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Optimizing Perioperative Outcomes with Selective Bowel Resection following Algorithm based on Pre-operative imaging for Bowel Endometriosis

Mauricio S Abrão, MD PhD[1,2], Marina P Andres, MD[1,2], Rodrigo N Barbosa, MD[1], Marco A Bassi, MD[2], Rosanne M Kho, MD [3]

[1] Endometriosis Section, Gynecologic Division. Hospital das Clinicas HCFMUSP, Faculdade de Medicina, Universidade de Sao Paulo, Sao Paulo, SP, BR.
[2] Gynecologic Division, BP - A Beneficencia Portuguesa de Sao Paulo, Sao Paulo, SP, BR.
[3]Benign Gynecology Surgery Section, Department of Obstetrics and Gynecology, Cleveland Clinic. Cleveland, OH, USA.

Corresponding author:
Mauricio Simões Abrão, MD. Rua São Sebastião 550, São Paulo, SP, Brazil. 04708-001. msabrao@mac.com
Phone: +55 01131503344

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Abstract

Study objective: to validate the algorithm for selective bowel surgery based on preoperative imaging by comparing the perioperative outcomes of patients who undergo each type of bowel surgery for deep bowel disease. A secondary goal is to evaluate the incidence, factors and subsequent outcomes when the actual procedure performed deviated from the pre-operative surgical plan.
Design: retrospective study comparing three surgical interventions with intention-to-treat analysis.
Setting: a tertiary hospital.
Patients: women with significant pain (VAS >7), who were diagnosed with bowel endometriosis from pre-operative imaging, and who underwent laparoscopic surgery for bowel endometriosis at a large referral center from 2014-2017.
Intervention: laparoscopic shaving, disc resection or full-segment resection and reanastomosis of bowel endometriosis.
Measurements and main results: A total of 172 patients (mean age 36.6 y ± 5.2 years) underwent bowel surgery for endometriosis (N = 30 shaving, 71 disc, and 71 segmental resection). Total operative time was similar, while hospital stay was longer in segmental (5.3 ± 1.0 days) as compared to disc (4.6 ± 0.9 days) and shaving groups (3.8 ± 1.5 days; p=.001). Surgical procedure was performed as planned according to the clinical algorithm in 86.5% of patients. Adherence to the proposed clinical algorithm resulted in a low incidence of overall complications (8.7% of total, 4.6% of minor and 3.5% of major complications). Minor complications were higher in segmental group (9.9%) as compared to discoid (1.4%) and shaving groups (0%; p=.0236) while major complications were similar between groups (3.3%, 2.8%, 4.2%; p=.899). There was a significantly higher frequency of pseudomembranous colitis in the segmental resection group (7 patients, 9.9%) compared to disc resection (1, 1.4%) and shaving groups (0%; p=.04). Due to discrepancy between pre-operative imaging and intra-operative findings after dissection and mobilization, deviation from the planned procedure occurred in a total of 25/172 (14.5%) cases with a less extensive procedure actually performed in 21/25 (84%) of deviated cases. One of the four cases (25%) that had a more extensive procedure resulted in a major complication of rectovaginal fistula.
Conclusion: Selective bowel resection algorithm provides a systematic approach in the surgical management of patients with bowel endometriosis. Adherence to the surgical plan according to the pre-operative imaging and criteria outlined in the algorithm can be accomplished in the majority of patients. The surgical team, however, should be aware that upstaging or downstaging may be required depending on the intra-operative findings. When feasible, the team should opt for a less extensive procedure to avoid complications associated with more radical surgery.

Keywords: bowel endometriosis; deep endometriosis; transvaginal ultrasound; minimally invasive surgical procedures

Introduction

Deep endometriosis (DE) represents 48% of all cases of endometriosis and specifically involves the bowel in 5-12% of affected patients (1, 2). The use of pre-operative imaging for bowel endometriosis, either Magnetic Resonance Imaging (MRI) or transvaginal ultrasound with bowel preparation (TVUS-BP), has been shown to provide excellent accuracy with sensitivity and specificity values of 79% and 72% (MRI) and 90% and 96% (TVUS-BP), respectively (3). TVUS-BP in experienced hands can accurately identify the size and number of lesions, extent of bowel wall involvement and the distance of the lowest lesion from the anal verge (3). The availability of precise description of bowel lesions facilitates a more thorough pre-operative patient counseling and planning of the procedure that can be performed with greater confidence (4).

Surgical treatment of bowel endometriosis results in improvement of pain symptoms and patient quality of life (QoL) (5-7). The benefit of improvement in pain and QoL needs to be weighed against the risks of surgical complications depending on the type or extent of bowel surgery performed (8-10). Studies have shown that segmental resection increases the overall major complication rate, reaching up to 25.2%, when compared to discoid resection (11.2%) and shaving of superficial lesions (15.2%; p<.001) (8-10).

