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Major and minor complications after anterior rectal resection for deeply infiltrating endometriosis

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Abstract

Purpose The aim of the present study was to analyze major and minor complications—including long-term impairment of intestinal, bladder, and sexual function—following surgery for deeply infiltrating endometriosis using anterior rectal resection.

Methods Patients who had undergone anterior rectal resection due to endometriosis between 2001 and 2011 were included ($n = 113$). Clinical and surgical data, as well as minor and major complications, were recorded. A questionnaire was sent to the patients and also to a healthy control group ($n = 100$).

Results Major complications occurred in 15.9% of cases and minor complications in 15%. Patients with postoperative ileostomies ($n = 8$) initially had ultralow anastomoses significantly more often. The questionnaire response rate was 77%, with a mean follow-up period of 85.9 months. Weak urinary flow was reported by 22.4% of the patients: a feeling of residual urine by 18.4%; more than one bowel movement/day by 57.5%; and insufficient lubrication during intercourse by 36.5%. These results differed significantly from the control group. Subgroup analysis showed no statistical associations between questionnaire responses and major or minor complications, ultralow anastomoses, bilateral dissection of the sacrouterine ligaments, or dissection of the vagina and rectovaginal space.

Conclusions The major complication rate was consistent with the literature, but there were fewer minor complications. Patients with bowel anastomoses below 6 cm (ultralow) should receive information postoperatively about the high risk of insufficiency and should be closely monitored. The high rate of bladder, bowel, and sexual function impairment, and inadequate data make further prospective studies on this topic necessary.

Keywords Deeply infiltrating endometriosis · Minor complications · Long-term results · Major complications · Intestinal endometriosis · Anterior rectal resection

Introduction

Several organ structures may be affected in patients with deeply infiltrating endometriosis with rectal involvement, and the treatment consequently often requires a multidisciplinary approach. The gold standard is resection with healthy margins in a single procedure, which should be laparoscopic if possible [1, 2]. Patients with deeply infiltrating endometriosis often have severe fibrosis and adhesions of anatomic structures. The radical surgical approach needed is comparable with techniques used for malignancy surgery. In addition to anterior rectal resection, surgery may also be necessary in the area of the vagina, rectovaginal space, and/or sacrouterine ligaments. This also explains the type and frequency of the complication rates. Segment-preserving procedures such

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as shaving techniques or wedge resections appear to be associated with lower complication rates, but also with lower success rates relative to pain reduction [3, 4]. There are as yet insufficient data on this topic.

The literature reports distinguish between major and minor complications. Di Cicco et al. [5] include anastomotic insufficiencies, intestinal perforation, rectovaginal fistulas, severe infections, and bleeding requiring transfusion among the major complications, for example. Complications that require a revision procedure and intraoperative injuries to organs and structures are also included. In the literature, major complications of resection for deeply infiltrating endometriosis with segmental resection of the intestine are reported in 7.4% [6] to 25% [7] of cases.

These are distinct from minor complications, which include slight-to-moderate infections, peripheral sensory disturbances, bladder voiding dysfunction, and postoperative urinary obstruction. These are reported in the literature on resection for deeply infiltrating endometriosis, including segmental bowel resection, in 0.6% [8] to 57% [9] of cases.

The surgical procedure affects structures and anatomic regions whose resection can lead to long-term impairment of the vascular and neural supply to the lesser pelvis. Lasting functional deficits in bladder, bowel, and sexual function may occur.

Dousset et al. [10] investigated 100 patients with rectal endometriosis who underwent open rectal resection and removal of any additional endometriosis lesions and assessed postoperative complications over a 5-year follow-up period. The most frequent minor postoperative complications, at 16%, were temporary peripheral neurogenic bladder voiding disturbances. Eleven percent of the bladder voiding disturbances persisted, even after the 5-year follow-up period, as long-term minor complications. In a total of 86 patients with deeply infiltrating endometriosis, 58 of whom had deeply infiltrating rectal endometriosis; Dubernard et al. also reported that nearly all of the patients had postoperative bladder complications: incontinence, bladder voiding disturbances, and weak urinary flow. Newly developing bladder problems involving delayed urinary flow, urinary flow control, and incomplete voiding occurred more often in the group with rectal endometriosis [11].

The aim of the present study was to analyze major and minor complications of operations for deeply infiltrating endometriosis including rectal resection conducted in the Department of Gynecology at Erlangen University Hospital/Friedrich Alexander University during the period from 2001 to 2011. Special attention was given to long-term impairments of bowel, bladder, and sexual function.

Materials and methods

The surgical reports for all patients with ICD-10 diagnosis N80.4 (endometriosis of the rectovaginal septum and vagina) and/or N80.5 (endometriosis of the intestine) and/or N80.8 (other endometriosis) during the period 2001–2010 were analyzed. Approval for the study was received from the Ethics Committee at Friedrich Alexander University (No. 307_12B).

