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REVIEW

Outcomes after rectosigmoid resection for endometriosis: a systematic literature review

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Abstract

Purpose "Endometriosis" is defined such as the presence of endometrial glands and stroma outside the uterine cavity. This ectopic condition may develop as deeply infiltrating endometriosis (DIE) when a solid mass is located deeper than 5 mm underneath the peritoneum including the intestinal wall. The ideal surgical treatment is still under search, and treatment may range from simple shaving to rectal resection. The aim of the present systematic review is to report and analyze the postoperative outcomes after rectosigmoid resection for endometriosis.

Methods We performed a systematic review according to Meta-analysis of Observational Studies in Epidemiology guidelines. The search was carried out in the PubMed database, using the keywords: "rectal resection" AND "endometriosis" and "rectosigmoid resection" AND "endometriosis." The search revealed 380 papers of which 78 were fully analyzed.

Results Thirty-eight articles published between 1998 and 2017 were included. Three thousand seventy-nine patients (mean age 34.28 ± 2.46) were included. Laparoscopic approach was the most employed (90.3%) followed by the open one (7.9%) and the robotic one (1.7%). Overall operative time was 238.47 ± 66.82. Conversion rate was 2.7%. In more than 80% of cases, associated procedures were performed. Intraoperative complications were observed in 1% of cases. The overall postoperative complications rate was 18.5% (571 patients), and the most frequent complication was recto-vaginal fistula (74 patients, 2.4%). Postoperative mortality rate was 0.03% and mean hospital stay was 8.88 ± 3.71 days.

Conclusions Despite the large and extremely various number of associated procedures, rectosigmoid resection is a feasible and safe technique to treat endometriosis.

Keywords Endometriosis · Deeply infiltrating endometriosis (DIE) · Rectal resection · Rectosigmoid resection · Postoperative outcomes

Introduction

The presence of endometrial glands and stroma outside the uterine cavity is defined "endometriosis" [1]. It is a chronic inflammation that involves women in their reproductive period [1]. Endometriotic disease has an incidence of 0.1% among women with age between 15 and 49 years, and a prevalence of about 5%, with a peak between 25 and 35 years of age [1]. However, these percentages may be underestimated as a consequence of the variable anatomical localization and symptoms [1]. Moreover, the diagnosis of bowel involvement is not simple, and often, the entity might be an intraoperative finding with changing of the operative strategy [1, 2].

This condition can be developed such as deeply infiltrating endometriosis (DIE) when a solid mass is located deeper than 5 mm under the peritoneum [2]. It is common to observe this ectopic tissue in the pelvis, particularly not only in the rectal wall and at the rectosigmoid junction up to achieve the 93% of all intestinal endometriotic lesions, but also in other organs such as bladder or ureters [1–3].

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Two main surgical approaches are proposed to treat the DIE of the rectum that may range from a complete or segmental rectal resection to a simpler nodule excision by shaving (without opening the rectal wall) or by full-thickness disc excision (resecting the nodule together with the adjacent rectal wall) [4]. The rectosigmoid resection is a radical and more definitive treatment but is obviously associated with possible severe and definitive complications of a colorectal resection. On the other hand, when a less invasive treatment is chosen to remove the nodule (i.e., shaving), this may result in incomplete treatment jeopardizing the radicality [3]. As a consequence, the treatment remains a challenge for the surgeon and an ideal treatment is still under search. Moreover, literature data are variable in patients selection and results, often derived from small series of retrospective nature.

The aim of the present systematic review is to report and analyze the early postoperative outcomes after rectosigmoid resection for endometriosis in order to better clarify the best approach.

Materials and methods

Search strategy

We conducted a systematic review of published papers according to Meta-analysis of Observational Studies in Epidemiology (MOOSE) guidelines [5]. The search was carried out in the PubMed database, using the keywords "rectal resection" AND "endometriosis" and "rectosigmoid resection" AND "endometriosis". The search revealed 380 papers published between March 1990 and June 2017.

Inclusion criteria

Inclusion criteria were (1) articles from any country written English and (2) articles reporting postoperative outcomes after rectosigmoid resection for endometriosis through any approach (open, laparoscopic, robotic, or transanal).

Exclusion criteria

Exclusion criteria were (1) articles in languages other than English; (2) articles about surgical techniques that do not provide for the rectosigmoid resection, for the treatment of endometriosis; (3) articles reporting more than one technique in which was not possible to extract only data regarding colorectal resection technique; (4) articles about other diagnosis; (5) reviews, systematic reviews, meta-analysis, case reports, correspondence and letters to authors or editors, editorials, technical surgical notes, and imaging studies; and (6) articles involving animals.

Outcome of interest

Data extracted from each paper were number of patients, age, Body Mass Index (BMI), symptoms, previous abdominal surgery, surgical approach (laparotomy, laparoscopy, robotic), operative time, associated procedures, creation and closure of colostomy/ileostomy, intra- and postoperative complications, estimated blood loss, hospital stay, recurrence, mortality, and follow-up data.