To optimize complete DE resection while avoiding greater complications associated with extensive surgery, a clinical algorithm for the surgical approach for deep lesions involving the rectosigmoid was proposed and published in a Perspective piece in 2015 by a multi-national group of endometriosis experts (11). Briefly, the expert panel recommended performing the following bowel procedures on a selective group of DIE patients who present with significant pain (defined as pain scores using Visual Analog Score [VAS] >7): (1) shaving resection when imaging shows a unique nodule that affects only the external muscularis of the bowel; (2) disc resection when a solitary lesion less than 3 cm in size infiltrates beyond the external muscularis, is located between 5- 9 cm from the anal verge, and does not constrict the bowel circumference by more than 40%; and a (3) segmental resection and reanastomosis when the lesion is greater than 3 cm, is located above 5 cm from the anal verge, or when multiple lesions of the rectosigmoid are present. (Figure 1). A temporary diverting loop ostomy is recommended when a very low muscularis-infiltrating lesion (< 5 cm from the anal verge) is diagnosed on imaging.

The applicability and perioperative outcomes following the previously described algorithm based on pre-operative imaging findings have not been previously assessed. The main purpose of this study is to validate the algorithm previously described by evaluating and comparing the perioperative surgical outcomes of patients who undergo each type of selective bowel surgery for bowel endometriosis. In addition, to better understand possible limitations of the clinical algorithm, we also aim to determine the incidence, factors involved and subsequent outcomes when the performed procedure deviated from the pre-operative surgical plan.

Methods

Medical records from all consecutive patients who underwent both conservative and excisional surgery for bowel DIE from 2014 – 2017 (which is after the drafting and publication of the clinical algorithm) were reviewed and patient demographics were abstracted. Patients were included if they were of reproductive age (18 – 50) and excluded if they have had any previous bowel surgery, were pregnant, menopausal, diagnosed with inflammatory bowel disease or have known or history of malignancy. This study was approved by the Internal Review Board of the Hospital Beneficencia Portuguesa of Sao Paulo.

Preoperative imaging

All patients suspected with endometriosis underwent a TVUS-BP within a month prior to the surgical procedure, performed by two experienced radiologists, to identify and characterize sites of involvement, size, number and extent of invasion of disease following the protocol previously described (Figure 1) (3, 12). Before undergoing TVUS, all patients underwent a simple bowel preparation by taking an oral laxative on the eve of the exam (5.0 mg of sodium picosulfate) and rectal enema (120 ml of sodium diphosphate) within an hour before initiation of exam (4, 12). Pain symptoms related to endometriosis such as dysmenorrhea, deep dyspareunia, acyclic pelvic pain, dysuria and dyschezia were documented using the visual analogue scale (VAS) before the surgery (13).

Pre-operative bowel preparation included 100 ml of oral lactulose (Duphalac, Solvay, Brazil) the day before and an enema the evening before surgery. Prophylactic intravenous antibiotic treatment was given up to one hour prior to surgery.

All procedures were performed by the same multidisciplinary surgical team of gynecologist (MSA) and colorectal surgeon (MAB), and consisted of careful survey of the pelvis and abdomen for sites and extent of disease involvement. For peritoneal and bowel endometriosis, the goal was for complete excision of endometriotic lesions with clear margins. After insufflation of pneumoperitoneum with a Verres needle, an 11-mm trocar was inserted in the umbilical wound, as well as 3 accessory ports (suprapubic, left and right iliac fossa). A thorough abdominal survey was performed, and the procedure proceeded with adhesiolysis, drainage and cystectomy of ovarian endometriomas, if present, and resection of peritoneal endometriosis. After bilateral ureterolysis, opening of the para-rectal spaces, identification of hypogastric nerve plexus, and dissection to the rectovaginal space in order to isolate the bowel lesion(s) were completed. Specific bowel procedure (shaving, disc vs full-segment resection) was performed according to the pre-operative imaging and intra-operative findings. Shaving resection was performed with combination of monopolar instruments, ultrasonic device and cold scissors, followed by placement of seromuscular suture of the rectosigmoid when serosal defect was noted. Disc resection was accomplished with circular stapler (Ethicon CDH 29 or CDH 33 Circular Stapler ™, BR) after the bowel lesion was isolated and a circumferential suture was placed to tuck the nodule into the stapler. On the other

hand, a bowel segmental resection was performed after full mobilization of the bowel affected, preserving the vascular and nervous supply. The distal bowel loop was transected with a linear laparoscopic stapler (Ethicon Echelon Flex GST System ™, BR) at least 1- 2 cm away from the disease. The affected proximal loop is exteriorized through the extended (3-4 cm) right lower trocar incision and transected 1-2 cm away from the involved lesion. The anvil of the circular stapler (Ethicon CDH 29 or CDH 33 Circular Stapler ™, BR) was then inserted into the proximal loop and returned into the pelvis. The anastomosis was performed with a trans-anal stapler (CDH 29 or 33cm, Ethicon, BR) and its integrity evaluated by both distension of the rectosigmoid with air and also with diluted methylene blue solution. In all cases, venous thromboembolism (VTE) prophylaxis was provided with well-fitted compression stockings and intermittent pneumatic compression devices. For patients with high risk of VTE, according to Caprini Score (14), additional prophylaxis measure was given with subcutaneous enoxaparin.

