Full length article

Diverting stoma-related complications following colorectal endometriosis surgery: a 163-patient cohort

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ABSTRACT

Objective: Deep endometriosis may simultaneously infiltrate the vagina and the rectosigmoid, which associated resection may increase the risk of postoperative complications. Among these complications, rectovaginal fistula is one of the worst. To reduce the risk of rectovaginal fistula and related complications, surgeons may employ diverting stoma. The literature is rich in data concerning the usefulness of stoma in patients managed for low rectal cancer. However, extrapolation of these data to patients managed for rectal endometriosis is disputable. For this reason, there are no guidelines on the role of stoma in preventing rectovaginal fistula in patients managed for colorectal endometriosis. The objective of our study was to assess the risk of complications related to the use of stoma in patients managed for colorectal endometriosis.

Study Design: A retrospective comparative study has been performed using data prospectively recorded in the CIRENDO database. 163 consecutive women with colorectal endometriosis who had temporary stoma have been enrolled at the University Hospital of Rouen, from June 2009 to December 2016. The main outcome was stoma-related complications rate using Clavien-Dindo classification. No women were lost to follow-up.

Results: Among the 163 women, 158 (96.9%) had a primary diverting stoma and 5 women (3.1%) with an immediate post-surgical bowel fistula had a secondary diverting stoma. Stoma involved the ileum in 28 women (17.2%) and the colon in 135 (82.8%). Surgical management of the rectosigmoid junction was rectal shaving in 2 women (1.2%), disc excision in 62 (38%), colorectal resection in 87 (53.4%), and combined rectal disc excision and sigmoid colon segmental resection in 12 (7.4%). Clavien Dindo I stoma-related complications occurred in 38 patients (23.3%) and were related to abnormal healing of stoma scar. Most Clavien-Dindo II complications were wound or urinary infections following stoma closure. Clavien Dindo III complications occurred in 14 patients (8.6%) and were related to leakage, hemoperitoneum, hernia of the abdominal wall, subcutaneous abscess and bowel obstruction syndrome.

Conclusion: Specific complications may occur directly related to the use of stoma in the surgery of deep endometriosis of the rectosigmoid. The risk of these complications should be taken into account and full preoperative information should be provided to patients and their family.

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Introduction

The surgical management of colorectal endometriosis is complex and may be responsible for severe postoperative complications such as rectovaginal fistula, pelvic abscess, hemo-peritoneum or peritonitis (1). Several surgical procedures are performed routinely: nodule excision without opening the rectum (shaving), resection of the nodule with excision of the anterior rectal wall (disc excision) and segmental colorectal resection (1,2). Choosing the optimal surgical procedure is complex and based on many factors related to a patient's characteristics (age, desire to preserve fertility, nodule localization etc.), risk of immediate and delayed complications, as well as on a surgeon's experience and beliefs (1).

However, deep endometriosis nodules may simultaneously infiltrate the vagina and uterosacral ligaments and associated resection may increase the risk of postoperative complications

related to colorectal procedures. Among these complications, rectovaginal fistula is one of the worst and repair requires additional complex surgical procedures which may negatively impact young patients' quality of life. To reduce the risk of rectovaginal fistula and related complications, colorectal surgeons employ diverting stoma, which involves exteriorization of a loop of ileon or colon during a lapse of time considered necessary for complete healing of colorectal sutures (3–5). After approximately 1 week to 3 months, surgeons then perform a second surgical procedure to close the stoma by bowel suture and a layer-by-layer suture of abdominal wall.

The literature is rich in data concerning the usefulness of stoma in patients managed for low rectal cancer (up to 5 to 7 cm above the anus) (3–5). However, extrapolation of these data to patients managed for rectal endometriosis is disputable on the basis of several major differences: patients managed for rectal endometriosis are younger than those treated for rectal cancer, their BMI is usually low or normal and they are more likely to undergo concomitant large resection of the vagina (6). For this reason, there are no guidelines on the role of stoma in preventing rectovaginal fistula in patients managed for colorectal endometriosis. Hence the debate continues regarding the use of stoma in this context overlooking one major variable: the risk of complications related to the use of stoma.

The aim of our study was to assess the risk of complications related to the use of stoma in patients managed for colorectal endometriosis, in a series of consecutive patients undergoing various colorectal procedures along with primary or secondary diverting stoma.

Material and methods

We conducted a retrospective cohort study from June 2009 to December 2016 in the Expert Center in the Diagnosis and Multidisciplinary Management of Endometriosis at Rouen University Hospital, France. We enrolled consecutive patients managed for colorectal endometriosis who had received temporary diverting stoma. The intervention was either primary, performed during the surgical procedure on the rectum/sigmoid colon, or secondary, performed during a second procedure required by a postoperative complication.

