Human Reproduction Update, Vol.17, No.3 pp. 311–326, 2011
Advanced Access publication on January 13, 2011 doi:10.1093/humupd/dmq057

human reproduction update

Surgical treatment of deeply infiltrating endometriosis with colorectal involvement

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Submitted on February 15, 2010; resubmitted on September 21, 2010; accepted on November 11, 2010

BACKGROUND: Treatment of colorectal endometriosis is difficult and challenging. We reviewed the clinical outcome of surgical treatment of deeply infiltrating endometriosis (DIE) with colorectal involvement.

METHODS: Review was based upon a literature search using following search terms: (1) 'surgery' and 'colorectal endometriosis', (2) 'bowel' and 'endometriosis' and 'surgery'. Inclusion criteria: clear explanation of surgical technique and follow-up data on at least one of the following items: complications, pain, quality of life (QOL), fertility and recurrence.

RESULTS: Most of the 49 studies included complications (94%) and pain (67%); few studies reported recurrence (41%), fertility (37%) and QOL (10%); only 29% reported (loss of) follow-up. Out of 3894 patients, 71% received bowel resection anastomosis, 10% received full-thickness disc excision and 17% were treated with superficial surgery. Comparison of clinical outcome between different surgical techniques was not possible. Post-operative complications were present in 0–3% of the patients. Although pain improvement was reported in most studies, pain evaluation was patient-based in <50% (Visual Analogue Scale in only 18%). While QOL was improved in most studies, prospective data were only available for 149 patients. Pregnancy rates were 23–57% with a cumulative pregnancy rate of 58–70% within 4 years. The overall endometriosis recurrence rate in studies (>2 years follow-up) was 5–25% with most of the studies reporting 10%. Owing to highly variable study design and data collection, a CONSORT-inspired checklist was developed for future studies.

CONCLUSIONS: Prospective studies reporting standardized and well-defined clinical outcome after surgical treatment of DIE with colorectal involvement with long-term follow-up are needed.

Key words: deeply infiltrating endometriosis / surgery / colorectal / bowel / outcome

Introduction

Endometriosis is a gynecologic disorder, characterized by the presence of ectopic endometrium outside the endometrial cavity. Endometriosis predominantly affects women of reproductive age and is associated with pelvic pain and infertility (Kennedy *et al.*, 2005). The prevalence of endometriosis in the general female population has been estimated to be 10% (Viganò *et al.*, 2004). The pathogenesis of endometriosis may be explained by ectopic implantation of endometrial cells following retrograde menstruation via the Fallopian tubes into the pelvis (Sampson, 1927). However, the precise etiology of endometriosis remains unknown.

Three clinical presentations of endometriosis have been described: peritoneal endometriosis, ovarian endometriosis (endometriomas) and deeply infiltrating endometriosis (DIE; Donnez *et al.*, 1992). In women with endometriosis, intestinal involvement is estimated to occur in 3.8–37% of the patients (Remorgida *et al.*, 2007). Intestinal endometriosis usually affects the rectosigmoid colon and can be associated with symptoms such as diarrhea, dyschezia (defined as the difficulty in defecating, usually as a consequence of long-continued voluntary suppression of the urge to defecate, wordnetweb.princeton.edu/perl/webwn), bowel cramping and pain on defecation (Sinaii *et al.*, 2002).

DIE nodules extend more than 5 mm beneath the peritoneum and may involve the uterosacral ligaments, vagina, bowel, bladder or

ureters. Different systems (Koninckx and Martin, 1994; Donnez and Nisolle, 1995; Chapron et al., 2003a, b) have been reported to describe the phenotypes of DIE. In one classification system (Koninckx and Martin, 1994), three types of DIE are distinguished: Type I is a rather large lesion in the peritoneal cavity, infiltrating conically with the deeper parts becoming progressively smaller; Type II has the main feature of the bowel being retracted over the lesion, which thus becomes deeply situated in the rectovaginal septum although not actually infiltrating it; and Type III lesions are the deepest and most severe. The Type III lesions are spherically shaped, situated deep in the rectovaginal septum, and are often only visible as a small typical lesion at laparoscopy or often not visible at all. The type and severity of symptoms is related to the depth of infiltration (Koninckx and Martin, 1994). In a second classification system (Donnez and Nisolle, 1995), only two types of DIE are distinguished. The first type is true DIE, caused by the invasion of a very active peritoneal lesion deep in the retroperitoneal space. In cases of lateral peritoneal invasion, uterosacral ligaments can be involved as well as the anterior wall of the rectosigmoid bowel junction resulting in a retraction, adhesions and secondary obliteration of the cul-de-sac. A second type is pseudo-DIE or adenomyosis of the rectovaginal septum. This lesion originates from the rectovaginal septum tissue and consists essentially of smooth muscle with active glandular epithelium and scanty stroma (Donnez and Nisolle, 1995). A third classification system is based on the location of the DIE lesions (Chapron et al., 2003a, b) that can be distinguished in the anterior or posterior section (P), subdivided according to the involvement of the uterosacral ligament (P1), vagina (P2) or intestine (P3) (Chapron et al., 2003a, b). Recently, the relevance of these classification systems has been questioned, since most women with DIE also have peritoneal endometriosis and/or ovarian endometriotic cysts (Chapron et al., 2009) and since the depth of the cul-de-sac is significantly reduced in women with DIE, suggesting that most cases of DIE originate from peritoneal endometriosis, followed by adhesion formation between uterosacral ligaments and rectum, bowel retraction and partial or full obliteration of the cul-de-sac (Chapron et al., 2003a; Vercellini et al., 2004; Vercellini et al., 2009a).

Treatment of colorectal endometriosis is difficult and challenging. Medical management of DIE with colorectal extension (with non-steroidal anti-inflammatory drugss, oral contraceptives, gestogens, antigestogens or GnRH agonists) is based on suppression of the symptoms, is not curative and is often associated with significant side effects (Telimaa, 1988; Marana et al., 1994; Vercellini et al., 2009b). It is not clear if the medical management approach prevents disease progression, especially in more severe cases of endometriosis with colorectal extension. In addition, discontinuation of this therapy commonly results in recurrence (Jatan et al., 2006). Therefore, it is widely agreed that surgical management is the primary treatment for more severe forms of endometriosis, such as symptomatic DIE with colorectal extension (Garry, 2004; Emmanuel and Davis, 2005). This surgical approach has evolved in many ways since Weed and Ray reviewed in 1987 a series of 163 cases of endometriosis of the bowel and found that colon and rectal surgeons performed bowel resection of the colon, while gynecological surgeons resected bowel implants and the bowel was opened in 15% of the implant resections (Weed and Ray, 1987). Laparoscopy has changed tremendously over the past 30 years with respect to surgical techniques and quality of imaging. Laparoscopic segmental excision of the rectum and other types of colorectal surgery, such as discoid excision and superficial shaving, have become increasingly popular but the most appropriate surgical approach for this difficult disease remains controversial. However, little is known about the impact of the different types of surgery in the treatment of DIE on complications, pain, the patients' quality of life (QOL), recurrence rate and pregnancy rate or fertility. The aim of this literature review is therefore to evaluate the outcomes of the different surgical modalities for management of DIE with colorectal involvement based on the above-mentioned parameters.

Methods

This review is based upon a literature search in Pubmed using the following search terms: (1) 'surgery' and 'colorectal endometriosis', (2) 'bowel' and 'endometriosis' and 'surgery'. The original search was performed on 03 June 2009 and was completed with studies published until 31 December 2009. To ensure the relevance of the publications retrieved, additional inclusion criteria were applied. To be included, the published studies had to be in English and had to contain a clear explanation of the surgical technique used as well as an adequate follow-up phase describing data on at least one of the following terms: post-operative complications, evaluation of pain (dysmenorrhea, dyspareunia, chronic non-menstrual pelvic pain) and QOL (preoperative versus post-operative), fertility (pregnancy rate) and recurrence rate. A flow diagram describing the selection of the papers is given in Fig. 1.