Postoperative care

In all cases, oral intake with fluids was started on the first postoperative day and gradually advanced. The indwelling bladder catheter was removed the next day unless a concomitant partial cystectomy (bladder endometriosis resection) was performed, in which case the catheter was removed between 7-10 days postoperatively. Patients were discharged home after confirmation of bowel function with bowel movement and were all re-evaluated in clinic at one and four to six weeks postoperatively.

Outcomes measured

Patient age, parity, body mass index (BMI), previous surgeries and pre-operative TVUS characteristics of the DIE (size, distance from anal verge, number of lesions, depth of invasion, and extent of circumferential involvement), and surgical procedure (operative time, length of hospital stay) were abstracted from medical electronic charts. Perioperative complications were reported following Enhanced Recovery Implementation in Major Gynecologic Surgeries (ERAS) protocol (15, 16) and included: infection, urinary tract infection, sepsis, pneumonia, thromboembolic events, transfusion, renal failure, intubation, cardiac arrest, unplanned return to the operating room; 30-days re-admission rates, and mortality. Minor complications included urinary infection, pseudomembranous colitis, and skin infection while major complications included sepsis, pneumonia, thromboembolic event, transfusion, renal failure, intubation, cardiac arrest, re-operation, and death. Post-operative histopathology reports were also abstracted for confirmation of endometriosis and presence of clear margins.

Statistical Analysis

Continuous variables were analyzed as mean ± standard deviation and compared using Kruskal Wallis test or ANOVA. Categorical variables were analyzed as absolute numbers and frequencies and compared using Fisher's exact and Chi-square tests. Intention-to-treat analysis between the bowel surgery groups (i.e., shaving, discoid and segmental resection) was performed. P-values <.05 were considered significant.

Results

Patient Groups

A total of 827 surgeries were performed for all types of endometriosis in the study time period (2014-2017), of which 172 (20.7%) patients had surgeries for bowel endometriosis (Figure 2). Following the clinical algorithm described, patients with bowel endometriosis were divided into three surgical groups as determined by the pre-operative imaging findings: shaving (n=30, 17.4%), discoid resection (n=71, 41.2%) and segmental resection (n=71, 41.2%).

There was no statistical difference between the 3 groups in age, BMI, number of pregnancies, previous surgeries, current hormonal treatment, and American Society for Reproductive Medicine (ASRM) staging (Table 1). There was no statistical difference between the groups in pain symptoms of dysmenorrhea, acyclic pelvic pain, cyclic dysuria, and infertility. Dyspareunia VAS score was significantly lower in the segmental resection group (3.7 ± 3.6) compared to disc resection (5.2 ± 3.8) and shaving groups (4.5 ± 3.8; p = .047), and cyclic dyschezia was significantly greater in the segmental resection group (4.6 ± 4.2 vs. 3.2 ± 4.0 discoid vs. 1.0 ± 2.7 shaving; p = .0001, respectively).

Characteristics of TVUS-BP findings

The characteristics of the bowel lesions – i.e., number, size, bowel circumference compromised, depth of invasion of lesion and bowel circumference compromised - are described and summarized in Table 2. There was no significant difference in the prevalence of concomitant endometriotic lesions between groups.

Surgical Outcomes

All bowel endometriosis surgeries were performed and completed laparoscopically with no conversion to laparotomy. The mean operative time was 164 ± 65 min for shaving, 164 ± 64 min for discoid and 188 ± 90 min for segmental resection, with no significant difference between groups (p = .438). Mean estimated blood loss was less than 500 ml and blood transfusion was required in one case in the segmental resection group (1.4%; p=1.0). A concomitant hysterectomy was performed in 5

(6.1%), 18 (14.4%), and 12 (14.5%) patients in the shaving, discoid and segmental resection groups, respectively (p=.392, Table 3).
The number of minor complications was higher in segmental group (9.9%) as compared to discoid (1.4%) and shaving groups (0%; p=.0236) while major complications were similar (3.3%, 2.8%, 4.2%; p=.899) between groups (Table 3). There was a significantly higher frequency of pseudomembranous colitis in the segmental resection group (7 patients, 9.9%) compared to disc resection (1, 1.4%) and shaving groups (0%; p=.04). There was one intraoperative vascular injury of right internal iliac vein in a patient in the segmental resection group that required intra-operative blood transfusion. There were no cases of post-operative bowel stenosis at the anastomotic site in this series.
Segmental resection group was associated with a longer hospital stay (5.3 ± 1.0 days; p = .0001) compared to discoid (4.6 ± 0.9 days) and shaving group (3.8 ± 1.5 days). There were 2 rectovaginal fistulas: one on post-operative day 10 from the shaving group, who was readmitted at the hospital, noted to have a very small (5 mm) fistula, and treated conservatively with observation only; another patient was diagnosed with rectovaginal fistula on post-operative day 60 from the discoid group who was diagnosed in the office, noted to have a very small fistula (measuring 5 mm) on imaging, treated conservatively, and did not require hospitalization. A total of seven patients (4%) were re-admitted to the hospital: one from the shaving group (3.6%), one from the discoid group (1.5%) and five from the segmental resection group (8.1%; p=.161). The patient in the shaving group was re-admitted due to a small rectovaginal fistula as described above. The patient in the discoid group was readmitted for a deep venous thromboembolism of the lower extremity on POD 20. Five patients in the segmental resection group were re-admitted: one for ileal obstruction due to adhesions on POD 7 (requiring re-operation with resection and reanastomosis), one patient on POD 28 for pain management, and three for pseudomembranous colitis (one of whom presented with sepsis on POD 7 managed with intravenous antibiotics).