After screening the titles and abstracts, we identified articles that fulfilled the eligibility criteria and reviewed their full

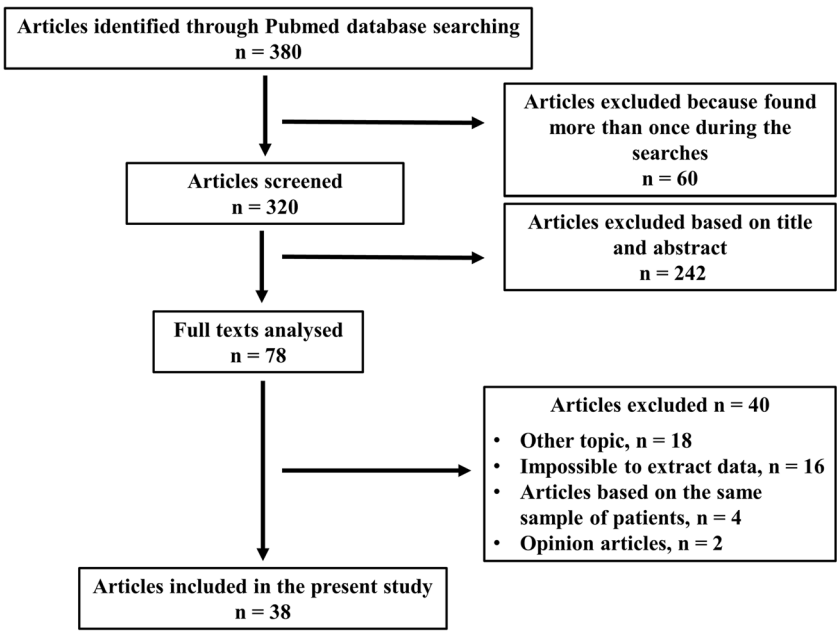

Fig. 1 Flow diagram

text. Data were extracted by two surgeons (A.B. and S.Q.) and stored in the Microsoft Excel program (Microsoft Corporation, Redmond, WA, USA).

Assessment of the studies quality

The quality of the studies was assessed by two authors (A.B. and S.Q.) using a modified Newcastle-Ottawa Scale (NOS) for cohort studies [6]. This was evaluated by examining three factors: patients selection, comparability, and the completeness of the reported results (postoperative outcomes). Good quality of the studies was assigned when 3 or 4 points were attributed to patients selection and 1 or 2 points were attributed to comparability and 2 or 3 points were attributed to outcomes. Fair quality of the studies was assigned when 2 points were attributed to patients selection and 1 or 2 points were attributed to comparability and 2 or 3 points were attributed to outcomes. Eventually, poor quality of the studies was assigned when 0 or 1 point was attributed to patients selection or 0 points were attributed to comparability or 0 points were attributed to outcomes [6]. The maximum available score for each study is 9 points [6].

Statistical analysis

Data were presented as frequencies and percentages. Mean and standard deviation (SD) were calculated according to Hozo et al. [7]. For groups comparison, statistical analysis was performed using the *t* test or Fisher's exact test. Data were analyzed in the SPSS version 22 (IBM Corp. SPSS Inc. Armonk, NY, USA). A probability (p) value lower than 0.05 was considered statistically significant.

Results

Of the 380 articles identified in the search, 60 were excluded due to the overlap between the two searches. Of the remaining 320 articles, 242 were excluded after screening the title and abstract. The remaining 78 articles were fully analyzed, and 40 further studies were excluded (Fig. 1).

Finally, 38 articles published between September 1998 and May 2017 were included in the present systematic review [8–45], as shown in the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) flow diagram (Fig. 1) [46]. The maximum score (9 points) was achieved in seven articles (Table 1). Nineteen papers were retrospective studies, 17 were prospective studies, 1 was a case-control study, and 1 was a Randomized Control Trial (RCT) (Table 2) [8–45].

A total of 3079 female patients (mean age 34.28 ± 2.46) affected by DIE were included in the present study with a mean of 81 patients per article [8–45]. Table 3 shows patients' clinical characteristics.

The most frequent symptoms observed were dysmenorrhea (70.1%), pain (63.9%), dyspareunia (60.7%), dyschezia (39.1%), constipation (36.2%), infertility (34.6%), and rectal bleeding (21.3%) (Table 4).

Laparoscopic approach was the most employed (90.3%) followed by the open one (7.9%) and the robotic one (1.7%) (Table 5). Overall operative time was 238.47 ± 66.82 and conversion rate was 2.7% (79 patients) (Table 5). In more than 80% of cases (2472 patients), associated procedures were performed, and among these, the most frequent observed were uterosacral ligament resection (13.4%), ureterolysis (12.5%), vaginal resection (12.5%), adhesiolysis (7.9%), and excision of intra-abdominal endometrioma nodules (6.8%) (Table 5). Intraoperative complications were observed in 1% of cases (Table 5). In 21 articles, intraoperative bowel diversion during primary surgery was reported for a total of 472 cases (15.3%) (Table 5). Closure of the bowel diversion performed during the primary surgery was reported in five articles for a total of 25 patients (5.2%).