The study included all patients identified in whom an anterior rectal resection in cooperation with a colorectal surgeon had been carried out due to deeply infiltrating endometriosis, with or without involvement of the vagina and/or rectovaginal space and/or sacrouterine ligaments.

Deeply infiltrating intestinal endometriosis was considered to be present if the patient had an Enzian score of C1–3. Optionally, Enzian A1–3 and/or Enzian B1–3 could be included. In principle, deeply infiltrating endometriosis was defined as an endometriosis lesion with an infiltration depth >5 mm [12–14]. Patients who underwent wedge resection of the intestine and patients with hysterectomy before or during the operation were excluded.

The following patient data were taken from the files: age, height, weight, duration of peridural anesthesia (PDA), duration of opioid administration, hospitalization period, patient's symptoms, and reasons for the operation. In addition, information was also obtained from the files concerning the postoperative course, histological findings, postoperative diagnostics (for example rectoscopy), and findings noted at any later hospital stays or outpatient consultations.

The surgical reports were examined for the following data: access route, operating time, estimated blood loss, change of access, excision of endometriosis lesions in the vagina, excision of endometriosis lesions in the rectovaginal space, presence of other endometriotic lesions, intraoperative complications, level of the bowel anastomosis in centimeters from the anal line, and need for ileostomy. It was noted whether complete resection of the lesion (local R0 resection) and/or complete resection relative to the endometriosis (R0 resection overall) was achieved. All the patients received a questionnaire specially drawn up for the study, which included questions about the patient's history, postoperative course, and state of health. Bladder, bowel, and sexual function were inquired into using items from the German Pelvic Floor Questionnaire. This originally Australian questionnaire, with a validated German version, inquires into the areas of bowel, bladder, and sexual function and also pelvic organ prolapse symptoms during the previous 4 weeks. The questions are answered with "yes" or "no," or using a rating scale—"never; occasionally (less than once per week); frequently (once or more per week); daily" [15, 16]. The following questions were used for the analysis:

"Is your urinary stream weak, prolonged, or slow?" "Do you have a feeling of incomplete bladder emptying?" and "Do you have sufficient natural vaginal lubrication during intercourse?" The responses "never" and "occasionally" were treated as "no," and the responses "frequently" and "daily" were treated as "yes." The question "How often do you have bowel movements?" was also included in the analysis. The possible responses "less than once a week" and "less than every 3 days" were treated as equivalent to constipation.

Patients who returned the questionnaire and provided written consent were contacted once again by phone or in writing for follow-up questions and an opportunity to describe their state of health. The German Pelvic Floor Questionnaire [15, 16] does not include any cut-off values for the presence of a functional disturbance. A control group was, therefore, formed for comparison. For this purpose, the German Pelvic Floor Questionnaire was sent to volunteers aged 18–58 among contacts of the hospital staff and doctoral students (acquaintances, friends, students). Exclusion criteria were hysterectomy prior to the questionnaire and/or a medical history including past or current endometriosis.

The definitions of major and minor complications were based on the review by De Cicco et al. [5] and the publication "The accordion severity grading system of surgical complications" by Strasberg et al. [17]. Major complications consisted of intraoperative injuries to organs and structures, suture insufficiencies, fistulas, severe infections, anastomotic stenoses, bleeding requiring transfusions, thromboembolic events, compartment syndrome, organ failure, and death, as well as all complications that required a repeat surgical procedure or radiological interventional therapy.

The following were defined as minor complications: slight-to-moderate infections such as urinary tract infections, first- or second-degree urinary obstruction, and time-limited complications with slight-to-moderate effects on the patient's general condition. Postoperative residual urine volumes >100 mL were also regarded as minor complications, whether or not they required treatment [18, 19].

The data were analyzed using the R statistical package [20]. Fisher's exact test was used for comparison of categorical attributes between the two groups. Benjamini–Hochberg correction was carried out to take multiple testing into account, and the significance level was, therefore, set to 0.008.

Results

Between 2001 and 2011, a total of 683 patients received diagnoses of ICD-10 N80.4 and/or N80.5 and/or N80.8. The surgical reports for these patients were reviewed. Seven patients with intraoperative wedge resection of the intestine and 13 patients with intraoperative hysterectomy had to be excluded.

A total of 113 patients with anterior rectal resections were included in the study. Forty-eight patients (42.5%) had had one prior operation for endometriosis and 39 (34.5%) had had two or more. Table 1 lists the patients' characteristics.