Intention-to-treat analysis

Surgical procedure was performed as planned according to the clinical algorithm in 86.5% of patients. Surgical plan was changed in a total of 25 (14.5%) patients. Overall, in 21/25 (84%) of changed cases, a less extensive procedure was performed, and only in 4/25 (16%) cases was a larger resection actually pursued (2 in the shaving and another 2 in the disc resection group). In all cases, the change in procedure reflected the discrepancy between pre-operative imaging and intraoperative surgical findings after mobilization of the loop of bowel and isolation of the lesion (Figure 2). In the shaving group, 1 (3.3%) patient ended up with a discoid resection because of the larger extent of bowel infiltration and 1 (3.3%) patient ended with a segmental resection due to larger size of the lesion. In the disc resection group, 12 (16.9%) patients had a less extensive procedure – i.e., shaving resection, and 2 (2.8%) were upstaged due to findings of another lesion that was in close proximity requiring a segmental resection. In the segmental resection group,

all changed procedures were downstaged - 2 (2.8%) had shaving and 7 (9.8%) had discoid resection. There were no cases that required a diverting loop ostomy procedure in this series. In all cases, endometriosis, as well as clear margins of bowel lesions, were confirmed by histopathology.

In evaluating the patients who were upstaged or downstaged intra-operatively, there was no significant difference with regards to demographics (age, previous endometriosis surgery, BMI), additional sites affected, complications and TVUS-BP findings observed when compared to the group that did not deviate from the initial surgical plan (Table 4).

Rectovaginal fistula occurred in one of the four (25.0%) upstaged patients which is significantly higher compared to downstaged patients (0%) and to patients whose procedures did not deviate from the pre-operative plan (0.7%; p=.001).

At the 4-6 week follow up visit, all patients were placed on medical therapy for ovarian suppression (such as combined oral contraceptives or progesterone-only formulation) for at least two months if fertility is desired, or longer if fertility is not desired and no contraindications are present. In some cases, a levonorgestrel-containing intrauterine device is also offered particularly in the absence of history of ovarian endometrioma. In this series, no patients complained of obstructive bowel symptoms at the 4-6 week follow up visit that required re-intervention.

Discussion

Bowel endometriosis is a challenging disease; often causing anatomic distortion and dense adhesions that can result in major surgical complications. Extensive bowel resection for endometriosis is known to be associated with a higher rate of complications compared to less extensive excision. In comparing surgical complications, studies have shown that major complications can occur in 11 – 25% of segmental bowel resection cases compared to 11.2% in discoid and 3.8 – 11.2% in shaving resection cases ($p<.001$) (17, 18). Stenosis of the area of anastomosis is also significantly associated with segmental resection (5.8%) as compared to disc (0%) and shaving (0%) ($p= .003$) (17, 18).

In this series of patients with bowel endometriosis, adherence to the proposed clinical algorithm resulted in a low incidence of overall complications (8.7% of total complications, 4.6% of minor complications and 3.5% of major complications), rectovaginal fistula (0.6%), anastomotic leakage (0.6%), and re-intervention (0.6%). Our findings are comparable with those of other studies that reported complication rates ranging from 11.8% to 12.5%, including 0-3.6% of rectovaginal fistulas and anastomotic leakage in 0-1.1% (17, 19-22). Although there was an increase in the rate of minor complications in the segmental resection group, there was no overall difference in the rate of major complications among the three bowel surgery groups. This may be attributable to the availability of accurate pre-operative imaging and overall adherence to the surgical planning according to the clinical algorithm proposed.

In this series, we observed a higher rate of pseudomembranous colitis due to *Clostridium difficile* infection in the segmental resection group (9.9%) compared to

discoid and shaving (1.4% and 0%, respectively*). C. difficile* is an anaerobic, Gram-positive bacillus, that is spread by the oral-fecal route, and a common cause of diarrhea in hospitalized patients and a common cause of hospital-acquired infection (23). Risk factors for *C. difficile* infection include medical comorbidities, immunological status of the patient, greater duration of hospital stay, antibiotic exposure, and surgery (24). Previous studies reported lower rates of *C. difficile* infection following surgical procedures: up to 0.9% after bowel resection/repair, 0.7% after stomach or esophagus operations, and 0.1% after gynecologic procedures (23). Increased rate of *C.difficile* infection in our series of segmental resection may likely be due to prolonged antibiotic use of up to 3 days postoperatively and prolonged hospital stay compared to the other groups. Since evaluation of our data, we have reduced antibiotic use to just one dose of cefoxitin and metronidazole pre-operatively, implemented the Enhanced Recovery After Surgery (ERAS) protocol to hasten oral intake and home dismissal (15, 16), in addition to rigorous hand washing policy of hospital personnel.