Anatomical considerations

Before describing the different options for surgical management and their outcome, it is essential to take into account the anatomical distribution and histological findings of intestinal endometriosis. Intestinal endometriosis can be found in many areas between small bowel and anal canal, but the main locations of intestinal endometriosis are the rectum and rectosigmoid junction. In a recent observational study, 426 patients presented with 172 intestinal DIE lesions. The rectum and rectosigmoid junction were involved in 65.7% of the cases, followed by the sigmoid colon (17.4%), caecum and ileocaecal junction (4.1%), appendix (6.4%), small bowel (4.7%) and omentum (1.7%) (Chapron et al., 2006).

An important characteristic that should be taken into account before deciding on the surgical strategy for intestinal endometriosis is its multifocality (defined as the presence of endometriotic lesions within a 2 cm area from the main lesion) and its multicentric involvement (defined as the presence of endometriotic lesions beyond 2 cm from the main lesion; Kavallaris et al., 2003). Multifocal and multicentric involvement was observed in 62 and 38% of surgical *en bloc* specimens, respectively (Kavallaris et al., 2003). This multifocal/multicentric involvement can possibly be explained by the observation that endometriosis infiltration of the large bowel wall occurs preferentially alongside the bowel nerves, even at a distance from the palpated lesion (Anaf et al., 2004). Additionally, fibrosis in the muscular layer does not always surround bowel endometriotic lesions (Remorgida et al., 2005). Moreover, in almost 70% of the cases, intestinal endometriosis lesions are associated with DIE in other locations, justifying specific associated surgical procedures for the uterosacral ligaments, vagina, bladder and/or ureter (Chapron et al., 2003b).

The depth of infiltration of endometriotic lesions into the bowel wall is another important variable to consider in the surgical treatment of choice. In this context, a distinction can be drawn between the presence of endometriotic lesions on the bowel serosa and endometriotic lesions infiltrating the muscularis. According to Chapron, lesions of the serosa without infiltration of the muscularis must not be considered as true intestinal

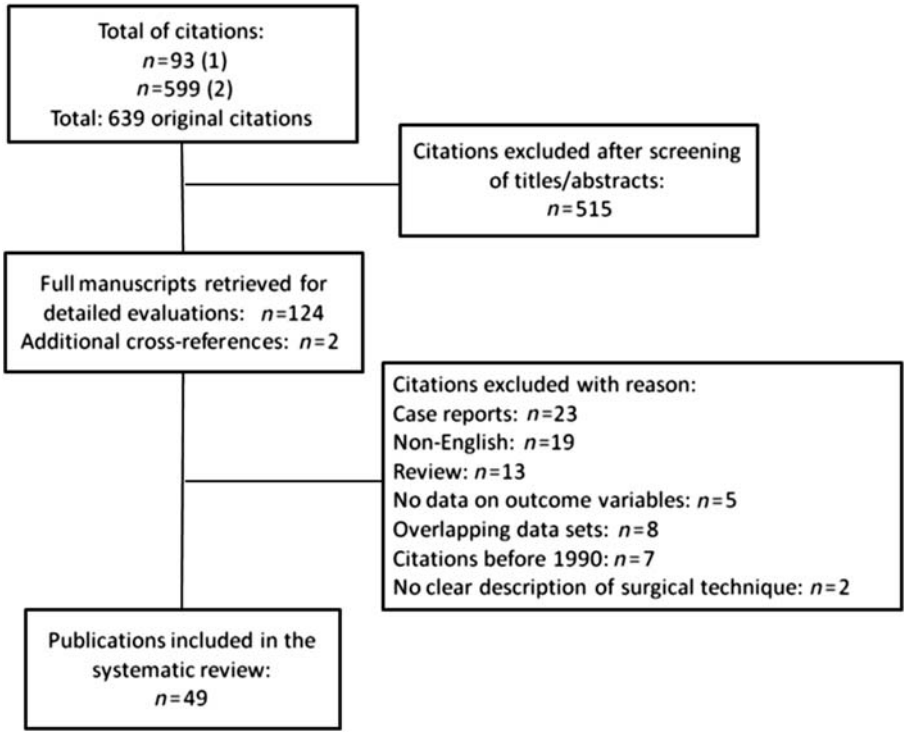

Figure 1 Flowchart for literature review of surgical treatment of DIE with colorectal involvement. Search Terms: (1) 'surgery' and 'colorectal endometriosis', (2) 'bowel' and 'endometriosis' and 'surgery'.

endometriosis because these superficial lesions do not justify any specific bowel procedure from a surgical point of view (Chapron *et al.*, 2003b). In practice, this superficial form of serosal bowel endometriosis may not be recognized, be ignored or be treated by surgical shaving, or eventually by full-thickness discoid excision if shaving resulted in significant bowel trauma.

Other relevant anatomical parameters include the effect of previous surgery on abdominopelvic anatomy, the existence and extension of associated pelvic adhesions and the distance between the intestinal lesion and the linea dentata.

Surgical technique

Several surgical procedures for endometriosis with bowel involvement have been described using a laparoscopic, a laparotomic, a transvaginal or a combined approach. Different options include shaving [defined as superficial peeling of bowel serosal and subserosal endometriosis (with diathermy or laser)], superficial excision (defined as selective excision of the bowel endometriosis lesion without opening of the bowel wall) full-thickness disc excision (defined as selective excision of the bowel endometriosis lesion with opening, followed by closure, of the bowel wall), or bowel resection anastomosis (defined as resection of a bowel segment affected by endometriosis followed by anastomosis). The choice of the operative technique depends on the extent and depth of bowel infiltration, and on the personal preferences and skills of the surgeon. However, when the intestinal tract is involved, a multidisciplinary approach has been proposed as mandatory (Meuleman *et al.*, 2009a; Ruffo *et al.*, 2010). Indeed, the concept is emerging that the best results, in terms of improvement of symptoms and QOL, are achieved by complete surgical excision of all endometriotic implants with a combined gynecological/general surgeon intervention (Garry *et al.*, 2000; Chapron *et al.*, 2001; Meuleman *et al.*, 2009a, b; Ruffo *et al.*, 2009).

Outcome variables

In this review, we have listed the number of patients in each study, the time of follow-up, the number of patients lost during follow-up, the number of previous therapeutic surgeries, the indication for surgery as well as histological data, post-operative complications, evaluation of pain (dysmenorrhea, dyspareunia, chronic non-menstrual pelvic pain), QOL (preoperative versus post-operative), fertility (pregnancy rate) and recurrence rate.

At the level of histological data, we checked if the following parameters were reported: histological confirmation of endometriosis, degree of endometriosis in the bowel wall, median length of the resected colorectal segment, median of the largest diameter lesions and positive margins (resected bowel specimens that were positive for endometriosis in at least one resection margin).

Major complications were defined as rectovaginal fistulae, anastomotic leakage, pelvic abscesses and post-operative bleeding and their prevalence and clinical management were reviewed. The number and nature of concomitant surgical procedures was noted. Concomitant surgical procedures were defined as surgical procedures that were carried out during the same surgery when also bowel endometriosis was treated surgically.

Pain and QOL were evaluated at the level of methodology (which test was used, patient-reported versus physician-reported etc.) and content (preoperative versus post-operative comparison).

Fertility outcome was assessed as follows: number of patients with a history of infertility, number of patients wishing to conceive and who conceived, median time to conceive after surgery, mode of conception (spontaneous or artificial) and live birth rate, presence of life table analysis.