Table 2 Patients' symptoms (multiple responses possible) and principal reasons for surgery

	n	%
Symptoms ($n = 111$)		
Dysmenorrhea	78	70.3
Dyspareunia	55	49.6
Dysuria	29	26.1
Dyschezia	67	60.4
Sterility	65	58.6
Main reason for surgery ($n = 113$)		
Pain	59	52.2
Sterility	38	33.6
Sterility + pain	12	10.6
Other	2	1.8
No data	2	1.8

Table 1 Patients' characteristics

	Patients (n)	Mean	Standard deviation
Age (years)	113	32.4	5.8
Body mass index (kg m^2)	109	23.6	4.3
Operating time (min)	110	324.5	93.1
Estimated blood loss (mL)	97	283.1	258.8
Duration of opiate administration (days)	111	3.8	4.5
Hospitalization (days)	113	12.1	7.3
Follow-up questionnaire (months)	87	85.9	26.1

Table 3 Details of surgical treatment

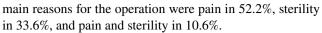| Group	Patients		
	Total	*n*	%
Laparoscopic access route	113	107	94.7
Endometriosis excision			
Vagina	113	83	73.5
Rectovaginal space	113	97	85.8
Sacrouterine ligament, unilateral	113	12	10.6
Sacrouterine ligament, bilateral	113	28	24.8
Other endometriotic lesions	113	81	71.7
Intestinal specimen histologically positive for endometriosis	113	109	96.5
Local R0 resection	113	111	98.2
Complete R0 resection	113	98	86.7
Intraoperative ileostomy	113	15	13.3
Postoperative ileostomy	98	8	8.2

Local R0, resection without residual lesion in the area of the deeply infiltrating endometriosis; complete R0, resection without residual lesion for all endometriotic lesions present

Table 4 Major and minor complications (113 patients)

	n	%	Operation-complication interval (days, SD)
Major complications			
Total	18	15.9	
Anastomotic insufficiency	8	7.1	7.25 (4.5)
Rectovaginal fistula	5	4.4	8.80 (5.0)
Vesicovaginal fistula	1	0.9	6.0 (0)
Erosion hemorrhage	1	0.9	21.0 (0)
Thrombosis	3	2.7	5.3 (2.1)
Embolism	1	0.9	5.0 (0)
Compartment syndrome	1	0.9	10.0 (0)
Bleeding requiring transfusion	9	8.0	1.78 (1.3)
Infections (severe)	0	0	–
Minor complications			
Total	17	15.0	
Postoperative residual urine >100 mL	15	13.3	8.0 (3)
Infection (mild-to-moderate)	3	2.7	12.33 (13.6)
Other[a]	2	1.8	

The intervals between the operation and the complication are given in days, with mean and standard deviation

[a] Recurrent vomiting due to pyloric stenosis ($n = 1$, day 6); hypesthesia and hypalgesia, suspected L5 nerve root lesion ($n = 1$, day 1)

The patients' symptoms and the main reasons given for the operations are listed in Table 2. Dysmenorrhea was reported by 70.3%, dyspareunia by 49.6%, dysuria by 26.1%, dyschezia by 60.4%, and sterility by 58.6%. The main reasons for the operation were pain in 52.2%, sterility in 33.6%, and pain and sterility in 10.6%.

The surgical access route was laparoscopic in 25 patients (22.1%) and laparoscopic/vaginal in 82 (72.6%). Laparoscopic access was thus possible in 107 cases (94.7%). Two patients received a transverse laparotomy (1.8%), one had a longitudinal laparotomy (0.9%), and three patients had a combination of longitudinal laparotomy and vaginal dissection (2.6%). Table 3 provides details of the operations. Endometriotic lesions were resected in the vagina in 73.5% of cases, in the rectovaginal space in 85.8%, and other endometriotic lesions in 71.7%. Resection in the area of the sacrouterine ligament was carried out in 10.6% of cases, with bilateral resection in 24.8%. Complete resection (R0) relative to the local findings was achieved in 98.2% of cases. R0 resections relative to the complete endometriotic involvement (excluding adenomyosis) were achieved in 86.7%. Among patients with macroscopic intestinal endometriosis and histologically confirmed endometriosis outside of the intestine, no endometriosis was identified histologically in the intestinal specimens for four patients. Creation of an ileostomy was required intraoperatively in 15 patients (13.3%). The level of the anastomoses in these cases was <6 cm in seven patients, between 6 and 10 cm in seven patients, and no data were available for one patient. None of the patients who received prophylactic ileostomies intraoperatively developed anastomotic insufficiencies or fistulas postoperatively.

Chromopertubation was carried out in 37 patients, unilaterally in 9 cases and bilaterally in 23 cases. The chromopertubation was negative in five patients.

A total of 32 patients (28.3%) suffered major and/or minor complications. Table 4 lists the major complications. Eighteen patients (15.9%) had one or more major complications ($n = 29$). In detail, these involved eight cases of anastomotic insufficiency (including five with rectovaginal fistulas), one vesicovaginal fistula, one case of erosion hemorrhage requiring revision, three thromboses, one embolism, one case of compartment syndrome, and nine cases of postoperative hemorrhage requiring transfusion.

One patient developed a deep venous thrombosis and pulmonary embolism on the fifth postoperative day (treated conservatively). Surgical vascular reconstruction was carried out on the 21st postoperative day after erosion hemorrhage from the common iliac artery. A total of 12 units of packed red cells and four fresh frozen plasma units were administered (on days 0, 16, 21, 23, and 36).

