

Bowel resection for deep endometriosis: a systematic review

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Background Deep endometriosis involving the bowel often is treated by segmental bowel resection. In a recent review of over 10 000 segmental bowel resections for indications other than endometriosis, low rectum resections, in particular, were associated with a high long-term complication rate for bladder, bowel and sexual function.

Objectives To review systematically segmental bowel resections for endometriosis for indications, outcome and complications according to the level of resection and the volume of the nodule.

Search strategy All published articles on segmental bowel resection for endometriosis identified through MEDLINE, EMBASE and ISI Web of Knowledge databases during 1997–2009.

Selection criteria The terms 'bowel', 'rectal', 'colorectal', 'rectovaginal', 'rectosigmoid', 'resection' and 'endometriosis' were used. Articles describing more than five bowel resections for endometriosis, and with details of at least three of the relevant endpoints.

Data collection and analysis Data did not permit a meaningful meta-analysis.

Main results Thirty-four articles were found describing 1889 bowel resections. The level of bowel resection and the size of the

lesions were poorly reported. The indications to perform a bowel resection were variable and were rarely described accurately. The duration of surgery varied widely and endometriosis was not always confirmed by pathology. Although not recorded prospectively, pain relief was systematically reported as excellent for the first year after surgery. Recurrence of pain was reported in 45 of 189 women; recurrence requiring reintervention occurred in 61 of 314 women. Recurrence of endometriosis was reported in 37 of 267 women. The complication rate was comparable with that of bowel resection for indications other than endometriosis. Data on sexual function were not found.

Conclusions After a systematic review, it was found that the indication to perform a segmental resection was poorly documented and the data did not permit an analysis of indication and outcome according to localisation or diameter of the endometriotic nodule. Segmental resections were rectum resections in over 90%, and the postoperative complication rate was comparable with that of resections for indications other than endometriosis. No data were found evaluating sexual dysfunction.

Keywords Bowel, colorectal, endometriosis, rectovaginal, resection.

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Introduction

Deep endometriosis is defined as a solid mass situated deeper than 5 mm under the peritoneum. It is surgically challenging when involving other organs, such as the bowel, bladder or ureters.^{1,2} The prevalence of deep endometriosis involving the bowel has been reported to be 5.3–12% of women affected by endometriosis.^{3,4} This estimation obviously varies with referral bias.⁵ Deep endometriosis involving the bowel is most frequently localised in the

recto-vaginal septum¹ and less in the sigmoid. Other bowel localisations are relatively rare.⁶ Most women with deep endometriosis have severe dysmenorrhoea, deep dyspareunia when localised low, dyschesia during menstruation and, occasionally, anal blood loss.⁷

Treatment consists of surgical excision,⁸ or segmental resection, reported increasingly over the last decade when the bowel is involved. Complications of segmental bowel resections for indications other than endometriosis have been well documented.⁹ The complication rate, leakage and

persistent bowel, bladder and sexual problems increase when resections are performed lower, being as high as 20–30% for low rectum resections and <1% for sigmoid resections. The main indication for surgery in these series, however, is cancer, and this may increase the radicality and extent of surgery, and hence the complication rate.⁹

We therefore decided to review all segmental bowel resections for endometriosis, focusing on complications according to the size of the nodules and the level of resection, in order to compare them with the outcome of bowel resections performed for other reasons.

Materials and methods

This systematic review of bowel resections for deep endometriosis was initiated in order to evaluate the complications and outcome according to the localisation and diameter of the deep endometriosis, and was performed using the PRISMA statement guidelines.¹⁰ We searched MEDLINE, EMBASE and ISI Web of Knowledge for articles in English for 'bowel', 'rectal', 'colorectal', 'recto-sigmoid' in combination with 'resection' and 'endometriosis' in the title, abstract or keywords published between 1997 and November 2009. Before 1997, few cases were published and the technique was less standardised.