The endometriosis recurrence rate was reported as follows: number of patients with recurrence after surgery, median time to recurrence, and data on life table analysis. The level of evidence for recurrence of endometriosis was classified in five categories:

(1) Symptom recurrence based on patient history, but no proof of recurrence by imaging and/or surgery.
(2) Endometriosis recurrence based on non-invasive imaging [e.g. ultrasound, magnetic resonance imaging (MRI)] in patients with or without symptoms (pain, infertility).
(3) Surgical reintervention without recurrence of endometriosis: in patients with recurrent symptoms, surgery without visual diagnosis of endometriosis, and with either normal pelvis or other abnormalities (e.g. adhesions).
(4) Recurrence of visual endometriosis without histological proof: during laparoscopy endometriosis is visually observed but either not biopsied or biopsied without histologically proven endometriosis.
(5) Recurrence of histologically proven endometriosis: during laparoscopy endometriosis is visually observed and confirmed histologically.

Suspicious recurrent endometriosis was present if the criteria for Categories 1 and 2 were met. Proven recurrent endometriosis was present if the criteria for Categories 4 and 5 were met. Additional surgery without evidence for endometriosis was present if the criteria for Category 3 were met.

Statistical analysis

Because of the different styles of reporting data throughout the reviewed papers as well as the heterogeneity of the mixed study group (including studies performing different surgical techniques for the treatment of DIE), no statistical comparisons were made on any of the outcome variables. All data provided are therefore treated in a descriptive manner.

Results

Overview

The process of literature identification and selection is shown in Fig. 1. From the electronic search, 639 original publications were retrieved (93 articles using 'surgery' and 'colorectal endometriosis' and 599 articles using 'bowel' and 'endometriosis' and 'surgery' as keywords; 53 articles were found in both categories). After screening the titles and/or abstracts, 124 articles were retrieved. Additionally, by checking the publications, two additional cross-references were included. Finally, after investigation of the full manuscripts, 49 articles were included in the review. Reasons for exclusion were: case reports (23), reviews (13), non-English articles (19), no data reported on outcome variables (5), overlapping data sets (8), citations before 1990 (7) and no clear description of surgical technique (2).

Since we were faced with five publications from the same team (Thomassin *et al.*, 2004; Daraï *et al.*, 2005a, b, 2007; Dubernard *et al.*, 2006), since one study (Daraï *et al.*, 2007) included 40 patients from a previous paper (Daraï *et al.*, 2005a), and since it was not clear if there was additional patient overlap between these four studies, only one paper from this team (Daraï *et al.*, 2007) was included.

Table I represents an overview of the final 49 studies that comprised this review. For all these studies, we have investigated a number of parameters including the type of study (prospective/retrospective), the number of patients, histopathological confirmation of DIE, the follow-up time and procedure, the surgical method applied, the number of previous surgeries for endometriosis, the indication for which the patients underwent surgery (pain, fertility or both), the collection of data on pain, QOL, recurrence, fertility rate and complication rates and, although mentioned only in a minority of the reports, the number of patients lost during follow-up. In only one study (Meuleman *et al.*, 2009a) were data on all outcome variables reported (Supplementary data, Table SI).

The majority of studies ($n = 32$) include data related to surgical treatment with only bowel resection anastomosis (Table I). Other studies ($n = 16$, mixed surgical group, Table I) include data related to a combination of mixed surgical techniques in different patients, mostly either resection anastomosis or disc excision. Only one study (Table I) includes data related to full-thickness disc excision only. Overall, on a total of 3894 patients included in the 49 studies presented in Table I, 2776 patients (71.3%) underwent bowel resection anastomosis, 383 patients (9.8%) underwent full-thickness disc excision and 679 patients (17.4%) were treated with a shaving or superficial excision technique. The majority of the studies (75.5%; 37/49) were performed by multidisciplinary teams (24/32 of the bowel resection anastomosis studies, 1 full-thickness disc excision study and 12/15 mixed studies). The majority of the patients underwent one or more previous therapeutic surgeries for endometriosis (59.0 and 55.9% in the bowel resection anastomosis and mixed studies, respectively). The main indication for surgery was pain alone (75.2 and 62.9% in the bowel resection anastomosis and mixed studies, respectively) or pain combined with infertility (24.8 and 36.3% in the bowel resection anastomosis and mixed studies, respectively).

The follow-up procedure and the number of patients lost during follow-up was reported in only 1/49 (29%) studies together representing 1101/3894 (28%) patients (Supplementary data, Table SI). In the bowel resection anastomosis studies, 53 (10.9%) of the patients were reported to be lost during follow-up, while 127 (20.9%) patients were lost during follow-up in the mixed surgical group. The use of post-operative hormonal treatment was only recorded in a minority of the studies (8.2%; 4/49).

Most studies included information on complication rate (94%; 46/49) and on pain (67%; 33/49). Less than half of the studies included information on recurrence rate (41%; 20/49) and fertility rate (37%; 18/49). Furthermore, the QOL was only investigated in 5/49 (10%) of the studies (Supplementary data, Table SI).

Preoperative assessment of colorectal involvement by imaging techniques

Supplementary data, Table SI shows that preoperative assessment of colorectal involvement was not recorded in 37% (18/49) studies, or was limited to gynecological ultrasonography (transrectal, vaginal or abdominal) in 4% (2/49) of the studies. In more than half of the studies (59%; 29/49 studies) preoperative assessment of colorectal involvement by bowel barium enema (26%; 13/49 studies), computerized tomography-scan (31%; 15/49 studies) and/or MRI (28%; 14/49 studies) was documented. Preoperative assessment of possible bladder/ureter involvement by i.v. pyelography or by ultrasonography of kidneys and bladder was recorded in only 10% (5/49) of studies.

Level of invasion of endometriosis in resected bowel specimens

In the bowel resection anastomosis studies reporting transmural invasion, 99.2% of the cases (1067/1076 patients) were histologically

Table I Surgical treatment of DIE with colorectal involvement.

Reference	Bowel surgery done	*n* (%)[a]	*n* (%)[b] previous therapeutic surgeries	Indication (%)	Histological confirmation *n* (%)	median or mean ± SD follow-up time (months)
Bowel resection and anastomosis						
Abrao *et al.* (2005)	Bowel resection anastomosis	8 (100)	NR	Pain (100)	NR	12
Anaf *et al.* (2004)	Bowel resection anastomosis	31 (100)	NR	Pain (45.2)	31 (100)	26 ± 5.7
Boni *et al.* (2007)	Bowel resection anastomosis	11 (100)	NR	NR	NR	4 ± 2
Bracale *et al.* (2009)	Bowel resection anastomosis	56 (100)	32 (57.1)	Pain (69.6)	56 (100)	45 (6–90)
Bromberg *et al.* (1999)	Bowel resection anastomosis	10 (100)	3 (30.0)	Pain (100)	10 (100)	NR
Campagnacci *et al.* (2005)	Bowel resection anastomosis	7 (100)	0 (0)	Pain (100)	7 (100)	38.7 (1–84)
Chopin *et al.* (2005)	Bowel resection anastomosis	16 (100)	NR	NR	16 (100)	38.4
Daraï *et al.* (2007)	Bowel resection anastomosis	71 (100)	40 (56.3)	Pain (100)	70 (98.6)	24.4 ± 2.2
de Jong *et al.* (2009)	Bowel resection anastomosis	5 (100)	NR	Pain and infertility (100)	5 (100)	18–36
de Nardi *et al.* (2009)	Bowel resection anastomosis	10 (100)	NR	Pain (100)	10 (100)	27.6 (18–37)
Ferrero *et al.* (2009)	Bowel resection anastomosis	46 (100)	29 (63.0)	Pain (100)	NR	49.9 ± 24.1
Fleisch *et al.* (2005)	Bowel resection anastomosis	23 (100)	22 (95.7)	Pain and infertility (95.7)	23 (100)	45.2 ± 18.0
Ghezzi *et al.* (2008)	Bowel resection anastomosis	33 (100)	27 (81.8)	Pain and infertility (100)	33 (100)	13 (3–27)
Juhasz-Böss *et al.* (2010)	Bowel resection anastomosis	6 (100)	NR	NR	NR	20.1 (1–29)
Kavallaris *et al.* (2003)	Bowel resection anastomosis	50 (100)	45 (90.0)	NR	50 (100)	32
Keckstein and Wiesinger (2005)	Bowel resection anastomosis	142 (100)	NR	NR	NR	NR
Kössi *et al.* (2010)	Bowel resection anastomosis	31 (100)	14 (45.2)	Pain (100)	NR	NR
Landi *et al.* (2006)	Bowel resection anastomosis	45 (100)	40 (88.9)	NR	NR	15.3 ± 10 (8.8–23)
Langebrekke *et al.* (2006)	Bowel resection anastomosis	24 (100)	18 (75.0)	NR	24 (100)	12 (4–15)
Lyons *et al.* (2006)	Bowel resection anastomosis	7 (100)	3 (42.9)	NR	7 (100)	12
Mereu *et al.* (2007)	Bowel resection anastomosis	192 (100)	91 (47.4)	Pain (100)	NR	1
Meuleman *et al.* (2009a)	Bowel resection anastomosis	56 (100)	42 (75.0)	Pain and infertility (100)	56 (100)	29 (6–76)
Minelli *et al.* (2009)	Bowel resection anastomosis	334 (100)	131 (39.2)	Pain (100)	334 (100)	19.6 (6–48)
Pereira *et al.* (2009)	Bowel resection anastomosis	168 (100)	NR	Pain and infertility (100)	168 (100)	37 ± 23
Possover *et al.* (2000)	Bowel resection anastomosis	34 (100)	NR	NR	34 (100)	16