The overall postoperative complications rate was 18.5% (571 patients) of which the most common were recto-vaginal fistula (2.4%), anastomotic leakage (2.1%), urinary retention (2%), bleeding (1.1%), and fever (1.1%) (Table 6). In 15 articles, the creation of stoma after primary surgery, to treat the complications, was reported and it occurred for a total of 70 cases (12.2%) (Table 6). In 8 articles, the closure of stoma to treat complications was reported, for a total of 20 cases (28%). Postoperative mortality was observed in one case (0.03%) for pulmonary embolism. Mean hospital stay was 8.88 ± 3.71 days (Table 6).

At mean follow-up of 37.42 ± 25.56 months, recurrences were observed in 112 cases (3.6%), but follow-up data were reported only in 20 papers (Table 6). Postoperative pain course was reported in 9 articles, and overall in 218 (32%) patients out of 693, pain has improved or resolved (data not reported for 475 patients) (Table 6).

Data based on surgical approach are reported in Tables 2, 3, 4, 5, and 6. Conversions to open surgery were all observed with laparoscopic surgery (79 out of 2782 procedures, 2.8%) (Table 5). In case of open surgery, blood loss, the number of associated procedures (371 out of 158 patients, 234%), the number of intraoperative complications (8 out of 210 patients, 3.8%), and stoma creation at primary surgery (98 out of 158 patients, 62%) and the number of postoperative complications (56 out of 210 patients, 26.6%) were higher and statistically significant than the laparoscopic and robotic surgery (Tables 5 and 6).

Table 1 Assessment of the study quality based on Newcastle-Ottawa scale

Author, year	Selection	Comparability	Outcomes	Total score	Evaluation
	1 2 3 4	**5**	**6 7 8**		
Urbach, 1998 [8]	* – * *	* *	* * –	7	Good
Darai, 2005 [9]	* – * *	* *	* * *	8	Good
Campagnacci, 2005 [10]	* – * *	* *	* * *	8	Good
Abrao, 2005 [11]	* – * *	* *	* – –	6	Poor
Dubernard, 2006 [12]	* – * *	* *	* * *	8	Good
Ribeiro, 2006 [13]	* – * *	* *	* – –	6	Poor
Seracchioli, 2007 [14]	* – * *	* *	* * *	8	Good
Zanetti-Dällenbach, 2008 [15]	* * * *	* *	* * *	9	Good
Ghezzi, 2008 [16]	* – * *	* *	* * *	8	Good
Minelli, 2009 [17]	* – * *	* *	* * *	8	Good
De Nardi, 2009 [18]	* – * *	* *	* * *	8	Good
Bracale, 2009 [19]	* – * *	* *	* * *	8	Good
Kim, 2009 [20]	– – * *	——	* – –	3	Poor
Kössi, 2010 [21]	* – * *	* *	* – –	6	Poor
Dousset, 2010 [22]	* – * *	* *	* * *	8	Good
Daraï, 2010 [23]	* * * *	* *	* * *	9	Good
Roman, 2010 [24]	* * * *	* *	* * *	9	Good
Moawad, 2011 [25]	* * * *	* *	* * *	9	Good
Lim, 2011 [26]	* * * *	* *	* * *	9	Good
Ruffo, 2012 [27]	* – * *	* *	* – –	6	Poor
Ceccaroni, 2012 [28]	* * * *	* *	* * *	9	Good
Vitobello, 2013 [29]	* – * *	* *	* – –	6	Poor
Kössi, 2013 [30]	* – * *	* *	* * *	8	Good
Neme, 2013 [31]	* – * *	* *	* * *	8	Good
Cassini, 2014 [32]	* – * *	* *	* – –	6	Poor
Fleisch, 2014 [33]	* – * *	* *	* * *	8	Good
Mangler, 2014 [34]	* – * *	* *	* * *	8	Good
English, 2014 [35]	* – * *	* *	* * *	8	Good
Akladios, 2015 [36]	* – * *	* *	* – –	6	Poor
Tarjanne, 2015 [37]	* – * *	* *	* – –	6	Poor
Rausei, 2015 [38]	* – * *	* *	* – –	6	Poor
Milone, 2015 [39]	* – * *	* *	* – –	6	Poor
Malzoni, 2016 [40]	* – * *	* *	* * *	8	Good
Roman, 2016 [41]	* – * *	* *	* – –	6	Poor
Riiskjaer, 2016 [42]	* – * *	* *	* * *	8	Good
Roman, 2016 [43]	* * * *	* *	* * *	9	Good
Vlek, 2017 [44]	* – * *	* *	* * –	7	Good
Renner, 2017 [45]	* – * *	* *	* * –	7	Good

Discussion

We conducted this study with the aim to report the outcomes after rectosigmoid resection for deep infiltrating endometriosis. Due to the nature of the included papers, most of which are retrospective, reporting small series of patients and heterogeneous data, a meta-analysis was not performed. Reporting the conclusions from the prospective papers included in this review, with higher evidence level, it seems that rectosigmoid resection for DIE improves postoperative symptoms, fertility, and in general patients' quality of life, and that laparoscopic approach is feasible and safe even if it is recommended to perform it in high volume centers with the availability of both the gynecologist and the general surgeon [12–14, 16–18, 22, 23, 26–28, 30–32, 34, 41, 42, 44].