All women referred to our expert center for deep endometriosis had clinical examination by a surgeon experienced in endometriosis, as well as MRI examination. When deep endometriosis was confirmed, endorectal ultrasound was performed to check whether the rectum was involved and to estimate the depth of rectal wall infiltration. Computed tomography based virtual colonoscopy was often used to check for digestive tract stenosis and associated digestive tract localizations. Complementary examinations, such as cystoscopy and unenhanced helical computed tomography were performed in women with associated involvement of the urinary tract.

The operative strategy was discussed with both the patient and the digestive surgeon before a decision was made concerning the surgical procedure to be used, i.e. rectal shaving, disc excision or segmental colorectal resection. The choice of procedure was decided preoperatively in a large majority of cases, on the basis of multiple arguments, such as endometriosis nodule features, symptoms, age, and pregnancy intention, as discussed in our previous reports (6). The principles and goals of the surgical approach were discussed before surgery, and patients were informed of the main postoperative complications. They were informed that a temporary diverting stoma could be created in case of simultaneous sutures of the rectum/sigmoid colon and vagina, when these sutures were close enough (less than 2 cm distance) to connect and lead to a rectovaginal fistula or in any other circumstances supposed to negatively impact the normal healing of bowel suture.

The techniques employed on the bowel were shaving, disc excision or segmental resection and have been presented extensively in our previous original studies and video articles (6,7). Disc excision was performed using the Rouen technique (large disc excision on the low and mid rectum using a combined laparoscopic-transanal approach), circular transanal staplers and rarely by direct approach using a suprapubic incision (6). Patients with multiple colorectal nodules were managed by either combined rectal disc excision and sigmoid colon segmental resection or en bloc colorectal resection (8). When the vagina was infiltrated by the disease, resection of vaginal cul de sac was routinely carried out with immediate discontinuous suture using resorbable stitches. In patients with no further pregnancy intention and adenomyosis, hysterectomy was proposed in order to improve postoperative outcomes (9). The decision to create a primary stoma, by ileostomy or colostomy, was based on intraoperative findings after discussion between gynecologic and digestive surgeons, based on the close proximity of vaginal and rectal sutures, unsatisfactory bubble test of the colorectal anastomosis, etc.

The surgical route was exclusively laparoscopic. Each time a procedure requiring bowel suture (either disc excision or segmental resection) was planned, antibiotics were systematically administered according to the guidelines of the French Society of Anesthesiology and Intensive Care (SFAR): 30 minutes before the incision, cefoxitine 1 g (to be repeated if surgery was longer than 2 hours). In women with allergy, metronidazol 1 g and gentamycine 5 mg/kg were used. The antibiotherapy was not prolonged after the surgery, except in rare circumstances, such as intra-abdominal bowel content spilling.

Patients underwent routine assessment of the level of C reactive protein on days 4, 5 and 6 after surgery. When the level of C reactive protein increased progressively, abdominal and pelvic computed tomography with barium enema was carried out in emergency to rule out bowel leakage, pelvic hematoma or abscess. In patients with leakage, second surgery with diverting stoma was carried out in emergency; in our study, these patients were recorded as having had a "secondary stoma". In patients with hematoma or abscess but without obvious bowel leakage, emergency laparoscopy was performed to drain the liquid followed by a rectal bubble air test; when the test was abnormal or equivocal, a secondary stoma was created prophylactically.

In patients with stoma, imaging assessment of the rectum by barium enema or computed tomography-based virtual colonoscopy was usually performed 2 months after the procedure, to rule out rectovaginal fistula. When complete healing was confirmed, the stoma was closed within 4 weeks. When rectovaginal fistula was still present, surgical management usually included transvaginal or/and transanal repair and the stoma was left in place. If the repair failed, an abdominal approach was proposed with either fistula suture or segmental resection and anastomosis. After each surgical procedure, imaging assessment was carried out to rule out fistula recurrence, prior to closing the stoma. Postoperative continuous hormonal therapy was recommended in patients with no pregnancy intention, with the aim of reducing the risk of postoperative recurrences.

During the study period, patients' data and follow-up were prospectively recorded in the CIRENDO (North-West Inter Regional Female Cohort for Patients with Endometriosis) database (NCT02294825) by a clinical research technician. Data included patients' medical history, clinical symptoms, findings of clinical and imagery examinations, surgical procedures and postoperative outcomes. This study was approved in 2009 by the French authority CCTIRS (Advisory Committee on information processing

in healthcare research, n° 09.445) (10). A detailed preoperative questionnaire was used to complete patients' symptom history. Standardized questionnaires were routinely used to assess pre- and post-operative digestive function and the quality of life and health status.

We defined "stoma-related complications" as being an intra- or post-operative complication that would not have occurred if the stoma had not been created, including any complication involving the stoma or related to the procedure of stoma closure. We did not include complications with a disputable relationship with the stoma, such as stenosis of colorectal anastomosis. Stoma-related complications were identified using data from the CIRENDO database along with complete review of the patient's medical charts. Complications were recorded using the Clavien-Dindo classification (11). According to French laws, analysis of retrospective data is exempt from approval by the institutional review board.