We (CDC and PK) started to review 273 articles describing bowel resections for deep endometriosis for several criteria, that is surgical technique used, number of patients, duration of surgery, indication for surgery, localisation and diameter of deep endometriosis nodules, other endometriosis lesions, complications during and after surgery, confirmation for endometriosis by pathology, recurrences and outcome of surgery, that is pain and fertility after 6 and 12 months. We soon realised that the information that could be retrieved was rarely complete and varied widely between articles. In order to avoid a selection bias in the inclusion of articles, we decided to widen the inclusion criteria and to include all articles describing at least five bowel resections and containing data from at least three of the relevant criteria. Thus, 41 articles were retained. Following independent screening by CDC and PK, and after discussion of minor discrepancies and elimination of articles containing data already included in other articles, 34 articles were retained for further analysis.

These articles were scrutinised for all the criteria described above, with special emphasis on the localisation and volume of the endometriosis preoperative examinations and indications for segmental resection, details of surgery and outcome. The localisation of bowel resection seemed to be important as complications of bowel resections for indications other than endometriosis⁹ are much higher in low and ultra-low rectum resections. Data on localisation were found in 15 articles describing 1096

lesions, and these were grouped into sigmoid, recto-sigmoid (defined as more than 10 cm from the anus), low rectum (6–10 cm from the anus) and ultra-low rectum (<6 cm from the anus) resections.⁶ We scrutinised for diameter of the nodule, as common sense suggests that the difficulty and duration of surgery will increase with the size of the nodule and/or depth of bowel invasion. The sizes of the nodules were so poorly documented, however, that we could only distinguish between small lesions (<2 cm) and larger lesions (>2 cm).

Postoperative pain relief was tabulated as the number of patients free from symptoms, improved, unchanged or worsened at follow-up between 6 and 12 months. For pregnancy rates following surgery, the overall pregnancy rate, spontaneous pregnancy rate and spontaneous conceptions with live birth were considered.

Recurrences were classified into three groups, that is recurrence of symptoms, recurrence of surgery and recurrence of endometriosis. Recurrence of symptoms was defined as requiring medical treatment. When symptom recurrence was sufficient to perform surgery, this was classified as surgical recurrence. When, during surgery, endometriosis was found, the recurrence was classified as endometriosis recurrence. The data did not permit superficial endometriosis recurrence and deep endometriosis recurrence/persistence to be distinguished.

Complications, when described, were regrouped as major and minor. Major complications comprised bowel leakage, recto-vaginal fistula, severe bowel obstruction, major infection and haemorrhage requiring blood transfusion. Minor complications included temporary bladder or bowel symptoms or other conditions such as superficial infections and peripheral sensory disturbances.

A meta-analysis was not performed as the data were too incomplete to correlate complications, pain, fertility or recurrence with the extent, size and level of resection.

Results

From January 1997 to October 2009, 34 articles were analysed describing 1889 segmental bowel resections for deep endometriosis. Increasing numbers of segmental bowel resections were published, with a progressive shift from laparotomy to laparoscopy. For the periods 1997–2000, 2001–2004 and 2005–2009, the number of segmental resections published were 76, 167 and 1646, respectively, and the percentage performed by laparoscopy increased from 9.2% to 38% and 82.5%, respectively.

Level of segmental resection and diameter of the lesions

The level of resection was specified in 1096 of 1889 procedures, as shown in Table 1. Of these 1096 resections,

Table 1. Level of bowel resection and diameter of 1889 deep endometriosis lesions

Localisation	Dimension		Total
	>2 cm	Unclear	
Sigmoid	54	81	135
High rectum	24	22	46
Low rectum	446	389	835
Ultra-low rectum	47	33	80
Unknown	119	674	793
Total	690	1199	1889

12.4% were sigmoid resections and 87.6% were rectum resections. For nodules reported as larger than 2 cm, the levels of resection were similar to those in which the diameter was not specified.

The diameters of the endometriotic nodules were reported in seven articles only ($n = 689$). In three articles, the diameters were reported as 'more than 2 cm' in all women.^{11–13} In four articles, the median diameters and ranges were given: 2.2 cm (range, 0.5–4 cm);¹⁴ 3.6 cm (range, 1.1–3.8 cm);¹⁵ 3 cm (range, 1–9 cm)¹⁶; and 3.59 cm (± 1.275 cm).¹⁷

In none of the articles did the data permit the analysis of the indication, duration of surgery, outcome and complications according to the level of resection or size of the nodule.