The most performed surgical approach was the laparoscopic approach, followed by the open and the robotic one, respectively. Conversions to open surgery were observed only

Table 2 Number of patients, type of surgery performed, and postoperative complications of studies included in the present review. *RCT* Randomized Control Trial

Author, year	Type of study	No. of patients	Surgical approach	Complications, *n* (%)
Urbach, 1998 [8]	Retrospective	29	Open	6 (20.6)
Darai, 2005 [9]	Retrospective	40	Laparoscopic	11 (27.5)
Campagnacci, 2005 [10]	Retrospective	7	Laparoscopic	1 (14.2)
Abrao, 2005 [11]	Retrospective	8	Laparoscopic	–
Dubernard, 2006 [12]	Prospective	58	Laparoscopic	8 (13.8)
Ribeiro, 2006 [13]	Prospective	125	Laparoscopic	12 (9.6)
Seracchioli, 2007 [14]	Prospective	22	Laparoscopic	12 (54.5)
Zanetti-Dällenbach, 2008 [15]	Retrospective	48	Laparoscopic	11 (22.9)
Ghezzi, 2008 [16]	Prospective	33	Laparoscopic	2 (6)
Minelli, 2009 [17]	Prospective	357	Laparoscopic	93 (26)
De Nardi, 2009 [18]	Prospective	10	Laparoscopic	2 (20)
Bracale, 2009 [19]	Retrospective	56	Laparoscopic	21 (37.5)
Kim, 2009 [20]	Retrospective	5	2 Laparoscopic 3 Open	–
Kössi, 2010 [21]	Retrospective	31	Laparoscopic	8 (25.8)
Dousset, 2010 [22]	Prospective	100	Open	32 (32)
Daraï, 2010 [23]	RCT	52	26 Laparoscopic 26 Open	22 (42.3)
Roman, 2010 [24]	Retrospective	15	Laparoscopic	11 (73.3)
Moawad, 2011 [25]	Retrospective	14	Laparoscopic	3 (21.4)
Lim, 2011 [26]	Prospective	18	Robotic	2 (11.1)
Ruffo, 2012 [27]	Prospective	750	Laparoscopic	66 (8.8)
Ceccaroni, 2012 [28]	Prospective	126	Laparoscopic	13 (10.3)
Vitobello, 2013 [29]	Retrospective	7	Robotic	1 (14.2)
Kössi, 2013 [30]	Prospective	26	24 Laparoscopic 2 Open	6 (23)
Neme, 2013 [31]	Prospective	10	Robotic	–
Cassini, 2014 [32]	Prospective	19	Robotic	2 (10.5)
Fleisch, 2014 [33]	Retrospective	4	Laparoscopic	4 (100)
Mangler, 2014 [34]	Prospective	71	Laparoscopic	3 (4.2)
English, 2014 [35]	Retrospective	74	Laparoscopic	17 (22.9)
Akladios, 2015 [36]	Retrospective	41	Laparoscopic	10 (24.4)
Tarjanne, 2015 [37]	Retrospective	164	112 Laparoscopic 52 Open	15 (9.1)
Rausei, 2015 [38]	Retrospective	41	Laparoscopic	6 (14.6)
Milone, 2015 [39]	Case-control	90	Laparoscopic	22 (24.4)
Malzoni, 2016 [40]	Retrospective	248	Laparoscopic	40 (16.1)
Roman, 2016 [41]	Prospective	103	Laparoscopic	28 (27.1)
Riiskjaer, 2016 [42]	Prospective	128	Laparoscopic	–
Roman, 2016 [43]	Retrospective	25	18 Laparoscopic 7 Open	29 (116)
Vlek, 2017 [44]	Prospective	11	6 Laparoscopic 5 TaTME	1 (9)
Renner, 2017 [45]	Retrospective	113	107 Laparoscopic 6 Open	49 (43.3)

during laparoscopy. In open surgery, the associated procedure rate was statistically higher if compared to laparoscopic or robotic surgery (Table 5). This could be related to the fact that for the surgeons, it is simpler to perform unexpected procedure in open surgery, probably for the absence of the tactile sense or the reduced operative field in laparoscopic or robotic surgery. Moreover, based on the present data, considering the intraoperative complications rate (3.8%), ileostomy