Statistical analysis was performed using Stata 11.0 software (Stat Corporation, Lakeway Drive, TX, USA). We present the number of patients and percentages (qualitative variables), as well as median values and range (continuous variables). Comparison of patients with and without complications was performed using Fisher exact test (qualitative variables), and Student t test (continuous variables). Women managed by respectively disc excision, segmental resection and combined technique (rectal disc excision + segmental resection of the sigmoid colon) were compared using Fisher exact test (qualitative variables) and ANOVA (continuous variables). The group of 2 patients managed by shaving was not included in statistical analysis because of the small sample size. P < 0.05 was considered statistically significant.

Results

From June 2009 to December 2016, 589 women were surgically managed in our expert center for deep endometriosis infiltrating the rectum/sigmoid colon from the muscular to the mucosal layer. Among them, 163 women had a diverting stoma, either primary in 158 (96.9%) or secondary in 5 (3.1%), in whom bowel fistula or leakage occurred immediately after surgery. Surgical management of deep colorectal endometriosis was rectal shaving in 2 women (1.2%), disc excision in 62 (38%), colorectal resection in 87 (53.4%), and combined rectal disc excision and sigmoid colon segmental resection in 12 women with multifocal colorectal endometriosis (7.4%). (Fig. 1). The patients were free from other chronic diseases.

Table 1 presents patients' main characteristics and intra-operative findings. Multifocal rectosigmoid endometriosis was recorded in more than 40% of women. When disc excision was carried out, the diameter of the specimen was 50.9 mm. Conversely, when segmental resection was performed, the length of the specimen was 10.9 cm in order to avoid unfavorable postoperative digestive functional outcomes.

Table 2 details complications related to diverting stoma, stratified on the Clavien Dindo classification. In 23.3% of women, stoma scar required specific postoperative care due to subcutaneous infection, dehiscence or delayed healing (Fig. 2). In 3.1% of women, there was an invagination of the proximal bowel through the stoma with negative impact on the quality of life (Fig. 3). Clavien Dindo II complications were mainly related to antibiotics administered for local infections during stoma healing or urinary infections following surgery for stoma closure. Clavien Dindo III complications following
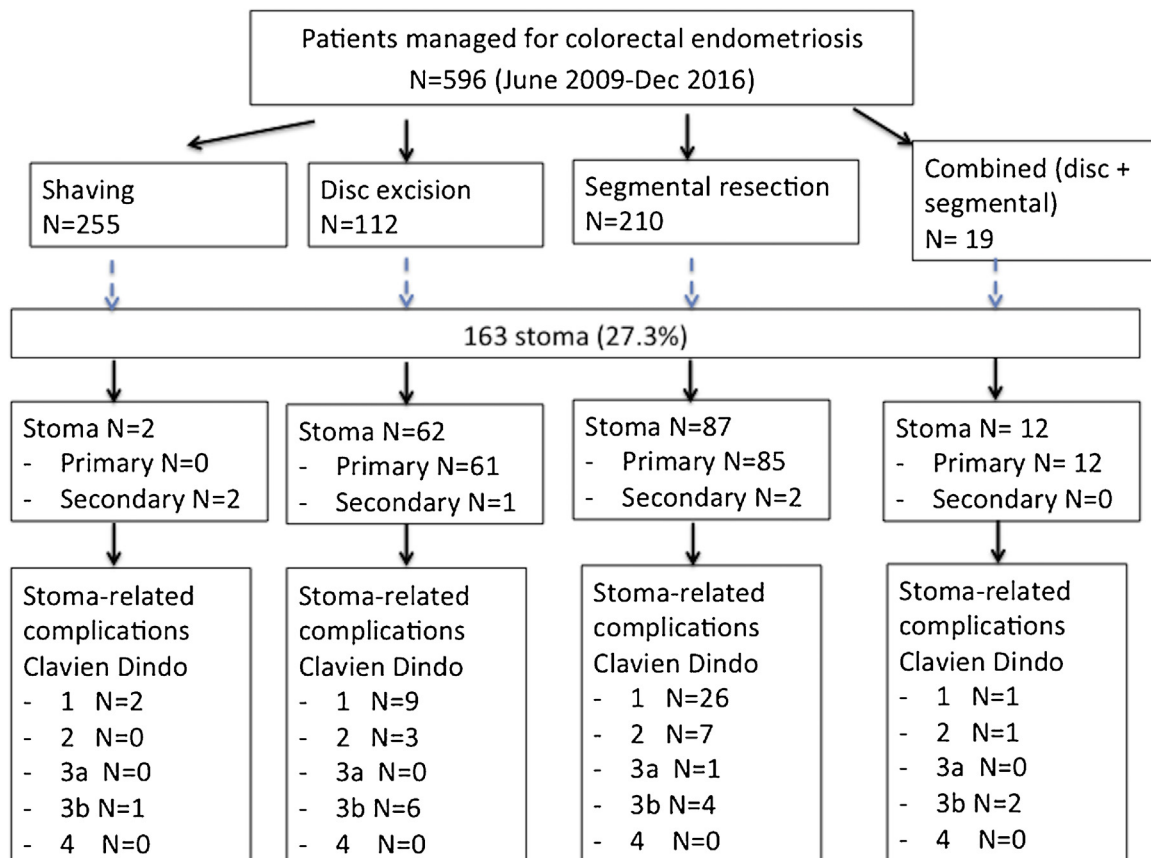

Fig. 1. Flow chart of the study.