With regard to fistulas and suture insufficiencies, the group was analyzed for intraoperative excision of endometriotic lesions from the vagina and/or rectovaginal space. All patients with a fistula and/or suture insufficiency had undergone intraoperative excision of endometriotic lesions from the vagina and from the rectovaginal

space. However, this finding was not significant in comparison with the overall groups ($P = 0.109$, $P = 0.355$).

It was found that patients in whom an ileostomy became necessary postoperatively ($n = 8$) had initially received an ultralow anastomosis (less than 6 cm from the anal line) significantly more often ($P < 0.001$). Twenty patients had an ultralow anastomosis postoperatively without an intraoperative ileostomy; 35% of these patients developed anastomotic insufficiency. Seventy-seven patients who did not receive an intraoperative ileostomy had a postoperative anastomotic level >6 cm from the anal line. One patient (1.3%) suffered an anastomotic insufficiency.

Minor complications occurred in 17 patients (15%) (Table 4). These consisted of postoperative residual urine volumes >100 mL ($n = 15$), mild-to-moderate infections ($n = 3$), and other complications ($n = 2$). One patient developed recurrent vomiting, with a suspected pyloric stenosis; and one patient developed hypesthesia and hypalgesia, with suspected L5 nerve root irritation. The symptoms resolved completely in both of these patients before discharge.

All the intraoperatively created ileostomies were reversed. Of eight ileostomies that became necessary postoperatively, seven were reversed (mean 105 days, standard deviation 31 days). One patient underwent repeated postoperative attempts at laparoscopic or vaginal fistula revision. With suspected concomitant inflammatory bowel disease, this was not possible, and a Hartmann situation ultimately became necessary.

Eighty-seven (87%) of the 113 patients returned the questionnaire, and contact was made with 85 of these patients again (75.2%). Their mean age was 32.4 years (SD 5.8 years), with a follow-up period of 85.9 months (SD 26.1 months). None of the patients reported a major complication or minor complication in the questionnaires that had not previously been known to us.

The control group consisted of 100 women aged 21–58 years, with a mean age of 35.0 (SD 8.7 years). None of the volunteers had a history of endometriosis or histologically confirmed endometriosis, nor had any of them undergone hysterectomy.

Nineteen of the patients (22.4%) stated that their urinary stream was weak, slow, or prolonged. Sixteen (18.4%) had a feeling of incomplete bladder emptying. Seven (8.1%) were suffering from constipation and 50 (57.5%) stated that they had more than one bowel movement per day. Twenty-seven patients (36.5%) reported insufficient lubrication during intercourse. With the exception of the item on "constipation", the results differed significantly from those in the control group (Table 5).

A subgroup analysis was then carried out to determine whether there were any statistical associations between bladder, intestinal, and sexual function and the presence of a major or minor complication, the presence of an ultralow anastomosis, prior bilateral dissection of the sacrouterine ligaments, and dissection of the vagina and rectovaginal space. No significant associations were found (Table 6). Nor were there any statistically significant associations between postoperatively increased residual urine volumes ≥ 100 mL ($n = 11$) and the response to the questions "Is your urinary flow weak, slow, or prolonged?" ($P = 0.711$) and "Do you have a feeling of incomplete bladder emptying?" ($P = 0.431$).

Discussion

The study included a total of 113 patients who had undergone anterior rectal resection for deeply infiltrating endometriosis. The patients' main symptoms were dysmenorrhea, dyspareunia, and dyschezia. Particularly in those with dyspareunia, this can be explained by the high rates of involvement of the vagina (73.5%) and rectovaginal space (85.8%). The patients' main reason for opting for surgical intervention was pain alone in more than half of the cases. In both groups, approximately 30% of the patients stated that the reason for surgery had been a sterility problem, although 58.6% reported sterility as a symptom.

A laparoscopic access route was possible in 94.7% of the cases. This shows the high level of expertise and routine in the field of endometriosis surgery in our hospital and represents an argument in favor of establishing endometriosis

Table 5 Questionnaire responses on minor complications after anterior rectal resection for deeply infiltrating endometriosis

Minor complications	Patients		Control group		P
	(n)	Yes (%)	(n)	Yes (%)	
Weak/slow/prolonged urinary flow	85	19 (22.4%)	99	6 (6.1%)	0.002
Voiding dysfunction	87	16 (18.4%)	100	4 (4%)	0.002
Constipation	87	7 (8.1%)	100	11 (11%)	0.621
>1 bowel movement/day	87	50 (57.5%)	100	12 (12%)	<0.001
Insufficient vaginal lubrication	74	27 (36.5%)	91	9 (9.9%)	<0.001

A total of 87 patients responded to the questionnaire; the control group consisted of 100 healthy women. Exact Fisher test; significance level with Benjamini–Hochberg correction: $P = 0.008$