Continued

Table I *Continued*

Reference	Bowel surgery done	*n* (%)[a]	*n* (%)[b] previous therapeutic surgeries	Indication (%)	Histological confirmation *n* (%)	median or mean ± SD follow-up time (months)
Remorgida *et al.* (2005)	Bowel resection anastomosis	16 (100)	5 (31.3)	NR	16 (100)	NR
Ruffo *et al.* (2010)	Bowel resection anastomosis	436 (100)	283 (64.9)	NR	NR	1
Seracchioli *et al.* (2007)	Bowel resection anastomosis	22 (100)	15 (68.2)	Pain (100)	22 (100)	36
Stepniewska *et al.* (2009)	Bowel resection anastomosis	60 (100)	45 (75.0)	NR	60 (100)	26.9
Tarjanne *et al.* (2009)	Bowel resection anastomosis	54 (100)	38 (70.4)	Pain (100)	NR	NR
Urbach *et al.* (1998)	Bowel resection anastomosis	29 (100)	21 (72.4)	Pain (100)	29 (100)	21.7 ± 12.3
Verspyck *et al.* (1997)	Bowel resection anastomosis	6 (100)	4 (66.6)	NR	6 (100)	36
Total		2039 (100)	948/1607 (59.0)	Pain (75.2) Pain and infertility (24.8)	1067 (99.2)	
Mixed procedures						
Bailey *et al.* (1994)	Bowel resection anastomosis	123 (94.6)	76 (58.5)	Pain (100)	NR	60 (16–184)
	Full-thickness disc excision	7 (5.4)				
Brouwer and Woods (2007)	Bowel resection anastomosis	137 (67.5)	NR	Pain and infertility (100)	NR	68 (7–158)
	Full-thickness disc excision	58 (28.6)				
	Shave	18 (8.9)				
Coronado *et al.* (1990)	Bowel resection anastomosis	72 (93.5)	40 (51.9)	Pain (100)	77 (100)	12–108
	Full-thickness disc excision	5 (6.5)				
Donnez *et al.* (1995)	Shave/superficial excision	231 (100)	NR	Pain (77.9)	69 (29.9)	NR
				Pain and infertility (22.1)		
Duepree *et al.* (2002)	Bowel resection anastomosis	18 (35.3)	39 (76.5)	NR	NR	NR
	Full-thickness disc excision	5 (9.8)				
	superficial excision	26 (51.0)				
Ford *et al.* (2004)	Bowel resection anastomosis	10 (16.7)	NR	Pain (100)	55 (91.7)	12 (2–22)
	Full-thickness disc excision	2 (3.3)				
	Shave	48 (80.0)				
Jatan *et al.* (2006)	Bowel resection anastomosis	14 (14.7)	56 (58.9)	Pain (56.8)	NR	21 (0.25–75)

Continued

Table I *Continued*

Reference	Bowel surgery done	*n* (%)[a]	*n* (%)[b] previous therapeutic surgeries	Indication (%)	Histological confirmation *n* (%)	median or mean ± SD follow-up time (months)
	Full-thickness disc excision	20 (21.1)				
	Shave/superficial excision	61 (64.2)				
Jerby *et al.* (1999)	Bowel resection anastomosis	7 (25.0)	26 (92.9)	Pain (100)	28 (100)	10 (1–32)
	Full-thickness disc excision	5 (17.9)				
	Superficial excision	12 (42.9)				
Maytham *et al.* (2010)	Bowel resection anastomosis	27 (50.0)	NR	NR	NR	6–30
	Full-thickness disc excision	7 (13.0)				
	Shave	20 (37.0)				
Mohr *et al.* (2005)	Bowel resection anastomosis	48 (25.7)	NR	Pain and infertility (31.0)	181 (96.8)	24 (2–81) or 28.2 ± 19.6
	Full-thickness disc excision	39 (20.9)		Pain (69.0)		
	Shave	100 (53.5)				
Redwine and Wright (2001)	Bowel resection anastomosis	6 (7.1)	31 (36.9)	Pain (100)	NR	50.9 ± 34.2
	Full-thickness disc excision	21 (25.0)				
	Superficial excision	23 (27.4)				
Ribeiro *et al.* (2006)	Bowel resection anastomosis	115 (92.0)	77 (61.6)	Pain (100)	125 (100)	NR
	Full-thickness disc excision	2 (1.6)				
	Shave	8 (6.4)				
Slack *et al.* (2007)	Bowel resection anastomosis	3 (2.3)	NR	NR	128 (100)	6–48
	Full-thickness excision	111 (86.7)				
Varol *et al.* (2003)	Bowel resection anastomosis	25 (14.8)	146 (86.4)	Pain and infertility (100)	NR	35
	Full-thickness disc excision	12 (7.1)				
	Shave	132 (78.1)				
Wills *et al.* (2009)	Bowel resection anastomosis	85 (48.0)	NR	Pain (79.1)	174 (98.3)	NR
	Full-thickness disc excision	80 (45.2)		Infertility (5.6)		
				Pain and infertility (14.7)		
Zanetti-Dällenbach *et al.* (2008)	Bowel resection anastomosis	47 (97.9)	36 (75.0)	Pain and infertility (100)	46 (95.8)	NR
	Full-thickness disc excision	1 (2.1)				

Continued

Table I *Continued*

Reference	Bowel surgery done	n (%)[a]	n (%)[b] previous therapeutic surgeries	Indication (%)	Histological confirmation n (%)	median or mean ± SD follow-up time (months)
Total	Bowel resection anastomosis	737 (39.9)	451/767 (58.8)	Pain (62.9)	883 (83.2)	
	Full-thickness disc excision	375 (20.3)		Pain and infertility (36.3)		
	Shave/superficial excision	679 (36.8)		Infertility (0.8)		
Full-thickness disc excision						
Nezhat *et al.* (1994)	Full-thickness disc excision	8	8	Pain and infertility (100)	NR	5–18
Total		8	8			