Table 3 Patients' characteristics

	Overall sample	Open approach	Laparoscopic approach	Robotic approach	*p* value
Patients for whom age is reported	2895	210	2492	54	Open vs Lap: 0.814
Mean age ± SD (years)	34.28 ± 2.46	35.36 ± 2.47	34.19 ± 2.11	38.45 ± 2.17	Open vs Rob: 0.12
					Lap vs Rob: *0.002**
Patients for whom BMI is reported	2381	178	2017	47	Open vs Lap: 1.0000
Mean BMI ± SD (kg/m^2)	23.20 ± 1.96	24.22 ± 3.31	23.13 ± 1.76	24.23 ± 3.65	Open vs Rob: 1.0000
					Lap vs Rob: 1.0000
Patients for whom previous surgery is reported	3079	210	2651	54	Open vs Lap: *0.0038**
Previous abdominal surgery not for endometriosis	81	–	81	–	Open vs Rob: 1.0000
					Lap vs Rob: 0.4089
Patients for whom previous surgery is reported	3079	210	2651	54	Open vs Lap: *0.0001**
Previous surgery to treat endometriosis					
One procedure	1356	145	1143	6	Open vs Rob" *0.0001**
Two procedures	123	–	84	–	
≥ Three procedures	80	–	80	–	Lap vs Rob: *0.0001**
Total	1559	145	1307	6	

BMI Body Mass Index, *SD* standard deviation

*Statistically significant differences in italics

Table 4 Preoperative patients' symptoms. *GI* gastrointestinal

Symptoms	Overall sample (1057 patients), *n* (%)	Open approach (132 patients), *n* (%)	Laparoscopic approach (758 patients), *n* (%)	Robotic approach (36 patients), *n* (%)
Dysmenorrhea	741 (70.1)	105 (79.5)	544 (71.7)	14 (38.9)
Pain/pain on defecation/pain on bowel movement/back pain/pelvic pain/ abdominal pain/rectal pain	676 (63.9)	149 (112.9)	437 (57.6)	24 (66.6)
Dyspareunia	642 (60.7)	101 (76.5)	479 (63.2)	7 (19.4)
Dyschezia	414 (39.1)	67 (50.7)	302 (39.8)	9 (25)
Constipation	383 (36.2)	71 (53.8)	308 (40.6)	3 (8.3)
Infertility	366 (34.6)	77 (58.3)	218 (28.7)	6 (16.6)
Rectal bleeding/hematochezia	226 (21.3)	44 (33.3)	169 (22.3)	8 (22.2)
Diarrhea	153 (14.5)	2 (1.5)	133 (17.5)	–
Dysuria	151 (14.3)	–	113 (17.5)	9 (25)
Intestinal/GI symptoms	128 (12.1)	–	54 (7.1)	–
Tenesmus	21 (2)	2 (1.5)	13 (1.7)	6 (16.6)
Asthenia	21 (2)	–	21 (2.8)	–
Urgency on defecation	16 (1.5)	–	–	–
Bowel occlusion	16 (1.5)	–	16 (2.1)	–
Cramping	13 (1.2)	–	13 (1.7)	–
Urinary frequency	9 (0.9)	9 (6.8)	–	–
Hypermenorrea	9 (0.9)	–	9 (1.2)	–
Hematuria	4 (0.4)	3 (2.3)	1 (0.1)	–
Pencil-thin stools	4 (0.4)	4 (3)	–	–
Menorrhagia	2 (0.2)	2 (1.5)	–	–
Hydroureter	1 (0.09)	–	1 (0.1)	–
Pressure on the rectum	1 (0.09)	–	1 (0.1)	–
Feeling of incomplete evacuation	1 (0.09)	1 (0.8)	–	–

Table 5 Intraoperative details. *SD* Standard Deviation. *Five patients underwent laparoscopic transanal total mesorectal excision. *Statistically significant differences in italics