Table 6 Subgroup analysis of patients with and without complications; with and without ultralow anastomoses; with and without dissection of the sacrouterine ligament; and with and without dissections of the vagina + rectovaginal space

Subgroup	Prolonged urinary flow	Voiding dysfunction	Constipation	>1 bowel movement/ day	Insufficient vaginal lubrication
Complications present	23	24	23	23	20
Affirmative	5 (21.7%)	9 (37.5%)	0 (0%)	15 (65.2%)	5 (25.0%)
Complications absent	62	63	64	64	54
Affirmative	14 (22.6%)	7 (11.1%)	7 (10.9%)	35 (54.7%)	22 (40.7%)
P	1	0.011	0.182	0.465	0.281
Ultralow anastomosis present	20	20	19	19	17
Affirmative	3 (15%)	5 (25%)	0 (0%)	11 (57.9%)	6 (35.3%)
Ultralow anastomosis absent	64	66	66	66	56
Affirmative	16 (25%)	11 (16.7%)	7 (10.6%)	37 (56.1%)	20 (35.7%)
P	0.541	0.512	0.341	1	0.587
Dissection of sacrouterine ligaments present	28	28	27	27	27
Affirmative	10 (35.7%)	6 (21.4%)	3 (11.1%)	13 (48.1%)	10 (37.0%)
Dissection of sacrouterine ligaments absent	57	59	59	59	47
Affirmative	9 (15.8%)	10 (17%)	4 (6.8%)	36 (61%)	17 (36.2%)
P	0.053	0.768	0.673	0.349	1
Dissection of vagina and rectovaginal space present	61	63	62	62	54
Affirmative	14 (22.6%)	14 (22.2%)	4 (6.5%)	42 (67.7%)	22 (40.7%)
Dissection of vagina and rectovaginal space absent	13	13	13	13	10
Affirmative	3 (23.1%)	1 (7.7%)	1 (7.7%)	7 (53.8%)	3 (30.0%)
P	1	0.444	1	0.354	0.728

Significance was calculated using the exact Fisher test; significance level with Benjamini–Hochberg correction: $P = 0.008$

centers [21]. This argument is further supported by the very high rate of complete resections (local R0) and complete resections relative to the entire endometriosis in situ (overall R0).

The histological findings were positive for endometriosis directly in the intestinal specimens in 96.5% of cases. In four intestinal specimens, no stroma with endometrial glandular tissue was visible in the intestinal segment. However, cicatricial fibrotic tissue was identified in all of these bowel specimens. Stromal tissue with endometrial glandular groups was found in other endometriotic lesions outside of the intestine in these four patients, so that positive histological findings for endometriosis were present in 100%.

Major complications occurred in 15.9% of the patients ($n = 18$). A total of 29 major complications were observed. In detail, these consisted of eight cases of anastomotic insufficiency (five with rectovaginal fistulas), one vesicovaginal fistula, one case of erosion hemorrhage requiring revision, three thromboses, one embolism, one case of compartment syndrome, and nine cases of postoperative hemorrhage requiring transfusion. Patients in the group with deeply infiltrating intestinal endometriosis who required ileostomies postoperatively had initially had ultralow anastomoses (<6 cm from the anal line) significantly more often ($P < 0.001$). Thirty-five percent of the patients with ultralow intestinal anastomoses who did not receive ileostomies intraoperatively developed anastomotic insufficiency. In view of the high risk of insufficiencies (35%), patients with an intestinal anastomosis at a level lower than 6 cm (ultralow) need to have the increased risk explained to them postoperatively and require close monitoring. By contrast, the risk of anastomotic insufficiency is very low, at 1.3%, when the level of the anastomosis is >6 cm.

All patients with anastomotic insufficiencies or fistula formation had undergone vaginal and rectovaginal space excisions intraoperatively, although this was not significant relative to the overall group. Despite this, we would regard not only ultralow anastomoses but also simultaneous vaginal and rectovaginal space excision as representing a risk factor for anastomotic insufficiency or fistula formation.

The study by Akladios et al. included 41 patients with deeply infiltrating endometriosis who underwent laparoscopic rectal resection. In six patients (15%), the anastomosis was at the level of the sigmoid; in 21 patients (51%), it was in the high rectum (>10 cm from the anal line); in 10 (24%), it was in the low rectum (<10 cm from the anal line); and in four patients, it was ultralow (<5 cm). Temporary ileostomies were created intraoperatively in four cases (9.7%). All four patients with ultralow anastomoses received ileostomies. Postoperatively, one patient

developed anastomotic insufficiency (2.4%). The anastomosis level was 6 cm from the anal line. The patient received a secondary ileostomy [22].

Tarjanne et al. [8] investigated 164 patients with segmental intestinal resections and endometriosis. Prophylactic ileostomies were created in 14 (9%), mainly due to low anastomoses (nine of the 14 cases). The anastomosis was in the low rectum in 15 patients (9%), in the mid-rectum in 102 (62%), and in the high rectum in 47 (29%). Four patients (2.4%) developed anastomotic insufficiencies postoperatively, and two patients (1.2%) developed rectovaginal fistulas. No details were given on the anastomotic level in these patients. All six women (3.6%) received a secondary ileostomy. Low anastomosis was not found to be a risk factor for major postoperative complications in the study. According to the authors, this may have been because prophylactic ileostomies were created in the majority of patients with low anastomoses [8].