The need for diverting ostomies has been reported in up to 6.9%-13.8% of patients with bowel endometriosis in previously published series (2, 18). Loop diversions are performed in order to protect or allow healing of the ultra-low segmental resection. It is known, however, that ostomies can greatly and negatively impact the patient's QoL in addition to requiring another surgery for reversal. In contrast to other studies, there were no patients in this series of 172 patients with bowel endometriosis who required a diverting stoma. In our experience, the finding of very low rectal lesions (<5 cm from the anal verge) is not common in this patient population. Even with somewhat low-lying lesions on pre-operative imaging, diverting ostomies were avoided after adhesiolysis, dissection into the rectovaginal septum and mobilization of the involved rectosigmoid segment. What was previously perceived to be a very low lesion on imaging may actually be located farther away (>5 cm) from the anal verge after mobilization of the rectosigmoid. Diverting ostomies were not performed in this series of patients that may be explained by both the low incidence of ultra-low rectal lesions in this group and the expertise of the surgical team.

Availability of accurate pre-operative imaging is the cornerstone of the proposed clinical algorithm for selective bowel surgery in patients with endometriosis. In expert hands, the use of MRI and TVUS-BP for bowel endometriosis have been found to be associated with high sensitivity and specificity (11). As shown in this study, accurate pre-operative imaging facilitated surgical planning with availability of appropriate team, proper counseling of patients and may have precluded many unforeseen or unanticipated procedures. The use of TVUS-BP was the imaging of choice with this group of patients given its lower cost and easy accessibility.

The selective bowel resection algorithm previously proposed by an international panel of endometriosis experts provided a clear set of criteria to optimize patient peri-operative outcomes. The planned procedure, however, may need to be altered depending on the intra-operative findings. While adherence to the planned procedure was accomplished in the majority (86%) of patients in this series, the planned procedure was altered in others. In most altered cases (12.2%, n

= 21), a less extensive procedure was accomplished in order to avoid inherent complications related to more radical bowel surgery. In only 2.3% (n=4) of altered cases, the plan deviated to a more extensive procedure in order to allow complete resection. Downstaging to a less extensive procedure depending on the intra-operative findings may also have contributed to the low complication rate in this study.

While the overall major complication rate was low in this series of patients with bowel endometriosis, we found a significantly greater risk of major complication (25%) when a more extensive bowel procedure was performed compared to patients who were downstaged or underwent the bowel surgery as planned pre-operatively. A prospective trial involving a larger number of patients would be helpful to determine if this finding remains to be true. For now, it would be worthwhile for the surgical team to counsel patients accordingly and follow upstaged patients more closely during the post-surgical recovery period.

The major strengths of this study include the presence of a large volume of consecutive patients with deep bowel endometriosis, and an experienced imaging team of radiologists and surgeons (MSA, MB) who followed the clinical algorithm previously described. The main limitation of this study includes the lack of data from validated patient questionnaires to evaluate the short- and long-term impact of each type of bowel surgery on patient's pain, QoL and subsequent bowel function, and the small number of complications observed that limits the ability to make conclusive statements. A larger prospective and multicenter study that includes the use of accurate imaging method, validated patient surveys, and experienced surgical team would be helpful in mitigating the limitations noted above.

In summary, the selective bowel resection algorithm previously proposed provides a systematic approach in the surgical management of patients with bowel endometriosis. Our study revealed that following the clinical algorithm resulted in complete resection of disease as noted on histopathologic reports, and a low overall rate of post-operative complications. The availability of accurate pre-operative imaging findings is fundamental to the successful implementation of the clinical algorithm. Adherence to the surgical plan according to the pre-operative imaging and criteria outlined in the algorithm can be accomplished in the majority of patients. The surgical team, however, should be aware that upstaging or downstaging may be required depending on the intra-operative findings. When feasible, the team should opt for a less extensive procedure in order to avoid complications associated with more radical bowel surgeries.

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Conflict of interest

Abrao MS and Kho RM serve on the Scientific Advisory Board for Abbvie Pharmaceutical. Abrao MS is a Consultant for Bayer Pharmaceutical and Myovant. The other authors declare no conflict of interest.

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Figure 1 – Clinical pathway algorithm for bowel endometriosis according to the clinical exam and pre-operative transvaginal ultrasound with bowel preparation