Indications for segmental bowel resection

The indication for bowel resection was variable. Although not always stated unequivocally, it appears that most authors decided to perform a bowel resection before surgery, based on preoperative examinations,^{11–13,15,16,18–29} such as magnetic resonance imaging (MRI), transvaginal or transrectal ultrasound. The indication was reported to be based on dimensions of the nodule >2 cm¹¹ or 3 cm^{12,22,23}, and/or on muscularis involvement^{16,22,25,26} and/or the percentage of circumference involvement.^{11,12,23} In other articles, the indication was less clear and the dimensions given seem to relate more to perioperative or postoperative findings. In none of the reports did the indication involve the localisation of the nodule. Some authors seemed to decide during surgery.^{6,14,30–40} The data, however, did not permit us to retrieve whether the indication was made by size or localisation at inspection or during surgery, that is after the volume of the nodule and the degree of muscularis infiltration had been judged. Generally, the indication seemed to be a variable mixture of all criteria listed, that is before and during surgery. The difficulty of retrieving the indications is illustrated in the numbers. Some authors reported series

in which only segmental bowel resections were performed ($n = 1072$). The indication seemed to be taken predominantly before surgery, although, in these articles, it was unclear whether only bowel resections were reported, or whether only bowel resections were performed. In addition, in the series reporting all the procedures performed for deep endometriosis ($n = 1248$), that is 309 rectal shavings, 324 discoid resections and 615 segmental resection, it was unclear when the decision was made. We estimated that, in these 1248 procedures, the indication to perform a segmental bowel resection was taken before surgery in 14% and during surgery in 86%. The percentage of segmental resections performed varied widely from 11.5% for Redwine and Wright⁴⁰ to 92% for Ribeiro *et al.*,²⁶ but we were unable to judge whether this reflected a referral bias, that is the size of the nodule, or a surgery bias, that is a more liberal use of segmental resection. Surprisingly, in these series, there were no reports of hydronephrosis.

Surgical data

Median operating times varied from 101 minutes⁴¹ to 436 minutes.⁴² Hospitalisation varied from 4 to 14 days. In none of the articles was the operating time or hospitalisation correlated with the size, localisation or infiltration of the nodules.

In a total of 1275 laparoscopic segmental bowel resections, 45 (3.5%) conversions to laparotomy occurred.

The length of the bowel resected was reported in six articles,^{14,16,17,22,24,33} with median lengths of 7.8, 9.2, 10, 10, 17 and 17.3 cm, respectively (range, 4–20 cm). In none of the articles was the length of resection correlated with preoperative or perioperative findings.

Pain and recurrences

Although not recorded prospectively, pain relief after surgery was consistent with 71.4–93.6% of women being pain free after 1 year of follow-up. Recurrence of pain overall was poorly documented and is given in Table 2. The recurrence of symptoms for follow-up periods of 2–5 years varied between 4% and 54%, possibly because of unclear definitions. The recurrence of pain requiring surgery was in the range 0–34%. Proven bowel endometriosis recurrence was between 0% and 25% (Table 3).

Fertility outcome

Fertility outcome was reported in seven articles with 105 nodules only.^{21–24,34,43} The cumulative spontaneous pregnancy rate was reported in two articles, being two of 21 and four of 30, or 10%²² and 13%,²³ respectively. The live birth rate following spontaneous conception was reported in three articles, being two of 21, two of 17 and four of 13, or 10%,²² 12%⁴⁴ and 31%,²³ respectively. The other four articles reported only cumulative pregnancy

Table 2. Pain reduction after segmental bowel resection for deep endometriosis evaluated after 1 year