	Overall sample (3079 patients)	Open approach (243 patients, 7.9%)	Laparoscopic approach (2782 patients*, 90.3%)	Robotic approach (54 patients, 1.7%)	*p* value
Conversion, *n* (%)	79 (2.7%)	–	79 (2.8%)	–	Lap vs Rob: *0.0001**
Patients for whom operative time is reported	238.47 ± 66.82	178	2432	54	Open vs Lap: 1.0000
Mean operative time (minutes) ± SD		261 ± 50.68	261.92 ± 63.25	263.07 ± 115.49	Open vs Rob: 1.0000
					Lap vs Rob: 1.0000
Patients for whom blood loss is reported	281.28 ± 117.06	52	1774	44	Open vs Lap: *0.0003**
Mean estimated blood loss (mL) ± SD		2501	375.18 ± 175.96	360.83 ± 264.41	Open vs Rob: *0.0003**
					Lap vs Rob: 1.0000
Associated procedures, *n* (%)	*2472 (80.2)*	*371 out of 158 (234)*	*1906 out of 2539 (75.1)*	*33 out of 54 (61.1)*	Open vs Lap: *0.0001**
Uterosacral ligament/torus/parametrium resection	413 (13.4)	91 (57.6)	299 (11.7)	–	Open vs Rob: *0.0001**
Ureterolysis	385 (12.5)	6 (3.8)	224 (8.8)	8 (14.8)	Lap vs Rob: *0.0258**
Vaginal resection	385 (12.5)	23 (14.5)	269 (10.6)	6 (11.1)	
Adhesiolysis	246 (7.9)	–	213 (8.3)	7 (12.9)	
Endometrioma nodule excision	211 (6.8)	–	182 (7.1)	2 (3.7)	
Unilateral ovarian cystectomy/tumor excision/enucleation	132 (4.2)	–	63 (2.5)	7 (12.9)	
Hysterectomy	109 (3.5)	8 (5)	85 (3.3)	–	
Unilateral ovariectomy	94 (3)	61 (38.6)	25 (1)	1 (1.8)	
Partial cystectomy	82 (2.6)	14 (8.8)	72 (2.8)	–	
Posterior colpectomy/partial posterior colpectomy	81 (2.6)	64 (40.5)	17 (0.6)	–	
Right colectomy/cecum-ileocecal-small bowel resection	65 (2.1)	51 (32.2)	18 (0.7)	–	
Salpingectomy	47 (1.5)	–	41 (1.6)	–	
Appendicectomy	46 (1.4)	11 (7)	30 (1.1)	2 (3.7)	
Ureteral resection and reimplantation	43 (1.3)	7 (4.4)	36 (1.4)	–	
Bilateral ovariectomy	36 (1.1)	18 (11.4)	11 (0.4)	–	
Cystectomy	27 (0.8)	–	23 (0.9)	–	
Unspecified ovarian procedures	20 (0.6)	–	20 (0.8)	–	
Hysterectomy and bilateral ovariectomy	10 (0.3)	10 (6.3)	–	–	
Ovariectomy/tubectomy	10 (0.3)	–	10 (0.4)	–	
Hysterectomy + colpectomy	5 (0.1)	–	5 (0.2)	–	
Tubal lavation	5 (0.1)	–	5 (0.2)	–	
Laser ablation	4 (0.1)	–	4 (0.1)	–	
Bilateral ovarian cystectomy	3 (0.09)	–	–	–	
Unilateral nephroureterectomy	3 (0.09)	3 (1.9)	–	–	
Myomectomy	3 (0.09)	–	3 (0.1)	–	
Ureteroneocistostomy	2 (0.06)	–	2 (0.07)	–	
Bilateral nephroureterectomy	2 (0.06)	2 (1.2)	–	–	
	2 (0.06)	2 (1.2)	–	–	
	1 (0.03)	–	–	–	

Table 5 (continued)

	Overall sample (3079 patients)	Open approach (243 patients, 7.9%)	Laparoscopic approach (2782 patients*, 90.3%)	Robotic approach (54 patients, 1.7%)	*p* value
Bilateral ureteral resection and reimplantation					
Bilateral ovarian endometriosis ablation					
Intraoperative complications, *n* (%)	*33 (1)*	*8 out of 210 (3.8)*	*25 out of 2651 (0.9)*	*0 out of 54*	Open vs Lap: *0.0021** Open vs Rob: 0.3666 Lap vs Rob: 1.0000
Ureteral injuries	3 (9)	1 (0.4)	2 (0.07)	–	
Bleeding	2 (6)	1 (0.4)	1 (0.03)	–	
Rectal perforation	1 (3)	1 (0.4)	–	–	
Unspecified urologic complications	7 (21.2)	–	7 (0.3)	–	
Unspecified intestinal complications	7 (21.2)	–	7 (0.3)	–	
Unspecified vascular complications	5 (15.1)	–	5 (0.2)	–	
Unspecified complications	8 (24.2)	5 (2.3)	3 (0.1)	–	
Intraoperative ileostomy/colostomy creation, *n* (%)	472 (15.3)	98 out of 158 (62)	343 out of 2651 (12.9)	0 out of 54	Open vs Lap: *0.0001** Open vs Rob: *0.0001** Lap vs Rob: *0.0013**

creation rate at primary surgery (62%), and postoperative complications rate in case of open surgery, the laparoscopic or robotic surgery seems to be the better approach of choice in case of rectosigmoid resection for DIE.

The overall complications rate observed was 18.5% (571 patients), and the most frequent complication occurred was recto-vaginal fistula (2.4%, 74 patients). It was not possible to classify the complications according to Clavien classification [47] because the treatment was not specified in all papers or was not the same in any case.

In the present study, 472 stomas were performed during primary surgery, but approximately only the 5% of them were closed. On the contrary, in literature was reported a stoma closure rate up to 85% and up to 93% in case of rectosigmoid resection for rectal cancer or for gynecologic malignancies, respectively [48]. Anyway, in our opinion, in many of the included studies, data regarding the long-term period were not reported, so probably the closure rate is higher. Regarding the pain symptom, an improvement was observed; anyway it is difficult to draw definitive data due to the huge number of missing data (Table 6).