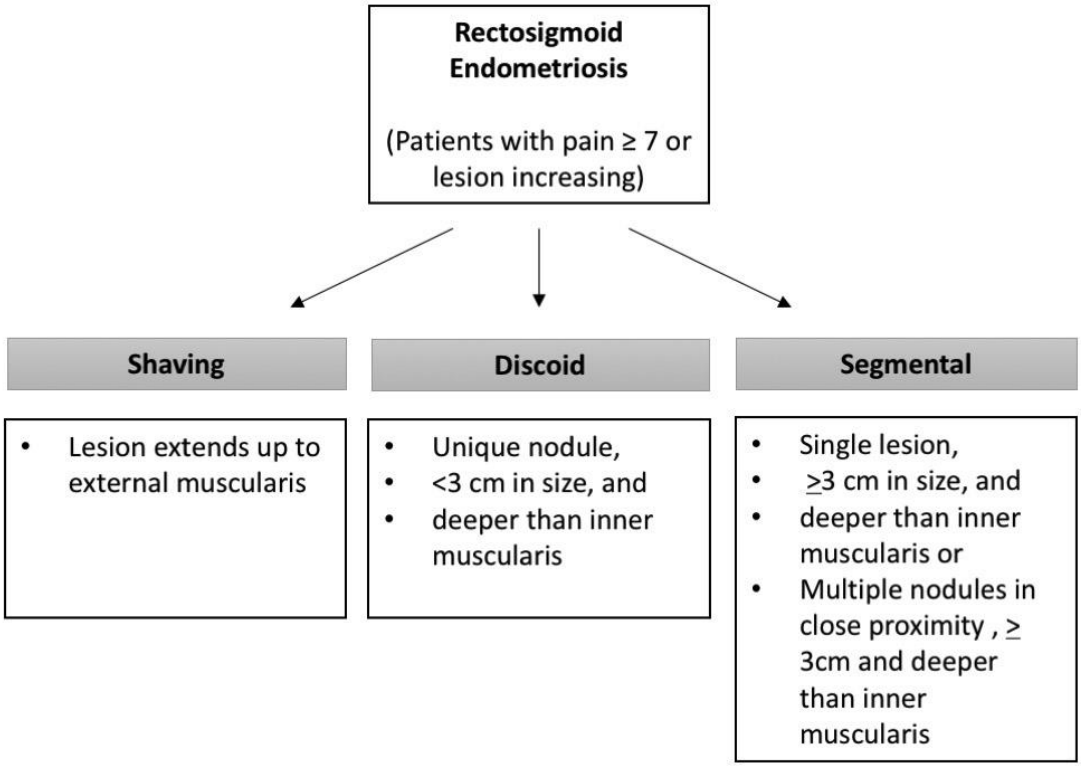

Figure 2 – Flowchart of patients included in the study
TVUS: transvaginal ultrasound; DE: deep endometriosis

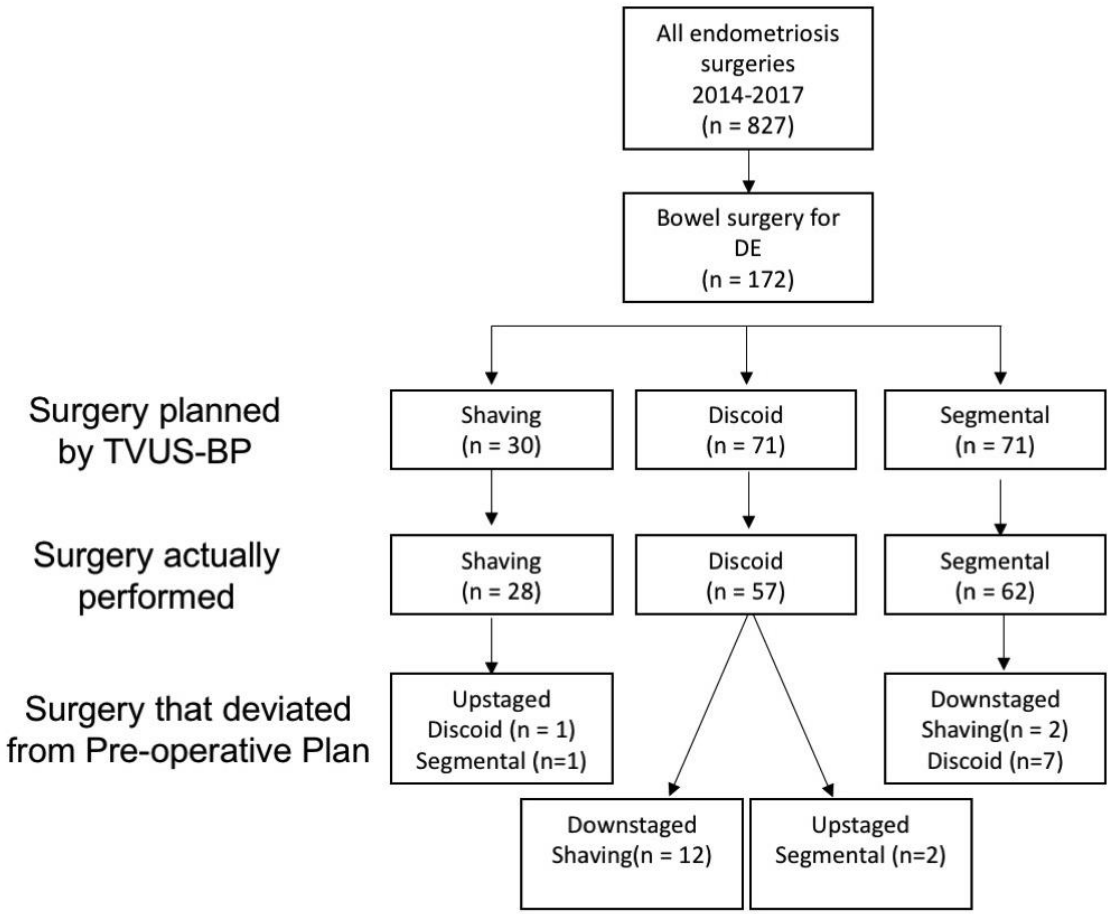

Table 1 – Demographic characteristics of patients with bowel endometriosis per group (intention-to-treat)

