additional risks in terms of post-operative and oncologic outcomes. Although uneasy, a randomized prospective study should be performed to avoid individual bias.

Compliance with ethical standards

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

Research involving human participants All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

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

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