Overview of the studies included in the review: bowel resection anastomosis studies; studies including mixed procedures; full-thickness disc excision studies. NR, Not Recorded; Histological confirmation = histological confirmation of transmural invasion.
[a]Number of patients treated with this technique and percentage of patients treated reported in the paper.
[b]Number of patients who underwent previous surgery (for total percentage of patients, if previous surgery was not reported, studies were excluded).

confirmed compared with 83.2% of the reported cases (883/1061 patients) in the mixed surgical group (Table I). Although 31/49 studies reporting the outcome of surgery for endometriosis with colorectal extension included patients with histologically confirmed endometriosis, only 18 of these 31 studies contained specific histopathological data for bowel endometriosis, or included details on the bowel lesion diameters and length of the resected segment (Supplementary data, Table SII). The microscopic extent of bowel invasion by colorectal endometriosis in surgically excised bowel specimens was presented in 15 out of 18 studies evaluating either bowel resection anastomosis (11/14 studies) or a combination of bowel resection anastomosis and full-thickness disc excision (4/4 studies). As shown in Supplementary data, Table SII, the bowel serosa was reported to be involved in 94.5% of the patients undergoing bowel resection anastomosis (121/128). In the same category of studies, endometriotic lesions were reported to be found in the muscularis propria in 95.1% of the cases (583/613). In 37.8% (74/196) and 6.4% (17/265) of the cases, the submucosa and the mucosa, respectively, were reported to be involved. Exclusive involvement of the bowel serosa was not observed, probably because these cases are not clinically labeled as 'bowel endometriosis', as discussed in the Methods section (Anatomical considerations).

Furthermore, the prevalence of resection specimens with margins that were histologically positive for endometriosis was only reported in 33% (6/18) of the studies. After bowel resection anastomosis, margins positive for endometriosis were observed in 25/127 patients (19.7%; Supplementary data, Table SII). In case of bowel resection anastomosis, the median length of the resected colorectal segment ranged between 0.92 and 21 cm, while the median largest diameter of the colorectal endometriosis lesions varied between 2.9 and 4.1 cm.

Surgical complications

The large majority of studies (94%; 46/49) included complication rates. Major complications, as defined in the Methods section, varied between 0% (especially in the smaller studies with a low number of patients) and 42.9% (Supplementary data, Table SIII). In the bowel resection anastomosis group, 55 (2.7%) rectovaginal fistulae, 30 (1.5%) anastomotic leakages and 7 (0.34%) abscesses were reported in a total of 2036 patients. In the mixed surgical group, 12 (0.7%) rectovaginal fistulae, 12 (0.7%) anastomotic leakages and 6 (0.3%) abscesses were reported for 1799 patients. The rectovaginal fistulae were treated with colostomy/loop ileostomy, Hartmann surgery or resuture (Supplementary data, Table SIII). Information on the time of occurrence of the rectovaginal fistulae (early or late) was only reported in one study (Slack *et al.*, 2007).

In the studies included in this review, post-operative bleedings were reported as (1) a drop in hemoglobin requiring blood transfusion without surgical intervention (Urbach *et al.*, 1998; Ford *et al.*, 2004; Keckstein and Wiesinger, 2005; Mohr *et al.*, 2005; Ferrero *et al.*, 2009; Juhasz-Böss *et al.*, 2010; Maytham *et al.*, 2010; Minelli *et al.*, 2009), or (2) a drop in hemoglobin requiring surgical reintervention (Fleisch *et al.*, 2005; Ruffo *et al.*, 2009). Post-operative bleeding occurred rarely with a prevalence of 3.1% (63/2036) in the bowel resection anastomosis group and 0.3% (6/1799) in the mixed group. However, it should be noted that, in the bowel resection anastomosis group, the majority of the post-operative bleedings (36/63) were reported in one study (Minelli *et al.*, 2009).

Additionally, in approximately half of the studies (14/29 bowel resection anastomosis studies and 10/17 in the mixed study group), the number and nature of the concomitant procedures were reported, as shown in Supplementary data, Table SIII.

Outcome on pain

The majority of the included studies (67%; 33/49) contained data on pain outcome (Supplementary data, Table SIV), but <50% of the studies reporting the outcome on pain [48% (16/33)] had a median or mean follow-up period of more than 24 months (11 studies with bowel resection anastomosis and 5 mixed studies). The other studies

(52%; 17/33) had a mean/median follow-up period <24 months. Supplementary data, Table SIV illustrates that most of the studies reporting pain outcome showed an improvement in pain, gynecological and digestive symptoms after surgery for colorectal endometriosis.

However, there is a lack of consistency in the way of measuring and reporting symptomatic efficacy between different series. Some authors report in terms of overall improvement of pain (Bailey *et al.*, 1994; Nezhat *et al.*, 1994; Jerby *et al.*, 1999; Possover *et al.*, 2000; Kavallaris *et al.*, 2003; Varol *et al.*, 2003; Ford *et al.*, 2004; Abrao *et al.*, 2005; Campagnacci *et al.*, 2005; Coronado *et al.*, 1995; Mohr *et al.*, 2005; Jatan *et al.*, 2006; Boni *et al.*, 2007; Slack *et al.*, 2007; Ghezzi *et al.*, 2008; Bracale *et al.*, 2009; Maytham *et al.*, 2010; Minelli *et al.*, 2009; Pereira *et al.*, 2009), while others focus on the intensity of specific symptoms before and after surgery (Redwine and Wright, 2001; Chopin *et al.*, 2005; Fleish *et al.*, 2005; Landi *et al.*, 2006; Langebrekke *et al.*, 2006; Lyons *et al.*, 2006; Brouwer and Woods, 2007; Daraï *et al.*, 2007; Seracchioli *et al.*, 2007; de Nardi *et al.*, 2009; Meuleman *et al.*, 2009a).

To evaluate pain symptom outcome, a variety of methods of measurement have been applied, ranging from non-specified methods (33%; 11/33) to interviews in person or by telephone and unspecified questionnaires to a qualitative and/or semi-quantitative visual analogue symptom scale (VAS; Supplementary data, Table SIV). In <50% of the studies reporting outcome on pain [42% (14/33)], the pain evaluation was reported to be patient-based (Redwine and Wright, 2001; Ford *et al.*, 2004; Chopin *et al.*, 2005; Fleisch *et al.*, 2005; Landi *et al.*, 2006; Brouwer and Woods, 2007; Daraï *et al.*, 2007; Bracale *et al.*, 2009; Juhasz-Böss *et al.*, 2010; Maytham *et al.*, 2010; Minelli *et al.*, 2009; Pereira *et al.*, 2009; Meuleman *et al.*, 2009a). In only 18% (6/33) of the studies, a patient-based VAS was used to assess the major pain complaints, including dysmenorrhea, chronic pelvic pain and deep dyspareunia, to compare the patients' status before surgery and at the time of the post-operative evaluation (Ford *et al.*, 2004; Fleisch *et al.*, 2005; Lyons *et al.*, 2006; Brouwer and Woods, 2007; Bracale *et al.*, 2009; Meuleman *et al.*, 2009a).

Outcome on QOL

Another important outcome measurement, related to the outcome on pain, is the impact of surgery for colorectal endometriosis on the QOL. Several validated questionnaires exist for the evaluation of the QOL (e.g. EHP-30, SF-36, EQ-5HD). However, only 10% (549) of the studies selected in this paper (Supplementary data, Table SV) reported data on the QOL after treatment for extensive DIE with colorectal extension (Ford *et al.*, 2004; Keckstein and Wiesinger, 2005; Lyons *et al.*, 2006; Maytham *et al.*, 2010; Meuleman *et al.*, 2009a). In three of these studies, only bowel resection anastomosis was applied, whereas mixed surgical techniques were used in two studies (Supplementary data, Table SV). Only two prospective studies (Keckstein and Wiesinger, 2005; Lyons *et al.*, 2006) reported the QOL in a total of 149 patients, with a median follow-up time of <2 years. Overall, most studies observed a significant improvement in QOL after surgery.