Still now in literature is debated which is the best surgical treatment of rectal DIE between nodule excision by shaving or by full-thickness disc excision and rectal resection [4]. Roman et al., in a prospective study about rectal disc excision, reported a postoperative complications rate of 42% and a recto-vaginal fistula rate of 4%, which were higher if compared to the present study, even if stoma was not performed in any case at primary surgery [4]. Similarly, Abo et al. reported an overall complications rate of 45% after disc excision and a recto-vaginal fistula rate of 3.7% [49]. Stoma at primary surgery was performed in 55% of cases [49]. On the other hand, shaving procedure seems to have similar outcomes to the rectosigmoid resection reporting a postoperative complications and recto-vaginal fistula rates of 19.3 and 2.1%, respectively [49]. Afors et al., in a series of 47 patients, reported similar postoperative results (complications rate 25%), but in any case, stoma was performed at primary surgery [50]. In the only trial reported in literature, in which conservative surgery (disc excision or shaving) was compared to rectal resection, better results were observed evaluating the postoperative complications rate in favor of bowel resection, even if in the latter group, the anastomotic stenosis rate was significant higher [51]. Moreover, differences in functional digestive and urinary outcomes were not observed [51].

Comparing the postoperative complications rate in this study, with the complications rate observed after rectosigmoid resection for rectal cancer, reported in literature, several differences are to be noted. First of all, the recto-vaginal fistula rate reported in literature ranged from 0.9 to 9% while in the present study was 2.4% [52–61]. The anastomotic leak ranged from 2 to 23% while in the present study was 2.1% [62]. After resection for cancer, pelvic abscess rate reported was about

Table 6 Postoperative details. *SD* standard deviation, *GI* gastrointestinal

	Overall sample, (3079 patients)	Open approach, (210 patients)	Laparoscopic approach, (2651 patients)	Robotic approach, (54 patients)	*p* value
Postoperative complications, *n* (%)	*571 (18.5)*	*56 (26.6)*	*418 (15.7)*	*5 (9.2)*	Open vs Lap:
Recto-vaginal fistula	74 (2.4)	6 (2.8)	59 (2.2)	4 (7.4)	*0.0001**
Anastomotic leak	67 (2.1)	2 (0.9)	54 (2)	–	Open vs Rob:
Urinary retention	63 (2)	–	60 (2.2)	–	*0.0062**
Unspecified complications	49 (1.6)	14 (6.6)	35 (1.3)	–	Lap vs Rob:
Bleeding/hemoperitoneum	35 (1.1)	3 (1.4)	21 (0.8)	1 (1.8)	0.2551
Fever	34 (1.1)	–	28 (1)	–	
Bladder athony	31 (1)	16 (7.6)	9 (0.3)	–	
Anastomotic stenosis	20 (0.6)	–	18 (0.7)	–	
Rectorrhagia	20 (0.6)	–	17 (0.6)	–	
Constipation	20 (0.6)	1 (0.5)	19 (0.7)	–	
Ureteral leak/fistula/injury	17 (0.5)	3 (1.4)	13 (0.5)	–	
Pelvic abscess/collection	16 (0.5)	–	15 (0.5)	–	
Residual urine	15 (0.5)	–	–	–	
Urinary infection	10 (0.3)	–	2 (0.07)	–	
Wound infection	10 (0.3)	6 (2.8)	4 (0.1)	–	
Bowel obstruction	10 (0.3)	1 (0.5)	9 (0.3)	–	
Bowel leak/perforation/fistula	9 (0.3)	–	9 (0.3)	–	
Vesico-vaginal fistula	8 (0.3)	1 (0.5)	6 (0.2)	–	
Stoma complications	7 (0.2)	–	3 (0.1)	–	
Peritonitis	7 (0.2)	–	7 (0.2)	–	
Dysuria	7 (0.2)	–	7 (0.2)	–	
Thrombosis	5 (0.2)	2 (0.95)	–	–	
Intra-abdominal abscess	5 (0.2)	–	5 (0.2)	–	
Bladder suture leak/bladder fistula	4 (0.1)	–	3 (0.1)	–	
Ileus	4 (0.1)	–	4 (0.1)	–	
Compartment syndrome	3 (0.09)	–	2 (0.07)	–	
Moderate infections	3 (0.09)	–	–	–	
Ureteral stenosis	3 (0.09)	–	2 (0.07)	–	
Nerve injuries	3 (0.09)	–	–	–	
GI infection	2 (0.06)	1 (0.5)	1 (0.03)	–	
Embolism	1 (0.03)	–	–	–	
Recurrent vomiting	1 (0.03)	–	–	–	
Definitive bladder dysfunction	1 (0.03)	–	1 (0.03)	–	
Uretero-vaginal fistula	1 (0.03)	–	1 (0.03)	–	
Cysto-recto-vaginal fistula	1 (0.03)	–	1 (0.03)	–	
Vaginal distress	1 (0.03)	–	1 (0.03)	–	
Anastomotic bleeding	1 (0.03)	–	–	–	
Vaginal suture dehiscence	1 (0.03)	–	–	–	
Pneumonia	1 (0.03)	–	1 (0.03)	–	
Myocardial infarction	1 (0.03)	–	1 (0.03)	–	
Postoperative ileostomy/colostomy creation, *n* (%)	70 (12.2)	11 (19.6)	50 (11.9)	1 (20)	Open vs Lap: 0.1338 Open vs Rob: 1.0000