	Complete relief	Improvement	Unchanged	Worsened
Overall pain	81.5% (111/135)	17% (19/112)	2.7% (3/112)	0% (0/112)
Dysmenorrhoea	54.9% (45/82)	37.8% (31/82)	7.3% (6/82)	0% (0/79)
Deep dyspareunia	62% (62/100)	33.3% (25/75)	8% (6/75)	2.7% (2/75)
Chronic pain	31.3% (5/16)	43.8% (7/16)	25% (4/16)	0% (0/16)
Dyschesia	46.3% (19/41)	51.2% (21/41)	9.8% (4/41)	4.9% (2/41)

Table 3. Recurrence rates after segmental bowel resection for deep endometriosis for follow-up periods of 2–5 years

Clinical recurrence of pain	23.8% (45/189)***
Surgical recurrence*	19.4% (61/314)****
Endometriosis recurrence**	13.9% (37/267)*****

*Repeat surgery required.

**Endometriosis confirmed at repeat surgery.

***1/7,³⁵ 8/23,⁴³ 21/83,²⁷ 2/50⁴⁴ and 14/26²⁹ women.

****13/137,⁶ 0/22,¹⁵ 16/47,³⁴ 25/83²⁷ and 7/25³⁸ women.

*****13/137,⁶ 0/22,¹⁵ 21/83²⁷ and 3/25³⁸ women.

rates, including *in vitro* fertilisation (IVF), being two of 11, two of four, 18 of 36 and three of three, or 18%,³⁴ 50%,⁴³ 50%²¹ and 100%,²⁴ respectively.

Confirmation of the extent of deep endometriosis by pathology

A detailed histological report of deep lesions was found in only 16 of 34 articles.^{6,12–14,16,17,23,24,26,28,29,33,35,36,42,44} The depth of invasion was reported in 12 articles ($n = 612$ nodules), with 1% serosa, 70% muscularis, 23% submucosa and 6% mucosa invasion. In 10 articles ($n = 527$), histological confirmation of endometriosis was reported, and endometriosis was confirmed in 98% of women. Confirmation varied widely, and one article reported that endometriosis was not found in seven of 49 bowel resections;⁴² in six articles, it was unclear whether confirmation of endometriosis was absent or not looked for. Surprisingly, in 8% of reported cases, the margins of resection were not free from disease.

Complications

The complications of surgery were reported in 30 articles (Table 4). The overall complication rate after surgery was 22.2%. Major complications occurred in 11% of women, that is 6.4% severe bowel complications (leakage rate, 1.9%; fistula rate, 1.8%; severe obstruction rate, 2.7%), 2.5% haemorrhage and 1% infections. Minor complications occurred in 14.7% of women, with an incidence of temporary bowel dysfunction of 3.6% and of bladder dysfunction

of 8.1%. Late complications after more than 3 or 6 months were not reported. The data did not permit a breakdown of complications according to the level of resection.

Discussion

Our aim was to analyse the results and outcome of bowel resections for deep endometriosis according to the localisation and diameter of the nodules. We soon realised, however, that the data available varied widely between articles. Caught between the dilemma of analysing specific criteria only and retaining only a few articles, with the risk of inducing selection bias, or avoiding selection bias, broadening the inclusion criteria and reporting the raw data without meta-analysis, we decided to do the latter. Thus, the inclusion criteria of this systematic review were broadened to articles describing at least five participants and giving detailed data on at least three of the relevant criteria.

Over the last decade, it seems to have been widely accepted that complete excision of deep endometriosis is the treatment of choice. Excision should be complete in order to achieve maximal pain relief and minimal recurrences. To our knowledge, however, there are no data to substantiate this. Unfortunately, the outcome was not specified for resections in which the margins were not free of endometriosis.