Post-operative pregnancy rate

In only 37% (18/49) studies (11 bowel resection anastomosis studies, six mixed studies and one full-thickness disc excision study), fertility outcome was reported after surgery for advanced endometriosis with colorectal extension, with pregnancy rates varying between 23.5 and 57.1% (Tables II and III). In the study of Lyons *et al.* (2006), a pregnancy rate of 100% was reported but the sample size of this study was very small (three women wishing to conceive). About half of the pregnancies (45%; 63/141) occurred after spontaneous conception whereas the other half (55%; 78/141) occurred after medically assisted conception (Supplementary data, Table SVI). In the studies under review, 39 spontaneous pregnancies and 6 artificial pregnancies were reported in the bowel resection anastomosis studies compared with 24 spontaneous and 9 artificial pregnancies in the mixed study group.

In only three studies, life table analysis was used to calculate the cumulative pregnancy rate (Coronado *et al.*, 1990; Stepniewska *et al.*, 2009; Meuleman *et al.*, 2009a). In our retrospective study with 56 patients who underwent multidisciplinary laparoscopic excision of DIE with colorectal extension, an overall pregnancy rate of 48% was associated with a cumulative pregnancy rate of 31, 49, 55 and 70% after 1, 2, 3 and 4 years, respectively (Meuleman *et al.*, 2009a). In another study (Coronado *et al.*, 1990), a pregnancy rate of 39.4% was associated with a cumulative pregnancy rate of 38% at 18 months and 52% at 29 months. In another study (Ferrero *et al.*, 2009), a cumulative pregnancy rate of 57.6% was reported 50 months after laparoscopic colorectal resection, which was significantly higher than after laparotomic procedures (23.1%).

Unfortunately, in most studies, the number of patients wishing to conceive prior to or after surgery is not clear, the distinction between active child wish, passive child wish, completed child wish and absent child wish is not made and likewise the mean period for conception following surgery and the spontaneous/assisted nature and outcome of the pregnancies are often not reported.

Recurrence of endometriosis

Recurrence of endometriosis was only reported in 43% (21/49) of the included studies. The studies reporting no or a very limited number of recurrences were performed with a short follow-up period (<2 years) and included a small sample size. Studies with a longer follow-up period (> 2 years) generally showed a higher recurrence rate (Supplementary data, Table SVII). In general, the recurrence rate in studies with a follow-up period >2 years varied between 4.69 and 25%, with most of the studies reporting a recurrence rate of about 10% after surgery. Overall, the recurrence rate was 5.8% in the bowel resection anastomosis group compared with 17.6% in the mixed study group.

The recurrence of endometriosis was defined according to the level of evidence, as mentioned in the Methods section, into three categories: suspicious endometriosis recurrence, additional surgery without endometriosis evidence and visually and/or histologically proven endometriosis recurrence. As shown in Supplementary data, Table SVII, recurrence after bowel resection anastomosis ($n = 44$) included suspicious recurrence ($n = 21$, 48%), additional surgery without endometriosis evidence ($n = 3$, 7%) and proven endometriosis recurrence ($n = 20$, 45%). Recurrence reported after mixed surgical techniques ($n = 138$) included suspicious recurrence ($n = 2$, 1%), additional surgery without endometriosis evidence ($n = 87$, 63%) and proven endometriosis recurrence ($n = 49$, 35%). Overall, the proven endometriosis recurrence rate appeared to be lower in the resection anastomosis group (2.5%; 20/812) than in the mixed surgical group (5.7%; 49/865) (Supplementary data, Table SVII). Furthermore, the cumulative recurrence rate was reported only in one

Table II Fertility outcome after with surgical treatment of DIE with colorectal involvement: bowel resection anastomosis group.

Reference	*n* (%) with infertility	*n* (%) wishing to conceive	*n* (%) conceived	Mean (SD) time interval between surgery and conception (months)	*n* live births/*n* women wishing to conceive (%)
Coronado *et al.* (1990)	41/77 (53.2%)	33/41 (80.5%)	NR	NR	13/33 (39.4%) term
Ferrero *et al.* (2009)	5/46 (10.8%) fertile	46/46 (100%)	3/5 (60%)	10.0 ± 5.3	3/5 (60%) fertile
	20/46 (43.5%) unknown		10/20 (50.0%)	18.5 ± 13.4	8/20 (40%) unknown
	21/46 (45.6%) infertile		9/21 (42.9%)	11.3 ± 4.6	8/21 (38.1%) infertile
Fleisch *et al.* (2005)	4/23 (17.4%)	17/23 (73.9%)	Overall 4/17 (23.5%)	NR	4/17 (23.5%) term
			In patients with pre-operative wish for childbearing 2/4 (50%)		
Ghezzi *et al.* (2008)	15/33 (45.5%)	13/15 (86.7%)	4/13 (30.8%)	NR	3/13 (23.1%) term
					1/13 (7.7%) pregnancy ongoing
Juhasz-Böss *et al.* (2010)	3/6 (50%)	3/6 (50.0%)	1/3 (33.3%)	NR	1/3 (33.3%) term
Kavallaris *et al.* (2003)	38/50 (76%)	17/38 (44.7%) post-operative	8/17 (47%)	NR	4/17 (23.5%) healthy newborns
					3/17 (17.6%) first trimester abortions
					1/17 (5.9%) pregnant at time of interview
Keckstein and Wiesinger (2005)	NR	36/142 (25.3%)	18/36 (50%)[a]	NR	NR
Lyons *et al.* (2006)	4/7 (57.1%)	3/7 (42.9%)	3/3 (100%)	NR	3/3 (100%) term
Meuleman *et al.* (2009a)	NR	33/56 (59%)	16/33 (48%)	6 spontaneous < 1 year post-operative	NR
				4 IVF < 1 year post-operative	
Minelli *et al.* (2009)	113/357 (31.6%)	NR	47/113 (41.6%)	NR	NR
Possover *et al.* (2000)	15/34 (44.1%)	15/34 (44.1%)	8/15 (53.3%)	NR	NR
Stepniewska *et al.* (2009)	60/60 (100%)	48/60 (80.0%)	17/48 (35.4%)	696 days	1/48 (2.1%) miscarriage
Total	339/693 (48.9%)	264/469 (56.3%)	135/344 (39.2%)		

[a]Two women conceiving twice.

study (Meuleman *et al.*, 2009a) and was 2 and 7%, 1 and 4 years after surgery, respectively.

In only a few studies, the use of post-operative hormonal treatment was recorded (Verspyck *et al.*, 1997; Urbach *et al.*, 1998; Fleisch *et al.*, 2005; Brouwer and Woods, 2007).

Discussion

General

Our review included 49 studies and a total of 3894 patients with advanced endometriosis and colorectal extension. Remarkably, a large majority of these patients has been treated by bowel resection anastomosis ($n = 2832$, 72.7%), and only a minority had been treated by full-thickness disc excision ($n = 383$, 9.8%), or shaving/superficial excision ($n = 679$, 17.4%). Data were reported in such a way that comparison of different surgical techniques was not possible. The bowel resection anastomosis group included the highest number of patients, was fairly homogenous, and allowed a meaningful analysis. It was impossible to meaningfully analyze the mixed surgical group since outcome was very often not specified according to surgical technique used (bowel resection anastomosis, disc excision or another surgical technique). The group of patients with discoid excision only was described in only one study with limited outcome data.

Table III Fertility outcome after with surgical treatment of DIE with colorectal involvement: mixed studies group.