Table 1
Patients' characteristics, surgical antecedents, intraoperative findings and main surgical procedures.

	Whole sample N = 163 (%)	Shaving N = 2 (%)	Disc excision N = 62 (%)	Segmental resection N = 87 (%)	Combined disc excision + segmental resection N = 12 (%)	P**
Age	30.4 ± 4.6	32 and 32	29.5 ± 4.2	30.9 ± 4.9	30.8 ± 4.9	0.18
BMI (kg/m^2)	23.6 ± 4.1	22.8 and 27.3	24.1 ± 5	23.5 ± 3.5	21.4 ± 3	0.11
Antecedents of gynecologic surgery						
Previous open surgeries	14 (8.6)	0	4 (6.4)	9 (10.3)	1 (8.3)	0.75
Number of previous laparoscopies						0.09
None	88 (54)	0	41 (66.2)	42 (48.3)	5 (41.7)	
1	55 (33.7)	2	17 (27.4)	32 (36.7)	4 (33.3)	
≥2	20 (12.2)	0	4 (6.4)	13 (14.9)	3 (25)	
Obstetrical antecedents						
- Nulligravida	116 (71.2)	2	48 (77.4)	55 (63.2)	11 (91.7)	0.05
- Nullipara	131 (80.4)	2	53 (85.5)	65 (74.7)	11 (91.7)	0.21
Type of stoma:						0.02
-Loop ileostomy	28 (17.2)	1	3 (4.8)	22 (25.2)	2 (16.7)	
-Loop colostomy	135 (82.8)	1	59 (95.1)	65 (74.7)	10 (83.3)	
Largest diameter of the disc (mm)*	50.9 ± 14.4	N/A	51.9 ± 14.9	N/A	45.4 ± 10.5	
Length of the segmental resection (cm)*	10.9 ± 5	N/A	N/A	11.4 ± 5	7.3 ± 2.9	
Rectal nodule size						0.42
-<1 cm	1 (0.6)	0	0 (0)	1 (1.1)	0 (0)	
-1-2.9cm	24 (14.7)	0	11 (17.7)	10 (11.5)	3 (25)	
- >=3 cm	138 (86.7)	2	51 (82.3)	76 (87.4)	9 (75)	
Vaginal infiltration						0.02
None	22 (13.5)	1	5 (8.1)	13 (15)	3 (25)	
-<1cm	16 (9.8)	0	2 (3.2)	14 (16.1)	0 (0)	
-1-2.9cm	29 (17.8)	0	14 (22.6)	11 (12.6)	4 (33.3)	
->=3 cm	96 (58.9)	1	41 (66.1)	49 (56.3)	5 (41.7)	
Operative time (min)*	270 ± 84	300 and 180	240 ± 87	293 ± 78	257 ± 59	<0.001
Operative route						1
-Laparoscopy	154 (94.5)	2 (100)	58 (93.5)	82 (94.3)	12 (100)	
-Laparoscopy followed by laparotomy	9 (5.5)	0	4 (6.5)	5 (5.7)	0 (0)	
AFSr score*	71.1 ± 36.4	70 and 106	55.5 ± 31.4	80.5 ± 38.1	80 ± 19.2	<0.001
Endometriosis stage						0.06
-2	19 (11.7)	0	10 (16.1)	9 (10.3)	0 (0)	
-3	9 (5.5)	0	7 (11.3)	2 (2.3)	0 (0)	
-4	135 (82.8)	2	45 (72.6)	76 (87.4)	12 (100)	
Douglas pouch complete obliteration	118 (72.4)	1	39 (62.9)	67 (77)	11 (91.7)	0.06
Endometriosis localizations						
-diaphragm	25 (15.3)	1	7 (11.3)	16 (18.4)	1 (8.3)	0.48
-sigmoid colon	70 (42.9)	1	8 (12.9)	49 (56.3)	12 (100)	<0.001
-rectum	160 (98.2)	2	61 (98.4)	85 (97.7)	12 (100)	1
Endometrioma	95 (58.2)	2	33 (53.2)	52 (59.8)	8 (66.7)	0.62
Hysterectomy + colpectomy	7 (4.3)	0	1 (1.6)	6 (6.9)	0 (0)	0.36
Other surgical procedures on digestive tract						
-Small bowel + caecum resection	7 (4.3)	0	0 (0)	6 (6.9)	1 (8.3)	0.06
-Cecum resection	3 (1.8)	0	0 (0)	3 (3.4)	0 (0)	0.42
-Appendectomy	11 (6.7)	0	5 (8.1)	4 (4.6)	2 (16.7)	0.17
Surgical procedures on urinary tract						0.05
-None	133 (81.6)	2	56 (90.3)	67 (77)	8 (66.6)	
-Resection of the bladder	11 (6.7)	0	1 (1.6)	9 (10.3)	1 (8.3)	
-Advanced ureterolysis requiring JJ stent	11 (6.7)	0	3 (4.8)	5 (5.7)	3 (25)	
-Ureteral resection and uretero-cystostomy	8 (4.9)	0	2 (3.2)	6 (6.9)	0 (0)	