The data suggest that the attitude towards bowel surgery for deep bowel endometriosis varies. One approach is to decide before surgery based on multiple examinations, such as MRI and rectal ultrasound. This approach seems to result in a very high incidence of bowel resection. From the reports, it is not clear whether only bowel resections were reported or whether bowel resections were performed systematically, something which seems to be suggested by the fact that deep endometriosis was not systematically confirmed by histology. The other approach is to decide during surgery based on findings such as the size, localisation and extension of the disease. In this approach, the pre-operative examinations are less important in decision making, and fewer examinations are performed. These seemingly opposite approaches might result, at least partly, from practical considerations, such as planning of surgery,

Table 4. Complications following segmental bowel resection for deep endometriosis

Reference	No. patients	No. complications	Major complications						Minor complications			
			Leak	Fistula	Haemorrhage	Infection	Obstruction/stricture	Other	Bladder dysfunction	Bowel dysfunction	Other	
Meuleman <i>et al.</i> ⁴²	49	7	2		1		1		3	NA	NA	NA
Maytham <i>et al.</i> ⁴¹	27	13	3				1	5	4	NA	NA	NA
Pereira <i>et al.</i> ³¹	92	7		2			2	3		NA	NA	NA
Ruffo <i>et al.</i> ¹⁹	436	146	9	14	9		3	16	6	71	15	3
Tarjanne <i>et al.</i> ²⁰	54	2		1	1					NA	NA	NA
De Nardi <i>et al.</i> ¹²	10	2								2		
Kossi <i>et al.</i> ¹⁸	31	8	1	1						2		4
Pandis <i>et al.</i> ³⁰	15	5	NA	NA	NA		NA	NA	NA	NA	NA	NA
Mangler <i>et al.</i> ³³	48	5					1			1	1	2
Ferrero <i>et al.</i> ²²	46	17	1	1	5		1	3	1	2		3
Ghezzi <i>et al.</i> ²³	33	21			1				1	3	16	
Brouwer <i>et al.</i> ⁶	137	23	2		3		2	2		2	12	
Zanetti-Dallenbach <i>et al.</i> ¹⁴	48	12	NA	NA	NA		NA	NA	NA	NA	NA	NA
Seracchioli <i>et al.</i> ¹⁵	22	7	1		1					5		
Darai <i>et al.</i> ¹⁶	71	26		6	11		3					6
Lyons <i>et al.</i> ²⁴	7	4						1		1		2
Keckstein and Wiesinger ²¹	202	15	6	0	1		1	6	0	NA	NA	NA
Abrao <i>et al.</i> ²⁵	8	0										
Ribeiro <i>et al.</i> ²⁶	115	12		2			1		1	3		5
Mohr <i>et al.</i> ³⁴	48	18	1	1	1			3	1	1		10
Campagnacci <i>et al.</i> ³⁵	7	1								1		
Fleisch <i>et al.</i> ⁴³	23	3	1		2							
Fedele <i>et al.</i> ²⁷	30	6			2			1		3		
Jatan <i>et al.</i> ³⁷	14	4			1			2		1		
Kavallaris <i>et al.</i> ⁴⁴	50	2	2									
Duepree <i>et al.</i> ³⁹	18	5	NA	NA	NA		NA	NA	NA	NA	NA	NA
Redwine and Wright ⁴⁰	7	0										
Possover <i>et al.</i> ¹³	34	2	2									
Verspyck <i>et al.</i> ²⁸	6	1		1								
Urbach <i>et al.</i> ²⁹	29	7		1	1		1	2	1	1		

NA, specific data not available. Empty cells, no complications.

that is whether a bowel surgeon is present. Bowel surgeons, moreover, have been trained mainly in oncology and bowel resections, and it may be difficult for them to consider another, more conservative, approach. Surprisingly, no hydronephrosis was reported in these series, suggesting that, overall, the lesions were not that large.

The complication rates of segmental bowel resections are high, which is consistent with the complication rates following low rectum resections for other indications. Only in one article¹¹ was the outcome related to the level of resection, confirming a higher risk of severe bowel complications for lower resections. Considering the immediate postoperative complication rate reported, together with the fact that most bowel resections in endometriosis were

rectum resections, it might be suggested that the complication rates probably are slightly lower after bowel resections for endometriosis than after bowel resections for other indications. Unfortunately, data on sexual dysfunction were not available. In conclusion, there is no basis to argue that complication rates are less after bowel resections for endometriosis than after bowel resections for other indications. Considering the young age of the women with endometriosis, this could be a very high price to pay if substantiated.