Characteristic	Shaving n (%)	Discoid n (%)	Segmental n (%)	p
Total	31	71	71	
Age (years), mean±SD	37.9 ± 4.8	36.1 ± 5.6	36.7 ± 5.0	0.27[a]
BMI (kg/m^2)				0.114[b]
<18	2 (7.1)	2 (3.0)	2 (3.0)	
18-25	20 (71.4)	47 (70.1)	43 (65.2)	
25-30	3 (10.7)	15 (22.4)	19 (28.8)	
>30	3 (10.7)	3 (4.5)	2 (3.0)	
Pregnancy				0.302[b]
0	15 (51.7)	46 (64.8)	43 (60.6)	
1	4 (13.8)	14 (19.7)	14 (19.7)	
2	9 (31.0)	7 (9.9)	12 (16.9)	
3	1 (3.4)	4 (5.6)	2 (2.8)	
Previous EDT surgery				0.238[b]
0	22 (73.3)	48 (67.6)	46 (64.8)	
1	5 (16.7)	18 (25.4)	21 (29.6)	
2	3 (10)	5 (7.0)	1 (1.4)	
≥ 3	0 (0)	0 (0)	3 (4.2)	
Previous abdominal surgery	5 (16.7)	15 (21.1)	7 (9.9)	0.172[c]
Hormone therapy	10 (33.3)	31 (43.7)	19 (26.8)	0.105[c]
ASRM stage				0.077[b]
I	1 (3.3)	3 (4.2)	0 (0)	
II	6 (20)	24 (33.8)	15 (21.1)	
III	7 (23.3)	13 (18.3)	9 (12.7)	

IV		16 (53.3)	31 (43.7)	47 (66.2)	
Dysmenorrhea (VAS), mean±SD		8.1 ± 2.9	8.3 ± 2.2	7.7 ± 2.8	0.501[a]
Dyspareunia (VAS), mean±SD		4.5 ± 3.8	5.2 ± 3.8	3.7 ± 3.6	0.047[a]
Acyclic pelvic pain (VAS), mean±SD		3.1 ± 3.8	3.7 ± 3.9	2.7 ± 3.9	0.281[a]
Cyclic dysuria (VAS), mean±SD		1.0 ± 2.6	0.8 ± 2.2	0.2 ± 0.9	0.054[a]
Cyclic dyschezia (VAS), mean±SD		1.0 ± 2.7	3.2 ± 4.0	4.6 ± 4.2	0.0001[a]
Infertility		14 (48.3)	39 (63.9)	42 (65.6)	0.825[c]

SD: standard deviation or n (%); BMI: body mass index; VAS: visual analogic scale; ASRM: American Society for Reproductive Medicine Classification; [a]Kruskal Wallis test; [b]Fisher's exact test; [c]Chi-square test

Table 2 – Surgical characteristics of endometriosis lesions per group

Site	Shaving n (%)	Discoid n (%)	Segmental n (%)	p
Total	30	71	71	
Number of rectosigmoid lesions				0.0001[a]
1	30 (100.0)	71 (100.0)	36 (50.7)	
2	0 (0)	0 (0)	31 (43.7)	
3	0 (0)	0 (0)	4 (5.6)	
Largest rectosigmoid lesion				
Size (cm), mean±SD	1.1 ± 0.8	2.1 ± 0.9	4.2 ± 2.1	0.0001[b]
Distance from anal verge (cm), mean±SD	11.3 ± 3.4	11.1 ± 3.5	10.5 ± 2.7	0.339[b]
Circumference (%)	19 ± 10	26 ± 10	35 ± 11	0.0001[b]
Depth of invasion				0.0001[a]
Submucosal	0 (0)	8 (11.3)	23 (33.8)	
Internal Muscularis	0 (0)	50 (70.4)	41 (60.3)	
External Muscularis	23 (76.7)	13 (18.3)	4 (5.9)	
Serosal	7 (23.3)	0 (0)	0 (0)	
Retrocervical	25 (83.3)	60 (84.5)	64 (90.1)	0.206[c]
Ovarian Endometrioma	16 (53.3)	25 (35.2)	30 (42.2)	0.234[c]
Bladder	4 (13.3)	4 (5.6)	7 (9.9)	0.396[a]
Vagina	7 (23.3)	22 (31.0)	24 (33.8)	0.581[c]
Ileum	0 (0)	7 (9.9)	8 (11.3)	0.163[a]
Appendix	5 (16.7)	9 (12.7)	9 (12.7)	0.843[c]
Cecum	0 (0)	3 (4.2)	3 (4.2)	0.741[a]

SD: standard deviation; [a] Fisher`s exact test, [b] Kruskal Wallis Test, [c] Chi-square test

Table 3 – Surgical outcomes of patients with bowel endometriosis per intention-to-treat group