* Mean ± SD, except in the shaving column where data are presented individually.
** Comparison of groups "Disc excision" vs. "Segmental resection" vs. "Combined disc excision + segmental resection" (the group of 2 patients managed by shaving was not included in the statistical analysis).

surgery for stoma closure (hemoperitoneum and leakage) were due to adhesions or hernia involving the abdominal stoma scar (Fig. 4).

Eleven women with a primary stoma (7%) had rectovaginal fistula: 3 following disc excision (4.9% of women managed by this technique), 5 following segmental resection (5.9% of women managed by this technique) and 3 following combined rectal disc excision and sigmoid colon segmental resection (25% of women managed by this technique). Five other women without primary stoma had rectovaginal fistula and benefited from a secondary stoma created in emergency: 2 of them after rectal shaving, 1 after disc excision and 2 after colorectal resection.

Fifteen women were secondarily managed by endoscopy or surgery for significant stenosis of colorectal anastomosis (9.2%). The primary procedure was segmental resection in 12 women

(13.8% of women managed by this technique) and combined rectal disc excision and sigmoid colon segmental resection in 1 woman (8.3% of women managed by this technique). In 2 patients (one managed by rectal shaving and the other by disc excision) stenosis occurred after segmental resection carried out to treat their rectovaginal fistula. In our study, stenosis of colorectal anastomosis was not considered to be an a priori complication related to stoma use.

Women with or without stoma-related complications were compared to identify factors related to the risk of complications (Table 3). Patients presenting with stoma-related complications were significantly older and had higher AFSr scores, and were more likely to be managed by segmental resection.

Table 2
Stoma-related complications.

Stoma-related complications	Whole sample N = 163 (%)	Shaving N = 2	Disc excision N = 62 (%)	Segmental resection N = 87 (%)	Combined Disc excision + segmental resection N = 12 (%)	P*
Clavien Dindo I	38 (23.3)	2	9 (14.5)	26 (29.9)	1 (8.3)	0.045
-Wound infection	22 (13.5)	1	5 (8.1)	15 (17.2)	1 (8.3)	0.25
-Wound care for delayed healing	9 (5.5)	0	2 (3.2)	7 (8)	0 (0)	0.39
-Wound dehiscence	2 (1.2)	0	1 (1.6)	1 (1.1)	0 (0)	1
-Stoma prolapse	5 (3.1)	1	1 (1.6)	3 (3.4)	0 (0)	0.74
Clavien Dindo II	11 (6.7)	0	3 (4.8)	7 (8)	1 (8.3)	0.62
-Urinary infection or pyelonephritis	7 (4.3)	0	2 (3.2)	4 (4.6)	1 (8.3)	0.56
-Antibiotherapy for wound infection	3 (1.8)	0	1 (1.6)	2 (2.3)	0 (0)	1
-Post-operative atrial fibrillation	1 (0.6)	0	0 (0)	1 (1.1)	0 (0)	1
Clavien Dindo IIIa	1 (0.6)	0	0 (0)	1 (1.1)	0 (0)	1
-Ultrasound-guided drainage of sub-cutaneous abscess	1 (0.6)	0	0 (0)	1 (1.1)	0 (0)	1
Clavien Dindo IIIb	13 (8)	1	6 (9.7)	4 (4.6)	2 (16.7)	0.17
-Hemoperitoneum after stoma closure	1 (0.6)	0	1 (1.6)	0 (0)	0 (0)	1
-Anastomotic stoma leakage	1 (0.6)	0	1 (1.6)	0 (0)	0 (0)	1
-Abdominal wall hernia	9 (5.5)	1	4 (6.5)	4 (4.6)	0 (0)	0.85
-Bowel obstruction syndrome	2 (1.2)	0	0 (0)	0 (0)	2 (16.7)	0.05
Clavien Dindo IV	0 (0)	0	0 (0)	0 (0)	0 (0)	1
Delay stoma closure (months) :		4.5 and 37				
-Mean (SD)	4.4 ± 4.3		4.1 ± 3.4	3.9 ± 2.9	6.2 ± 5.8	0.09
-Median (range)	3		3.5	3	3	
Duration of hospitalization (days) :		8 and 6				
-Mean (SD)	5.8 ± 1.7		5.7 ± 1.5	5.9 ± 2	6.1 ± 1.1	0.69
-Median (range)	6		5	6	6	
New stoma creation	2 (1.2)	0	1 (1.6)	1 (1.1)	0 (0)	1