Reference	Method	*n* (%) with infertility	*n* (%) wishing to conceive	*n* (%) conceived	Mean (SD) time interval between surgery and conception (months)	*n* live births/*n* women wishing to conceive (%)
Bailey *et al.* (1994)	BRA	NR	49	28/49 (57.1)	NR	28/28 (100) viable
	FTDE					
Donnez *et al.* (1995)	shave/SE	48/151 (31.8%)	NR	25/48 (52.1)	NR	NR
Jerby *et al.* (1999)	BRA	NR	7	3/7 (42.8)	NR	NR
	FTDE					
	SE					
Mohr *et al.* (2005)	BRA	58/187 (31.0%)	NR	23/58 (39.7)	NR	22/28 (78.6) full-term pregnancies[a]
	FTDE					5/28 (17.9) miscarriages
	Shave					1/28 (3.6) termination
Nezhat *et al.* (1994)	FTDE	NR	NR	1/8 (12.5)	NR	NR
Redwine and Wright (2001)	BRA	NR	28	12/28 (42.9)	NR	5/12 (41.7) term pregnancies
	FTDE					4/12 (33.3) spontaneous miscarriages
	SE					1/12 (8.3) ectopic gestation
						2/12 (16.7) pregnant at time questionnaire
Total		106/338 (31.4)	84	92/198 (46.4)	NR	

BRA, bowel resection anastomosis; FTDE, full-thickness discoid excision; SE, superficial excision.
[a]Three women conceiving twice, one woman conceiving three times.

Remarkably, only one study (Meuleman *et al.*, 2009a, b) included all relevant outcome variables: type of study (prospective/retrospective), number of patients, histopathological confirmation of DIE, follow-up time and procedure, surgical method applied, number of previous surgeries for endometriosis, indication for surgery (pain, fertility or both), complication rates, outcome data on pain, QOL, recurrence, fertility rate, number of patients lost during follow-up.

Histological confirmation

In the majority of the studies, histological confirmation of endometriosis with colorectal extension was obtained, and some studies, mainly in case of bowel resection anastomosis, contained additional histopathological details. At present, it is not known if endometriosis-positive histological margins on the resected bowel specimen, observed in six studies (Kavallaris *et al.*, 2003; Anaf *et al.*, 2004; Remorgida *et al.*, 2005; Lyons *et al.*, 2006; Zanetti-Dällenbach *et al.*, 2008; Meuleman *et al.*, 2009a), are associated with a higher recurrence rate after bowel resection anastomosis. Interestingly, in one of these six studies (Kavallaris *et al.*, 2003), it was noted that a distance of 2 cm between the margin and the main lesion was not sufficient to obtain endometriosis-free margins in more than one-third of the patients. Furthermore, margins of the resected bowel specimens were still positive for endometriosis in six patients (19%) after bowel resection was performed in an area with a distance of at least 3 cm from the edges of the palpated lesion, free of any induration at manual palpation, and free of any serosal or muscular visible endometriosis implant (Anaf *et al.*, 2004). It can be hypothesized that endometriotic lesions infiltrate the large bowel preferentially along the nerves, even at a distance from the palpated lesion (Anaf *et al.*, 2004), and may spread laterally to the point of serosal invasion, possibly explaining the positive margins (Remorgida *et al.*, 2005).

This 'neural metastasis' hypothesis also provides an explanation why full-thickness disc resection may result in an incomplete removal of bowel endometriosis. Indeed, evaluating histology in bowel specimens from 16 patients receiving a full-thickness disc resection first, followed by a bowel resection anastomosis during the same surgical procedure, showed that residual bowel endometriosis was still present in more than 40% of the bowel resection anastomosis specimens (Remorgida *et al.*, 2005). Interestingly, it has also been reported that fibrosis in the muscular layer does not always surround bowel endometriotic lesions (Remorgida *et al.*, 2005). Knowing that fibrosis is a main landmark during surgical resection, this explains why incomplete resection may occur.

Complications

Surgery for advanced endometriosis with colorectal extension can be associated with complications, such as rectovaginal fistulae,

anastomotic leakage, pelvic abscesses and post-operative bleeding. The prevalence of these complications was highly variable among studies. Although most of these complications are related to bowel surgery, it is important to realize that most of these patients also required additional surgery, such as uterosacral ligament resection, vaginal resection, ureterolysis and ovarian cystectomy, for endometrioma. Although it is not always reported, opening of the vagina at the time of the intestinal procedure is certainly a possible risk factor for these major complications. This pleads for the introduction of a systematic protective colostomy in case of concomitant vaginal and rectal resection as already applied in some recent studies (Daraï et al., 2005a; Zanetti-Dällenbach et al., 2008; Bracale et al., 2010; de Jong et al., 2009; Maytham et al., 2010). Additionally, extensive electrocoagulation can lead to necrosis of the posterior vaginal cuff with a higher risk for rectovaginal fistulae and abscesses (Dubernard et al., 2006). On the basis of our review, it is difficult to compare the complication rates associated with different types of surgery, since most of the published series are based on laparoscopic segmental colorectal resection whereas data on complications after full-thickness excision and superficial-thickness excision are very limited.

To avoid functional problems (urine retention, *de novo* dysuria, sexual dysfunction) related to pelvic denervation, different nerve-sparing techniques proven to be successful in the prevention of urinary, rectal and sexual dysfunction after radical surgery for pelvic malignancies, have been introduced in surgery for advanced endometriosis with colorectal extension (Maas et al., 1999; Possover et al., 2005; Landi et al., 2006). However, if minor nerve branches are impacted in an endometriotic/fibrotic nodule, they are sacrificed owing to the technique of 'radical excision of diseased tissue' to avoid leaving behind endometriotic tissue.

Considering the complexity and morbidity of these procedures, colorectal endometriosis is therefore best managed by a multidisciplinary approach, requiring at least a laparoscopically experienced gynecologist, a colorectal surgeon and an urologist (D'Hooghe and Hummelshoj, 2006). Precise pre-operative assessment of disease extent is necessary to select an appropriate treatment adapted to the individual case, as described previously (Abrao et al., 2007; Piketty et al., 2009; Meuleman et al., 2009a).

Pain

Although most of the studies reported pain outcome and showed an improvement in pain, gynecological and digestive symptoms after surgery for colorectal endometriosis, the quality of these studies was often variable owing to the duration of follow-up and the method used for pain measurement.

The need for larger prospective studies with a long follow-up period is supported by the fact that only 2 out of 16 studies with a median/mean follow-up period of more than 2 years were prospective (Redwine and Wright, 2001; Campagnacci et al., 2005), including a relatively small number of patients ($n = 7$ and 50, respectively).

Furthermore, most studies lacked a description of one or more aspects of the exact methodology used to measure pain, such as patient- or investigator-based report, type of measurement and timing of measurement (e.g. only after surgery or before and after surgery). Furthermore, studies did not report if, and in how many cases, post-operative pain evaluation was carried out by women receiving post-operative medical hormonal treatment (receiving additional pain reduction, possibly having no menstruation and therefore unable to have dysmenorrhea), and did not specify the type of treatment and the duration of this treatment since the moment of surgery.

A problematic observation is the fact that pain evaluation was patient-based in <50% of studies and was performed by patient-based VAS in only 18% of the studies reporting pain outcome after surgery. According to current consensus (Vincent et al., 2010), a patient-based 11-point Numerical Rating Score, in which the pre-operative and post-operative symptoms are given by the patient, allows a better evaluation of the post-operative pain situation as well as the evaluation of *de novo* pain symptoms possibly associated with a specific type of surgery, when compared with the rating of symptom prevalence and severity by others (physicians, nurses) who may be biased themselves or may introduce bias among patients.

Quality of life

There is still a need to document prospectively the QOL after surgery for endometriosis with colorectal extension, as only 10% (5/49) of the studies (only 4% or 2/49 prospective) reported data on the QOL after surgical treatment for extensive endometriosis with colorectal extension, only three used standardized questionnaires; all of the studies showed a significant improvement in QOL after surgery. This observation is in contrast with the improvement in QOL documented after laparoscopic treatment of DIE without significant bowel surgery (Garry et al., 2000; Abbott et al., 2004; Fedele et al., 2004).