Table 7 compares the individual studies on the major complication rate with segmental resections [6–10, 23–25]. Overall, the complication rates are similar to those in the present study.

Minor complications occurred in 15%, consisting of postoperative residual urine volumes >100 mL in 13.3% of cases, mild-to-moderate infections in 2.7%, and other minor complications in 1.8%. In a study including 436 segment resections, Ruffo et al. [7] report a minor complication rate of 29%, including 4% with infections, 16% with urinary stasis or urine retention, 8% with bladder dysfunction, 3.4% with bowel function disturbances, and 0.4% with other minor complications.

Zilberman et al. [9] report a minor complication rate of 57% in a group of 164 patients. Mild-to-moderate infections occurred in 24%, urinary stasis or urine retention in

4%, and bladder dysfunction in 29%. The study had a follow-up period of 7–114 months for long-term complications, and the major complication rates were taken from the patients' files.

In an overall group of 436 patients with intestinal surgery for endometriosis, Minelli et al. [24] investigated 351 patients who received segment resections. Minor complications were noted in 37% of cases, consisting of mild-to-moderate infections in 9%, urinary stasis/urine retention in 15%, bowel function disturbances in 4%, and other minor complications in 9%.

Fanfani et al. [25] noted minor complications in 32% of cases in 88 segment resections. Mild-to-moderate infections occurred in 12.5% of the patients, urinary stasis/urine retention in 15%, and bowel function disturbances in 4%. The rate of minor complications in the present study was markedly lower than this.

Long-term minor complications include those that are not self-limiting and can potentially lead to substantial impairment of the patient's quality of life. These include new postoperative disturbances of sexual function (e.g., disturbed lubrication), bladder voiding disturbances, and bowel function disturbances. To assess long-term minor complications, we included questions on the areas of voiding and bowel emptying and also sexuality from the validated German Pelvic Floor Questionnaire. The follow-up period covered more than 7 years and was thus very long in comparison with other studies. In the absence of a cut-off value, we formed a control group for assessment. Among the patients, 22.4% stated that their urinary flow was weak, slow, or prolonged; 18.4% had a feeling of incomplete bladder emptying; 57.5% stated that they had bowel movements more than once a day. Twenty-seven patients (36.5%) reported insufficient lubrication during intercourse. These

Table 7 Comparison of major complications reported in the literature

First author, year (references)	Patients (n)	Major complications	Anastomotic insufficiency	Fistulas	Anastomotic stenosis	Infection	Bleeding requiring transfusion	Other	Intraoperative complications
Ruffo 2010 [7]	436	111 (25.4%)	5 (1%)	22 (5%)	16 (4%)	0	60 (14%)	6 (1.4%)	2 (0.4%)
Brouwer 2007 [23]	137	9 (7%)	1 (0.7%)	0	1 (0.7%)	2 (1.4%)	0	4 (3%)	1 (0.7%)
Keckstein 2005 [6]	202	15 (7.4%)	6 (3%)	0	6 (3%)	2 (1%)	1 (0.5%)	0	n.a
Zilberman 2013 [9]	164	17 (10%)	n.a	5 (3%)	n.a	n.a	12 (7%)	0	0
Tarjanne 2015 [8]	164	19 (12%)	4 (2.4%)	7 (4%)	0	0	2 (1%)	1 (0.6%)	5 (3%)
Minelli 2010 [24]	436[a]	109 (25%)	n.a	22 (5%)	n.a	2 (0.5%)	n.a	70 (16%)	16 (4%)
Dousset 2010 [10]	100	22 (22%)	2 (2%)	6 (6%)	0	6 (6%)	6 (6%)	2 (2%)	0
Fanfani 2010 [25]	88	14 (16%)	1 (1%)	5 (6%)	0	0	5 (6%)	2 (2%)	1 (1%)
Present study	113	18 (15.9%)	8 (7.1%)	6 (5.3%)	0	0	9 (8%)	5 (4.4%)	0

[a] 351 of these were segment resections; *n.a.* no data available

three areas differed significantly from the control group. There were no significant differences in relation to the question about constipation (8.1 vs. 11%).

Dousset et al. investigated postoperative complications in 100 patients with rectal endometriosis, with a 5-year follow-up period. The authors reported that bowel function disturbances improved postoperatively in all patients and that sexual satisfaction returned. The most frequent minor complication, at 16%, involved temporary peripheral neurogenic bladder emptying disturbances. Eleven percent of the bladder emptying disturbances persisted as long-term minor complications even after the 5-year follow-up period [10]. Dousset et al. reported that injury to the inferior hypogastric nerve was the cause of de novo bladder emptying disturbances. This was more likely in patients with bilateral resection of the sacrouterine ligaments, parametrial deeply infiltrating endometriosis, and/or a low anastomosis level [10].