**Comparison of groups "Disc excision" vs. "Segmental resection" vs. "Combined disc excision + segmental resection" (the group of 2 patients managed by shaving was not included in the statistical analysis).
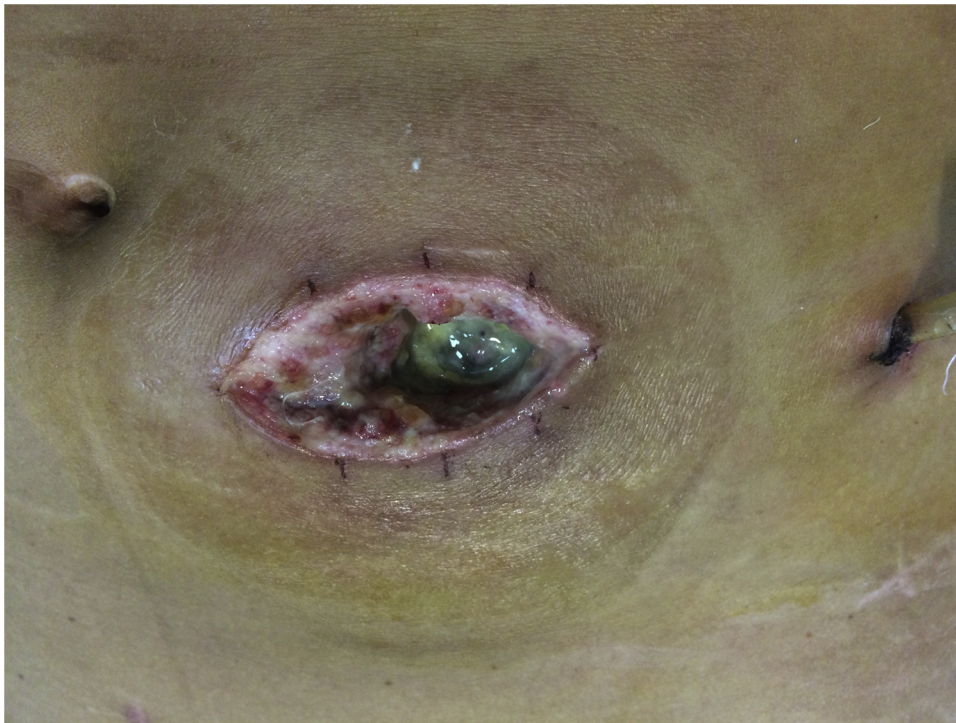
Fig. 2. Subcutaneous infection, leading to scar dehiscence and delayed healing.

Comment

We performed an original study revealing that the use of stoma in patients surgically managed for rectosigmoid endometriosis is responsible for a significant rate of complications. One patient out of 12 required a secondary surgical procedure due to stoma-related complications. One patient out of 5 presented with minor complications related to abdominal wall stoma scar (Clavien Dindo I) with potential negative esthetic consequences. These complications should be taken into account when surgeons recommend the use of stoma, and full preoperative information should be provided to patients and their family.

Our study has two main strengths: the large sample size and prospective data recording in a database. Our large sample size

Fig. 3. Colostoma prolapse.
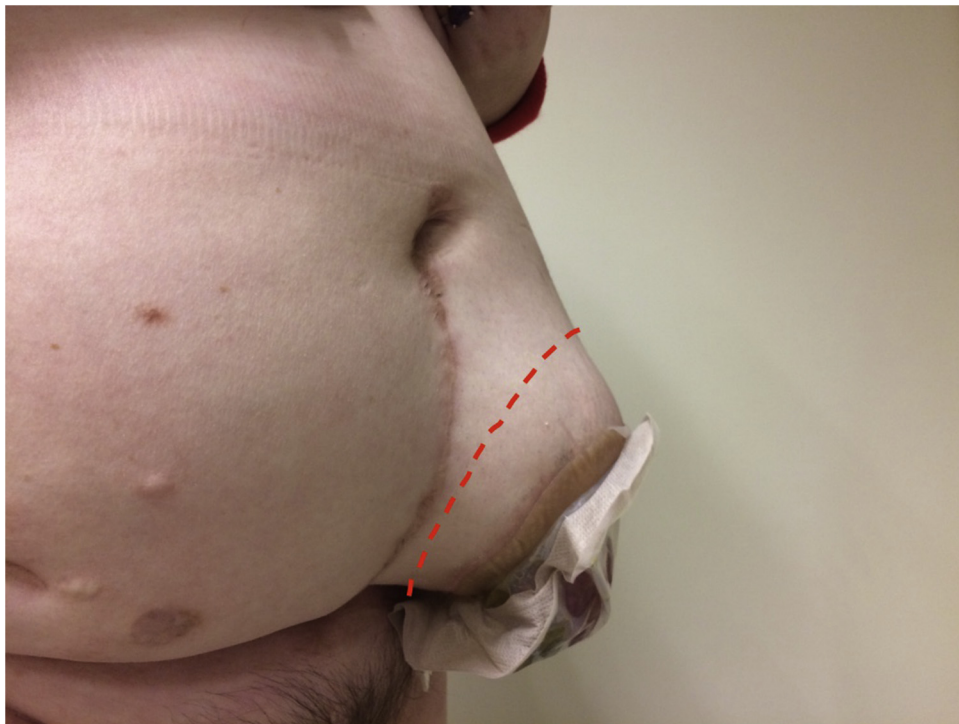
Fig. 4. Large hernia of abdominal wall muscles surrounding the colostoma (dotted line show the limits of the muscular hernia ring).