More and larger studies with a long-term follow-up using the same validated QOL questionnaires are required to allow comparison between the different surgical techniques used and to confirm the positive impact of colorectal resection on the QOL.

Fertility

The prevalence of endometriosis in infertile women is about 30% (D'Hooghe et al., 2003) and was about 50% in infertile women with normal ovulation and normospermic partners (Meuleman et al., 2009b). Improvement of fertility is often an important objective for women undergoing surgery for endometriosis. For mild endometriosis, laparoscopic surgery has been shown to improve fertility and pregnancy outcomes (Jacobson et al., 2002) and to have less negative impact on fertility than the laparotomy approach (Ferrero et al., 2009). However, it should be noted that patients undergoing laparoscopic or laparatomic treatment might not belong to the same group in daily practice. Although some studies suggest that complete removal of DIE potentially improves fertility (Chapron et al., 1999; Redwine and Wright, 2001; Abbott et al., 2003; Daraï et al., 2005b), no RCTs or meta-analyses are available to answer the question of whether surgical excision of moderate to severe endometriosis enhances pregnancy rate. On the basis of three studies (Adamson et al., 1993; Guzick et al., 1997; Osuga et al., 2002) there seems to be a negative correlation between the stage of endometriosis and the spontaneous cumulative pregnancy rate after surgical removal of endometriosis, but statistical significance was reached in only one study (Osuga et al., 2002).

In our opinion, the fertility wish of patients with advanced endometriosis with colorectal extension is underestimated in the papers

reviewed, revealing the indication infertility with or without pain in only 22–36% of all patients included in these papers. In our experience (Meuleman *et al.*, 2009a, b), most patients have a combined problem of pain and unfulfilled or uncompleted child wish, which may be formulated by the patient either passively (wish for preservation/restoration of fertility during surgery, without well defined child wish at the time of surgery) or actively (well defined child wish in the near or distant future). Furthermore, it is important to realize that many women with pelvic endometriosis and colorectal extension have been told for many years that they will never become pregnant as a result of their disease. Additionally, before surgery these women are in pain, implying that their first concern is how to stop the pain, rather than a child wish. In these women, child wish may only emerge after a successful removal of the endometriosis and pain reduction.

Life table analysis was used to calculate the cumulative pregnancy rate in only 4 out of 18 (22%) studies reporting fertility outcome (Coronado *et al.*, 1990; Stepniewska *et al.*, 2009; Ferrero *et al.*, 2009; Meuleman *et al.*, 2009a). This is surprising in view of the fact that it has been generally accepted for more than 20 years (Olive, 1986) that life table analysis is the best way to calculate fertility outcome while controlling for the duration of follow-up and drop-out rate for each patient. Overall, this observation supports the need for prospective follow-up studies with sufficient duration of follow-up and complete follow-up of all operated patients.

Recurrence

The recurrence rate was remarkably low in view of the number of patients who had already undergone previous therapeutic surgery for endometriosis (Table I). When evaluating the recurrence rate of endometriosis, several factors must be taken into consideration. First, it is important to distinguish symptom recurrence and actual disease recurrence with a need for further medical or surgical therapy. Second, it is difficult to distinguish between residual and recurrent disease (McDonough *et al.*, 2001).

Many authors believe that incomplete excision of endometriosis is a major cause for clinical recurrence (Chopin *et al.*, 2005; Vignali *et al.*, 2005). If this is true, then visually and/or histologically proven endometriosis recurrence must be lower after resection anastomosis than after discoid excision or superficial excision, since resection anastomosis is associated with a more complete excision of bowel endometriosis, as discussed above. It is hard to prove this hypothesis in view of the absence of outcome studies reporting recurrence after disc excision, shaving or superficial excision except for one study published 15 years ago (Donnez *et al.*, 1995). In previous studies, where only local excision or ablation was performed, the rate of recurrence varied between 3.7 and 74.7% (Kavallaris *et al.*, 2003). In this review both the total recurrence rate and the visually and/or histologically proven recurrence rate appeared to be lower in the bowel resection anastomosis group (5.8 and 2.5%, respectively) than in the mixed study group (17.6 and 5.7%, respectively). Interestingly, in a follow-up study of 83 women for over 12 months after conservative surgery for rectovaginal endometriosis (Fedele *et al.*, 2004), the cumulative rates of pain recurrence, clinical or sonographic recurrence and new treatment were 28, 34, and 27%, respectively, and were lower in patients who underwent segmental bowel resection anastomosis.

More prospective follow-up studies with large sample sizes and clear definitions of endometriosis recurrence (using life table analysis to calculate the cumulative endometriosis recurrence rate) are needed to compare endometriosis recurrence between patient groups receiving different surgical techniques for the treatment of endometriosis with colorectal extension. If endometriosis recurrence rates are shown in the future to be comparable according to surgical technique, this does not necessarily mean that each of these techniques has similar value in each patient, but merely implies that the correct technique has been used for the correct indication (i.e. a more conservative approach for superficial serosal bowel endometriosis only, more radical approach for more invasive/multifocal/bowel involvement, taking into consideration bowel functionality after surgery).

Conclusion

Of the 49 studies included in this review, only one study (Meuleman *et al.*, 2009a) reported data on all the outcome variables under review. Most studies documented the clinical outcome for surgical treatment of DIE with colorectal extension regarding post-operative complication rate (94%) and pain (67%). However, <50% of the studies included data with respect to the recurrence rate (41%), fertility outcome (37%) and QOL (10%). Additionally, these studies are often limited by a short-term follow-up period (1 or 2 years), making it difficult to estimate the actual pregnancy and recurrence rates. Furthermore, only a limited number of authors mention the number of patients that are lost during follow-up. However, a patient who is lost during follow-up is not necessarily cured, but has possibly turned to another gynecologist because of lack of satisfaction with the surgery received. As the fertility results in the different studies are encouraging, we can conclude that infertility or desire of pregnancy are not contra-indications for surgery. Finally, there is a lot of variability among studies regarding the exact indication of surgery, the exact surgical methods used, definitions of outcome variables etc. Indeed, there is a need for full documentation and standardization in clinical trials which evaluate endometriosis surgery with respect to indication, methodology, outcome variables and long-term follow-up. In the checklist in the next section we propose definitions to be used to record post-operative complications, document pelvic pain (dysmenorrhea, dyspareunia, chronic non-menstrual pelvic pain) and assess QOL, fertility (pregnancy rate) and recurrence rate after surgery for endometriosis. Hopefully, this checklist will help health professionals involved in the research into surgery for endometriosis to report unequivocally and completely in much needed prospective studies with large sample sizes and complete follow-up of all patients for a period of at least 2 years after surgery for DIE with colorectal extension.

Checklist

Supplementary data, Table SVIII shows a checklist based on the issues raised during this review and on the need to establish completeness and uniformity of the data collected during outcome studies evaluating the impact of surgery for DIE with colorectal extension. This checklist is similar to the CONSORT guidelines concerning randomized trials for non-pharmacological interventions (Boutron *et al.*, 2008). The

checklist contains 32 items that should ideally be taken into account when designing a study for the surgical treatment of DIE and reporting the results of that study. More specifically, the checklist provides details on the description of participants, interventions, follow-up period, pain measurement, QOL measurement, and how to report data on histological confirmation, complications, additional interventions, fertility rate and recurrence rate.

Supplementary data

Supplementary data are available at http://humupd.oxfordjournals.org/.

Acknowledgements

The authors would like to thank Dr S. Deferme (aMACE, Belgium) for his assistance in writing this manuscript.

Funding

This research was supported by the Clinical Research Fund of the University Hospitals Leuven, Belgium.

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