Dubernard et al. investigated postoperative bladder function disturbances in a total of 86 patients with deeply infiltrating endometriosis, 58 of whom had rectal involvement [11]. It was found that nearly all of the patients had postoperative bladder complications: incontinence, bladder emptying disturbances, and weak urinary flow. Newly occurring bladder problems such as delayed urinary flow, control of urinary flow, and incomplete bladder emptying occurred more often in the group with rectal endometriosis. Bladder emptying disturbances involving incomplete emptying occurred significantly more often in the group with bilateral resection of the sacrouterine ligaments. Patients who underwent surgery due to rectal endometriosis and who also underwent bilateral resection of the sacrouterine ligaments had general bladder emptying disturbances significantly more often [11].

In the present study, the subgroup analysis did not identify any significant associations between responses to questions about bladder, bowel, and sexual function and the presence of major or minor complications, the presence of an ultralow anastomosis, bilateral dissection of the sacrouterine ligaments, or dissection of the vagina and rectovaginal space. These results are inconsistent with the results presented by Dousset et al. and Dubernard et al. A residual urine volume ≥ 100 mL immediately after surgery also does not appear to be evidence of imminent long-term bladder impairment.

Strengths of the present study include the large number of patients included and the long follow-up period with the questionnaire. This made it possible to re-investigate 113 patients, with a follow-up period of 85.9 months. One limitation of the study is its retrospective design, in which the available files were analyzed in the hospital. The files were inspected 2.5 years after the operations at the earliest. As the patients are usually attached to our endometriosis center and present once again when complications occur or checkups are required, it was possible to record the major complications with certainty. This is shown by the fact that no complications additional to those already known to us were stated in the questionnaire responses. Further strengths of the study are its long follow-up period and registering of long-term impairments of bladder, bowel, and sexual function. Further prospective studies are needed to focus on these topics.

References

1. Keckstein J, Ulrich U, Kandolf O, Wiesinger H, Wustlich M (2003) Laparoscopic therapy of intestinal endometriosis and the ranking of drug treatment. Zentralbl Gynakol 125:259–266. doi: 10.1055/s-2003-42281

2. Minelli L, Fanfani F, Fagotti A, Ruffo G, Ceccaroni M, Mereu L, Landi S, Pomini P, Scambia G (2009) Laparoscopic colorectal resection for bowel endometriosis: feasibility, complications, and clinical outcome. Arch Surg Chic Ill 1960 144:234–239. doi:10.1001/archsurg.2008.555(discussion 239)

3. Mohr C, Nezhat FR, Nezhat CH, Seidman DS, Nezhat CR (2005) Fertility considerations in laparoscopic treatment of infiltrative bowel endometriosis. JSLS 9:16–24

4. Meuleman C, Tomassetti C, D'Hoore A, Van Cleynenbreugel B, Penninckx F, Vergote I, D'Hooghe T (2011) Surgical treatment of deeply infiltrating endometriosis with colorectal involvement. Hum Reprod Update 17:311–326. doi:10.1093/humupd/dmq057

5. De Cicco C, Corona R, Schonman R, Mailova K, Ussia A, Koninckx P (2011) Bowel resection for deep endometriosis: a systematic review. BJOG Int J Obstet Gynaecol 118:285–291. doi:10.1111/j.1471-0528.2010.02744.x

6. Keckstein J, Wiesinger H (2005) Deep endometriosis, including intestinal involvement—the interdisciplinary approach. Minim Invasive Ther Allied Technol 14:160–166. doi:10.1080/14017430510035916

7. Ruffo G, Scopelliti F, Scioscia M, Ceccaroni M, Mainardi P, Minelli L (2010) Laparoscopic colorectal resection for deep infiltrating endometriosis: analysis of 436 cases. Surg Endosc 24:63–67. doi:10.1007/s00464-009-0517-0

8. Tarjanne S, Heikinheimo O, Mentula M, Härkki P (2015) Complications and long-term follow-up on colorectal resections in the treatment of deep infiltrating endometriosis extending to bowel wall. Acta Obstet Gynecol Scand 94:72–79. doi:10.1111/aogs.12515

9. Zilberman S, Ballester M, Touboul C, Chéreau E, Sèbe P, Bazot M, Daraï E (2013) Partial colpectomy is a risk factor for urologic complications of colorectal resection for endometriosis. J Minim Invasive Gynecol 20:49–55. doi:10.1016/j.jmig.2012.08.775

10. Dousset B, Leconte M, Borghese B, Millischer AE, Roseau G, Arkwright S, Chapron C (2010) Complete surgery for low rectal endometriosis: long-term results of a 100-case prospective study. Ann Surg 251:887–895. doi:10.1097/SLA.0b013e3181d9722d