allowed us to identify a large number of potential complications related to the use of stoma, even among the least frequent (leakage, hemoperitoneum, abdominal wall hernia). Prospective recording of data in a specific database managed by a dedicated clinical researcher allowed for accurate analysis of postoperative outcomes, with a very low risk of patients lost to follow-up.

Our study also has several weaknesses. The sample size might have been too small to reveal very rare complications, with a rate inferior to 1%. Data analysis was based on a prospective cohort and surgeons selected surgical procedures based on the individual characteristics of patients as well as on their own experience and beliefs. These circumstances led to an unavoidable heterogeneity of procedures, not only on the rectum or sigmoid colon, but also concerning the diverting stoma itself. A majority of women had a

colostomy, thus our data cannot be extrapolated without caution to those surgeons who exclusively employ ileostomy.

Diverting temporary stoma is used in patients with concomitant rectal and vaginal sutures, in order to avoid the risk of complications due to rectovaginal fistula or leakage. Despite a lack of evidence based on randomized trials (12), colostomy may be preferred to ileostomy, as it is expected to lead to better patient adaptation and comfort. As opposed to liquid stools, solid stools lower the risk of appliance leakage, resulting in fewer appliance changes required per day and reduced diet restrictions. A meta-analysis pooling data provided by randomized and observational studies concluded that ileostomy was associated not only with a higher risk of dehydratation, but also with an increased risk of bowel occlusion after stoma closure (13). On the other hand, the

Table 3
Relationship between pre- and intra-operative factors and stoma-related complications.

	Whole sample N = 163 (%)	Patients free of stoma-related complications N = 111 (%)	Patients with stoma-related complications N = 52 (%)	P
Type of stoma				0.83
-Loop ileostoma	28 (17.2)	20 (18)	8 (15.4)	
-Loop colostoma	135 (82.8)	91 (82)	44 (84.6)	
Antecedents				
Age	30.3 ± 4.9	29.8 ± 4.5	31.6 ± 4.7	0.02
BMI (kg/m^2)	23.6 ± 4.1	23.5 ± 4.1	23.7 ± 4.3	0.7
Antecedents of gynecologic surgery	81 (49.6)	50 (45)	31 (59.6)	0.08
Laparotomies	14 (8.6)	10 (9)	4 (7.7)	0.78
Antecedent of laparascopy	75 (46)	46 (41.4)	29 (55.8)	0.09
Nulligravida	116 (71.2)	79 (71.2)	37 (71.2)	0.99
Nullipara	131 (80.4)	89 (80.2)	42 (80.8)	0.93
Rectal nodule size				0.55
-<1 cm	1 (0.6)	1 (0.9)	0 (0)	
-1-2.9cm	24 (14.7)	14 (12.6)	10 (19.2)	
- >=3 cm	138 (86.7)	96 (86.5)	42 (80.8)	
Vaginal infiltration	140 (85.9)	95 (85.6)	45 (86.5)	0.87
Vaginal infiltration size				0.32
-<1cm	16 (9.8)	10 (9)	6 (11.5)	
-1-2.9cm	28 (17.2)	16 (14.4)	12 (23.1)	
->=3 cm	96 (58.9)	69 (62.1)	27 (51.9)	
Operative time (min)	270 ± 84	271 ± 91	267 ± 66	0.76
Operative route				0.06
-Laparotomy	0 (0)	0 (0)	0 (0)	
-Laparoscopy	154 (94.5)	102 (91.9)	52 (100)	
-Laparoscopy + laparotomy	9 (5.5)	9 (8.1)	0 (0)	
AFSr score	71.1 ± 36.4	66.5 ± 34.9	80.8 ± 37.7	0.02
Endometriosis stage				0.10
-2	19 (11.7)	12 (10.8)	7 (13.5)	
-3	9 (5.5)	9 (8.1)	0 (0)	
-4	135 (82.8)	90 (81.1)	45 (86.5)	
Douglas pouch complete obliteration	118 (72.4)	78 (70.3)	40 (76.9)	0.38
Endometriosis lesions :				
-diaphragm	25 (15.3)	17 (15.3)	8 (15.4)	0.99
-sigmoid colon	70 (42.9)	44 (39.6)	26 (50)	0.23
-rectum	160 (98.1)	109 (98.2)	51 (98.1)	0.96
Endometrioma	95 (58.2)	63 (56.8)	32 (61.5)	0.56
-Right	63 (38.7)	43 (38.7)	20 (38.5)	0.97
-Left	77 (47.2)	50 (45)	27 (51.9)	0.41
-Both	45 (27.6)	30 (27)	15 (28.8)	0.81
Deep posterior endometriosis nodule localization				
-Left uterosacral ligament (USL)	32 (19.6)	21 (18.9)	11 (21.2)	0.74
-Right USL	21 (12.9)	14 (12.6)	7 (13.5)	0.88
-Rectovaginal septum	64 (39.3)	44 (39.6)	20 (38.5)	0.89
-Both USL and rectovaginal septum	95 (58.3)	65 (58.6)	30 (57.7)	0.92
Hysterectomy + colpectomy	7 (4.3)	4 (3.6)	3 (5.8)	0.53
Surgical procedures on digestive tract				
- Colorectal procedures				0.02
-Shaving	2 (1.2)	0 (0)	2 (3.8)	
-Disc excision	62 (38)	49 (44.1)	13 (25)	
-Segmental resection	87 (53.4)	54 (48.6)	33 (63.5)	
-Combined (disc excision + segmental resection)	12 (7.4)	8 (7.2)	4 (7.7)	
-Small bowel + caecum resection	7 (4.3)	6 (5.4)	1 (1.9)	0.31
-Caecum resection	3 (1.8)	2 (1.8)	1 (1.9)	0.96
-Appendectomy	11 (6.7)	8 (7.2)	3 (5.8)	0.73
Surgical procedures on urinary tract	30 (18.4)	19 (17.1)	11 (21.2)	0.54
-Resection of the bladder	11 (6.7)	8 (7.2)	3 (5.8)	0.73
-Advanced ureterolysis requiring JJ stent	11 (6.7)	5 (4.5)	6 (11.5)	0.10
-Ureteral resection and uretero-cystostomy	8 (4.9)	6 (5.4)	2 (3.8)	0.67