A total of over 1800 segmental bowel resections seems to be a large series. Yet, the data mainly describe feasibility, with little data permitting a judgement to be made of the outcome and complication rates according to the

localisation and size of the nodules. Few data relate the outcome to the level of segmental resection, something which is very important, as very low rectum resections, in particular, are associated with a much higher morbidity and complication rate.⁹ It is even more surprising that there were no solid data on the diameter of the nodule, a factor bound to be important with regard to the complexity of surgery and thus, probably, with regard to the decision to perform bowel resection. The lack of data may suggest that the diameter of the nodule is not considered to be an important criterion, supporting the concept that most decisions are made before surgery. The lack of data may also be a consequence of the small size of most series. In order to gain an insight into the future and to permit meta-analysis, we therefore suggest that all data on deep endometriosis surgery should be reported in a format describing when and on which criteria the indication for segmental resection was made, the localisation, diameter and level of infiltration of the nodule, and the short- and long-term complications stratified by size, localisation and depth of infiltration. It would greatly facilitate and permit meta-analysis if journals agreed on the format of reporting and when individual data could be submitted. Indeed, individual surgeons generally do not have sufficiently large series for meaningful conclusions and, most importantly, the results probably reflect as much individual surgical skills as differences in technique.

In conclusion, currently, segmental bowel resection represents a widely accepted therapeutic option for deep endometriosis with bowel involvement. The decision to perform bowel resection seems to be based on attitude rather than on data. Complications seem to be similar to those reported for bowel resections for other indications, although data on sexual dysfunction are lacking. As it is unrealistic to start randomised controlled trials comparing segmental resections stratified by the localisation and size of lesions, careful reporting of the available data is of utmost importance. In order to permit meta-analysis, we suggest that journals adopt a standard reporting of indications, surgery and outcome, size of the nodule and localisations. The common use of segmental bowel resections might be a result of the presence of bowel surgeons, who are used to performing bowel resections for cancer surgery.

Disclosure of interest

None of the authors had a financial interest.

Contribution to authorship

CDC and PRK initiated the concept of the review and wrote and edited the manuscript. Extraction of the data was performed by CDC and RC, and surgical coworkers RS, KM and AU contributed to the ideas expressed.

Details of ethics approval

Not applicable as this study did not involve direct patient intervention.

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References

- 1 Koninckx PR, Martin DC. Deep endometriosis: a consequence of infiltration or retraction or possibly adenomyosis externa? *Fertil Steril* 1992;58:924–8.
- 2 De Cicco C, Schonman R, Craessaerts M, Van Cleynenbreugel B, Ussia A, Koninckx PR. Laparoscopic management of ureteral lesions in gynecology. *Fertil Steril* 2009;92:1424–7.
- 3 Wills HJ, Reid GD, Cooper MJ, Morgan M. Fertility and pain outcomes following laparoscopic segmental bowel resection for colorectal endometriosis: a review. *Aust NZ J Obstet Gynaecol* 2008;48:292–5.
- 4 Koninckx PR, Timmermans B, Meuleman C, Penninckx F. Complications of CO₂-laser endoscopic excision of deep endometriosis. *Hum Reprod* 1996;11:2263–8.
- 5 Koninckx PR. Biases in the endometriosis literature. Illustrated by 20 years of endometriosis research in Leuven. *Eur J Obstet Gynecol Reprod Biol* 1998;81:259–71.
- 6 Brouwer R, Woods RJ. Rectal endometriosis: results of radical excision and review of published work. *Aust NZ J Surg* 2007;77:562–71.
- 7 Koninckx PR, Meuleman C, Oosterlynck D, Cornillie FJ. Diagnosis of deep endometriosis by clinical examination during menstruation and plasma CA-125 concentration. *Fertil Steril* 1996;65:280–7.
- 8 Koninckx PR, Martin D. Treatment of deeply infiltrating endometriosis. *Curr Opin Obstet Gynecol* 1994;6:231–41.
- 9 Ret Davalos ML, De Cicco C, D'Hoore A, De Decker B, Koninckx PR. Outcome after rectum or sigmoid resection: a review for gynecologists. *J Minim Invasive Gynecol* 2007;14:33–8.
- 10 Moher D, Liberati A, Tetzlaff J, Altman DG. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *Br Med J* 2009;339:332–6.
- 11 Mereu L, Ruffo G, Landi S, Barbieri F, Zaccoletti R, Fiaccavento A, et al. Laparoscopic treatment of deep endometriosis with segmental colorectal resection: short-term morbidity. *J Minim Invasive Gynecol* 2007;14:463–9.
- 12 De Nardi P, Osman N, Ferrari S, Carlucci M, Persico P, Staudacher C. Laparoscopic treatment of deep pelvic endometriosis with rectal involvement. *Dis Colon Rectum* 2009;52:419–24.
- 13 Possover M, Diebolder H, Plaul K, Schneider A. Laparoscopically assisted vaginal resection of rectovaginal endometriosis. *Obstet Gynecol* 2000;96:304–7.
- 14 Zanetti-Dallenbach R, Bartley J, Muller C, Schneider A, Kohler C. Combined vaginal-laparoscopic-abdominal approach for the surgical treatment of rectovaginal endometriosis with bowel resection: a comparison of this new technique with various established