11. Dubernard G, Rouzier R, David-Montefiore E, Bazot M, Daraï E (2008) Urinary complications after surgery for posterior deep infiltrating endometriosis are related to the extent of dissection and to uterosacral ligaments resection. J Minim Invasive Gynecol 15:235–240. doi:10.1016/j.jmig.2007.10.009

12. Koninckx PR, Martin D (1994) Treatment of deeply infiltrating endometriosis. Curr Opin Obstet Gynecol 6:231–241

13. Wolthuis AM, Meuleman C, Tomassetti C, D'Hooghe T, de Buck van Overstraeten A, D'Hoore A (2014) Bowel endometriosis: colorectal surgeon's perspective in a multidisciplinary surgical team. World J Gastroenterol 20:15616–15623. doi:10.3748/wjg.v20.i42.15616

14. Tuttlies F, Keckstein J, Ulrich U, Possover M, Schweppe KW, Wustlich M, Buchweitz O, Greb R, Kandolf O, Mangold R, Masetti W, Neis K, Rauter G, Reeka N, Richter O, Schindler AE, Sillem M, Terruhn V, Tinneberg HR (2008) ENZIAN-Klassifikation zur Diskussion gestellt: Eine neue differenzierte Klassifikation der tief infiltrierenden Endometriose. J Gynäkol Endokrinol 18:7–13

15. Baessler K, Junginger B (2011) Validation of a pelvic floor questionnaire with improvement and satisfaction scales to assess symptom severity, bothersomeness and quality of life before and after pelvic floor therapy. Aktuelle Urol 42:316–322. doi:10.1055/s-0031-1271544

16. Baessler K, O'Neill SM, Maher CF, Battistutta D (2009) Australian pelvic floor questionnaire: a validated interviewer-administered pelvic floor questionnaire for routine clinic and research. Int Urogynecol J Pelvic Floor Dysfunct 20:149–158. doi:10.1007/s00192-008-0742-4

17. Strasberg SM, Linehan DC, Hawkins WG (2009) The accordion severity grading system of surgical complications. Ann Surg 250:177–186. doi:10.1097/SLA.0b013e3181afde41

18. Gehrich A, Stany MP, Fischer JR, Buller J, Zahn CM (2007) Establishing a mean postvoid residual volume in asymptomatic perimenopausal and postmenopausal women. Obstet Gynecol 110:827–832. doi:10.1097/01.AOG.0000284445.68789.ee

19. Hawker GA, Mian S, Kendzerska T, French M (2011) Measures of adult pain: Visual Analog Scale for Pain (VAS Pain), Numeric Rating Scale for Pain (NRS Pain), McGill Pain Questionnaire (MPQ), Short-Form McGill Pain Questionnaire (SF-MPQ), Chronic Pain Grade Scale (CPGS), Short Form-36 Bodily Pain Scale (SF-36 BPS), and Measure of Intermittent and Constant Osteoarthritis Pain (ICOAP). Arthritis Care Res 63(Suppl 11):S240–S252. doi:10.1002/acr.20543

20. R Core Team (2013) R: a language and environment for statistical computing. R Foundation for Statistical Computing, Vienna. http://www.R-project.org/. Accessed 20 Feb 2017

21. Burghaus S, Fehm T, Fasching PA, Blum S, Renner SK, Baier F, Brodkorb T, Fahlbusch C, Findeklee S, Häberle L, Heusinger K, Hildebrandt T, Lermann J, Strahl O, Tchartchian G, Bojahr B, Porn A, Fleisch M, Reicke S, Füger T, Hartung CP, Hackl J, Beckmann MW, Renner SP (2016) The international endometriosis evaluation program (IEEP Study)—a systematic study for physicians, researchers and patients. Geburtshilfe Frauenheilkd 76:875–881. doi:10.1055/s-0042-106895

22. Akladios C, Messori P, Faller E, Puga M, Afors K, Leroy J, Wattiez A (2015) Is ileostomy always necessary following rectal resection for deep infiltrating endometriosis? J Minim Invasive Gynecol 22:103–109. doi:10.1016/j.jmig.2014.08.001

23. Brouwer R, Woods RJ (2007) Rectal endometriosis: results of radical excision and review of published work. ANZ J Surg 77:562–571. doi:10.1111/j.1445-2197.2007.04153.x

24. Minelli L, Ceccaroni M, Ruffo G, Bruni F, Pomini P, Pontrelli G, Rolla M, Scioscia M (2010) Laparoscopic conservative surgery for stage IV symptomatic endometriosis: short-term surgical complications. Fertil Steril 94:1218–1222. doi:10.1016/j.fertnstert.2009.08.035

25. Fanfani F, Fagotti A, Gagliardi ML, Ruffo G, Ceccaroni M, Scambia G, Minelli L (2010) Discoid or segmental rectosigmoid resection for deep infiltrating endometriosis: a case-control study. Fertil Steril 94:444–449. doi:10.1016/j.fertnstert.2009.03.066