risk of infectious complications was found to be higher after a procedure on the colon than on the ileum. Colostomy has also been associated with a higher risk of stoma prolapse and postoperative hernia of the abdominal wall (13).

Stoma is routinely used in colorectal surgery to reduce both the risk of fistula and reintervention for fistula after low colorectal anastomosis (3–5). These are the two main reasons that justified its use in our series. In addition, we believe that repair of rectovaginal fistula is less challenging in women with primary stoma. Nevertheless, we were unable to confirm that these women had more favorable outcomes than those with a secondary stoma. In our series, women who had a primary stoma represented 24% of the whole series of women managed for deep endometriosis involving the rectum/sigmoid colon in our center, and this rate was similar to that observed in France in 2015 (14). The rate of diverting stoma in women managed for colorectal endometriosis is widely variable in the literature, from 1.6% (15) to 96% (16), depending on study enrolment criteria and surgeons' preferences. In the literature, several series pooled patients with low/mid rectal endometriosis and those with nodules of the sigmoid colon, while other authors focused only on patients with low rectal infiltrations (6,16), with higher rates of fistula and stoma. Similarly, the rate of

patients undergoing simultaneous resection of the vagina is variable, and this procedure is directly related to the risk of fistula and consequently the probability of stoma.

Stoma-related complications did not present a significant correlation with the majority of parameters analyzed in our study. Women with complications were significantly older, although the difference in age (1.8 years) was actually not clinically relevant. Mean AFSr score was higher in patients with complications (80.8 vs. 66.5), although patients free of complications also had a high mean AFSr score corresponding to stage 4 endometriosis. Frequent use of segmental resection was also related to a higher risk of stoma-related complications, however there was no clear causal relationship, as a stoma is created at distance from the anastomosis, on a tension-free bowel loop.

The aim of our study was not to contest the use of stoma in the surgery of colorectal endometriosis. Despite extensive literature supporting the systematic creation of a diverting stoma after low colorectal anastomosis for rectal cancer, there are no definitive guidelines for rectal endometriosis surgery because the results in rectal cancer cannot automatically be extrapolated to deep endometriosis (17). It has been recommended that primary stoma should be discussed in patients at high risk of postoperative rectovaginal fistula, in order to attempt to reduce the risk of complications related to fistula (17). The overall risk of fistula, which usually varies from 3 to 11% depending on patients' characteristics (2,6,14), should be weighed against the risk of severe complications related to stoma, which averaged 8% in our series. Women should also be aware that the use of stoma does not completely exclude the occurrence of fistula (18). Indeed in our series, we observed a fistula rate of 7%. Nevertheless, immediate outcomes and fistula repair might be less challenging with primary stoma. Given the complex context of the surgery of deep endometriosis involving not only the rectum and the sigmoid, but also the vagina, surgeons should provide full information and accept patients' informed choice.

Conflict of interest

Prof. Roman reports personal fees from Plasma Surgical Inc. (Roswell, GA, US) for participating in a symposium and a masterclass, in which he presented his experience in the use of PlasmaJet®. Other authors had no conflict of interest.

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