- approaches by laparoscopy and laparotomy. *Surg Endosc* 2008;22:995–1001.
- 15 Seracchioli R, Poggioli G, Pierangeli F, Manuzzi L, Gualerzi B, Savelli L, *et al*. Surgical outcome and long-term follow up after laparoscopic rectosigmoid resection in women with deep infiltrating endometriosis. *BJOG* 2007;114:889–95.
 - 16 Darai E, Ackerman G, Bazot M, Rouzier R, Dubernard G. Laparoscopic segmental colorectal resection for endometriosis: limits and complications. *Surg Endosc* 2007;21:1572–7.
 - 17 Anaf V, El Nakadi I, De Moor V, Coppens E, Zalcmán M, Noel JC. Anatomic significance of a positive barium enema in deep infiltrating endometriosis of the large bowel. *World J Surg* 2009;33:822–7.
 - 18 Kossi J, Setala M, Enholm B, Luostarinen M. The early outcome of laparoscopic sigmoid and rectal resection for endometriosis. *Colorectal Dis* 2010;12:232–5.
 - 19 Ruffo G, Scopelliti F, Scioscia M, Ceccaroni M, Mainardi P, Minelli L. Laparoscopic colorectal resection for deep infiltrating endometriosis: analysis of 436 cases. *Surg Endosc* 2010;24:63–7.
 - 20 Tarjanne S, Sjöberg J, Heikinheimo O. Radical excision of rectovaginal endometriosis results in high rate of pain relief – results of a long-term follow-up study. *Acta Obstet Gynecol Scand* 2010;89:71–7.
 - 21 Keckstein J, Wiesinger H. Deep endometriosis, including intestinal involvement – the interdisciplinary approach. *Minim Invasive Ther Allied Technol* 2005;14:160–6.
 - 22 Ferrero S, Anserini P, Abbamonte LH, Ragni N, Camerini G, Remorgida V. Fertility after bowel resection for endometriosis. *Fertil Steril* 2009;92:41–6.
 - 23 Ghezzi F, Cromi A, Ciravolo G, Rampinelli F, Braga M, Boni L. A new laparoscopic-transvaginal technique for rectosigmoid resection in patients with endometriosis. *Fertil Steril* 2008;90:1964–8.
 - 24 Lyons SD, Chew SS, Thomson AJ, Lenart M, Camaris C, Vancaillie TG, *et al*. Clinical and quality-of-life outcomes after fertility-sparing laparoscopic surgery with bowel resection for severe endometriosis. *J Minim Invasive Gynecol* 2006;13:436–41.
 - 25 Abrao MS, Sagae UE, Gonzales M, Podgaec S, Dias JA Jr. Treatment of rectosigmoid endometriosis by laparoscopically assisted vaginal rectosigmoidectomy. *Int J Gynaecol Obstet* 2005;91:27–31.
 - 26 Ribeiro PA, Rodrigues FC, Kehdi IP, Rossini L, Abdalla HS, Donadio N, *et al*. Laparoscopic resection of intestinal endometriosis: a 5-year experience. *J Minim Invasive Gynecol* 2006;13:442–6.
 - 27 Fedele L, Bianchi S, Zanconato G, Bettoni G, Gotsch F. Long-term follow-up after conservative surgery for rectovaginal endometriosis. *Am J Obstet Gynecol* 2004;190:1020–4.