Characteristics	Shaving n(%)	Discoid n (%)	Segmental n (%)	p
Total	30	71	71	
Length of hospital stay (days), mean±SD	3.8 ± 1.5	4.6 ± 0.9	5.3 ± 1.0	0.001[a]
Duration of surgery (min), mean±SD	164 ± 65	164 ± 64	188 ± 90	0.438[a]
Concomitant Procedures				
Hysterectomy	5 (6.1)	18 (14.4)	12 (14.5)	0.392[b]
Ovarian cystectomy	16 (53.3)	25 (35.2)	30 (42.2)	0.234[b]
Colpectomy	7 (23.3)	18 (25.4)	23 (32.4)	0.534[b]
Appendectomy	7 (23.3)	13 (18.3)	14 (26.6)	0.843[b]
Right Colectomy	0 (0)	3 (4.2)	3 (4.2)	0.518[b]
Complications				
Surgical site infection/hematoma	0 (0)	0 (0)	1 (1.4)	1.00[c]
Urinary tract infection	0 (0)	0 (0)	0 (0)	-
Bowel anastomotic leak	1 (3.3)	0	0 (0)	0.174[c]
Rectovaginal fistula (after 28 d)	0	1 (1.4)	0	1.00[c]
Stenosis of anastomosis	0 (0)	0 (0)	0 (0)	-
Pseudomembranous colitis	0 (0)	1 (1.4)	7 (9.9)	0.04[c]
Intraoperative vascular injury	0 (0)	0 (0)	1 (1.4)	1.00[c]
Transfusion	0 (0)	0 (0)	1 (1.4)	1.00[c]
Unplanned return to OR	0 (0)	0 (0)	1 (1.4)	1.00[c]
Pneumonia	0 (0)	0 (0)	0 (0)	-
Venous/Pulmonary embolism	0 (0)	1 (1.4)	0 (0)	1.00[c]
Unplanned intubation	0 (0)	0 (0)	0 (0)	-
Acute renal failure	0 (0)	0 (0)	0 (0)	-
Cardiac arrest	0 (0)	0 (0)	0 (0)	-
Sepsis or septic shock	0 (0)	0 (0)	1 (1.4)	1.00[c]
Death within 30 d	0 (0)	0 (0)	0 (0)	-
Transient urinary retention	0 (0)	1 (1.5)	0 (0)	1.00[c]
Hospital re-admission	1 (3.6)	1 (1.5)	5 (8.1)	0.161[b]
Total complications	1 (3.3)	3 (4.2)	11 (15.5)	0.030[b]
Minor, n(%)	0 (0)	1 (1.4)	7 (9.9)	0.0236[b]
Major, n(%)	1 (3.3)	2 (2.8)	3 (4.2)	0.899[b]
Total complications (excluding postoperative transfusions)	1 (3.3)	3 (4.2)	7 (9.9)	0.293[b]

SD: standard deviation; OR: operating room; [a] Kruskal-Wallis Test, [b] Chi-square test [c] Fisher`s exact test

Table 4 – Characteristics of patients with bowel endometriosis who were upstaged or downstaged intra-operatively (procedures deviated from pre-operative plan) compared to patients whose procedures did not deviate from initial surgical plan.

Characteristics	Not followed pathway		Followed pathway	p
	Downstage n(%)	Upstage n(%)	n(%)	
Total	21 (12.2)	4 (2.3)	147 (85.5)	-
Age (years), mean ± SD	36.2 ± 4.8	34.8 ± 7.9	36.8 ± 5.2	0.459[a]
BMI (kg/m^2)				0.88[b]
<18	0 (0)	0 (0)	6 (4.4)	
18-25	16 (76.2)	3 (75.0)	91 (66.4)	
25-30	3 (14.3)	1 (25.0)	33 (24.1)	
>30	1 (4.8)	0 (0)	7 (5.1)	
Infertility	9 (42.8)	2 (50.0)	84 (62.7)	0.458[b]
Previous endometriosis surgery	7 (33.3)	1 (25.0)	49 (33.3)	0.940[b]
Number of rectosigmoid lesions				0.437[b]
1	18 (85.7)	2 (50.0)	103 (70.1)	
2	3 (14.3)	2 (50.0)	39 (26.5)	
3	0 (0)	0 (0)	5 (3.4)	
Size of rectosigmoid lesion (cm), mean ± SD	2.2 ± 1.3	2.6 ± 1.2	2.9 ± 2.0	0.052[a]
Distance from anal verge (cm), mean ± SD	12.0 ± 4.0	10.5 ± 3.9	10.8 ± 3.0	0.177[a]
Circumference (%), mean ± SD	20.6 ± 8.4	43.3 ± 7.0	30.7 ± 11.4	0.171[a]
Complications				
Septic shock	1 (4.8)	0 (0)	0 (0)	1.00[c]
Rectovaginal fistula	0 (0)	1 (25.0)	1 (0.7)	0.001[b]
Total Complications	1 (4.8)	1 (25.0)	8 (5.4)	0.250[b]

SD: standard deviation; [a] ANOVA, [b]Chi-square test