Table 6 (continued)

	Overall sample, (3079 patients)	Open approach, (210 patients)	Laparoscopic approach, (2651 patients)	Robotic approach, (54 patients)	*p* value
Mortality, *n* (%)	1 (0.03)	–	1 (0.03)	–	Lap vs Rob: 0.4757 Open vs Lap: 1.0000 Open vs Rob: 1.0000
Patients for whom hospital stay is reported Mean hospital stay (days) ± SD	8.88 ± 3.71	107 9.18 ± 1.28	2233 9.62 ± 3.7	54 4.76 ± 1.22	Lap vs Rob: 1.0000 Open vs Lap: 1.0000 Open vs Rob: 0.288 Lap vs Rob: *0.036**
Patients for whom follow-up is reported Mean follow-up (months) ± SD	37.42 ± 25.56	129 50.3 ± 39.17	1005 30.65 ± 14.46	19 12	Open vs Lap: 0.356 Open vs Rob: 0.159 Lap vs Rob: 0.835
Ileostomy/colostomy performed during primary surgery closure, *n* (%)	25 (5.2)	2 (2) (data not reported in 96 cases)	10 (2.9) (data not reported 333 cases)	–	Open vs Lap: 1.0000 Open vs Rob: 0.5389 Lap vs Rob: 0.3701
Ileostomy/colostomy performed to treat complications closure, *n* (%)	20 (28)	4 (36.3) (data not reported in seven cases)	12 (24) (data not reported in 38 cases)	1 (100)	Open vs Lap: 0.4569 Open vs Rob: 0.4167 Lap vs Rob: 0.2549
Recurrence, *n* (%)	112 (3.9) out of 2886	11 (5.2) out of 210	100 (0.3) out of 2651	–	Open vs Lap: 0.2668 Open vs Rob: 0.1274 Lap vs Rob: 0.2650
Patients for whom pain is reported Postoperative pain improvement reported, *n* (%)	693 218 (31.4)	149 –	520 194 (37.3)	24 24 (100)	Open vs Lap: *0.0001** Open vs Rob: *0.0001** Lap vs Rob: *0.0001**

12% while in the present study was 0.5% [62]. Eventually, mortality rate reported in the literature was 2% and in the present review was 0.03% [62]. Data regarding resection for rectal cancer were extracted from a sample of patients with the higher age (median 65 years, range 44–72) [62] than the sample of patients examined in this review (mean 34.28 ± 2.46). Rectosigmoid resection for DIE, in comparison to resection for rectal cancer, seems to be a safer procedure despite one patient out of three underwent previous surgical procedures to treat endometriosis and that about 80% of patients underwent more than one procedure in the same intervention.

Other risk factors were identified regarding the development of anastomotic leakage after rectal resection for cancer, such as the gender male, due to the difficulties in working in a narrow pelvis, the neoadjuvant chemo-radiotherapy, due to the pelvic fibrosis development, the ligation of the inferior mesenteric artery at its origin, due to the risk of devascularization of the colonic side of the anastomosis and the nutritional status [63–66]. All these issues were not observed in the present sample of patients, and this could explain the lower rate of postoperative complications. Moreover, it is interesting to note the high number of associated procedures during rectosigmoid resection for DIE (2472 associated procedures on 3079 rectosigmoid resections, 80.2%) that, anyway, did not increase significantly the complications rate compared to resection in case of cancer.

To the best of our knowledge, this is the first systematic review concerning the outcomes after rectosigmoid resection for DIE, reported in literature, with a significant number of patients included (3079). The major weaknesses of this review are the missing data from the included papers and the fact that 19 articles were retrospective studies. Moreover, even if some studies were included in the present review because they met the inclusion criteria, their aim was not to report the postoperative outcomes. Anyway, a wide revision of perioperative outcomes in patients who underwent rectosigmoid resection for DIE was obtained.

In conclusion, rectosigmoid resection is a feasible and safe technique to treat endometriosis even if a postoperative rectovaginal fistula rate of 2.4% is not negligible. This study shows good postoperative results, in terms of complications and mortality, despite the huge number of associated procedures. Probably, the factors which most influence the postoperative results in case of rectal surgery are age, gender (male), preoperative radiotherapy, ligation of inferior mesenteric artery at its origin, and nutritional status, all elements that are not frequent in young women patients affected by endometriosis.

Compliance with ethical standards

Conflict of interest Andrea Balla, Silvia Quaresima, José D. Subiela, Mostafa Shalaby, Giuseppe Petrella, and Pierpaolo Sileri have no conflicts of interest or financial ties to disclose.

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