 - 28 Verspyck E, Lefranc JP, Guyard B, Blondon J. Treatment of bowel endometriosis: a report of six cases of colorectal endometriosis and a survey of the literature. *Eur J Obstet Gynecol Reprod Biol* 1997;71:81–4.
 - 29 Urbach DR, Reedijk M, Richard CS, Lie KI, Ross TM. Bowel resection for intestinal endometriosis. *Dis Colon Rectum* 1998;41:1158–64.
 - 30 Pandis GK, Saridogan E, Windsor AC, Gulumser C, CR GC, Cutner AS. Short-term outcome of fertility-sparing laparoscopic excision of deeply infiltrating pelvic endometriosis performed in a tertiary referral center. *Fertil Steril* 2010;93:39–45.
 - 31 Pereira RM, Zanatta A, Preti CD, de Paula FJ, da Motta EL, Serafini PC. Should the gynecologist perform laparoscopic bowel resection to treat endometriosis? Results over 7 years in 168 patients. *J Minim Invasive Gynecol* 2009;16:472–9.
 - 32 Landi S, Barbieri F, Fiaccavento A, Mainardi P, Ruffo G, Selvaggi L, *et al*. Preoperative double-contrast barium enema in patients with suspected intestinal endometriosis. *J Am Assoc Gynecol Laparosc* 2004;11:223–8.
 - 33 Mangler M, Loddenkemper C, Lanowska M, Bartley J, Schneider A, Kohler C. Histopathology-based combined surgical approach to rectovaginal endometriosis. *Int J Gynaecol Obstet* 2008;103:59–64.
 - 34 Mohr C, Nezhat FR, Nezhat CH, Seidman DS, Nezhat CR. Fertility considerations in laparoscopic treatment of infiltrative bowel endometriosis. *JSL* 2005;9:16–24.
 - 35 Campagnacci R, Perretta S, Guerrieri M, Paganni AM, De Sanctis A, Ciavattini A, *et al*. Laparoscopic colorectal resection for endometriosis. *Surg Endosc* 2005;19:662–4.
 - 36 Ford J, English J, Miles WA, Giannopoulos T. Pain, quality of life and complications following the radical resection of rectovaginal endometriosis. *BJOG* 2004;111:353–6.
 - 37 Jatan AK, Solomon MJ, Young J, Cooper M, Pathma-Nathan N. Laparoscopic management of rectal endometriosis. *Dis Colon Rectum* 2006;49:169–74.
 - 38 Varol N, Maher P, Healey M, Woods R, Wood C, Hill D, *et al*. Rectal surgery for endometriosis – should we be aggressive? *J Am Assoc Gynecol Laparosc* 2003;10:182–9.
 - 39 Duepree HJ, Senagore AJ, Delaney CP, Marcello PW, Brady KM, Falcone T. Laparoscopic resection of deep pelvic endometriosis with rectosigmoid involvement. *J Am Coll Surg* 2002;195:754–8.
 - 40 Redwine DB, Wright JT. Laparoscopic treatment of complete obliteration of the cul-de-sac associated with endometriosis: long-term follow-up of en bloc resection. *Fertil Steril* 2001;76:358–65.
 - 41 Maytham G, Dowson H, Levy B, Kent A, Rockall T. Laparoscopic excision of rectovaginal endometriosis: report of a prospective study and review of the literature. *Colorectal Dis* 2009; [Epub ahead of print 3 July 2009].
 - 42 Meuleman C, D'Hoore A, Van Cleynenbreugel B, Beks N, D'Hooghe T. Outcome after multidisciplinary CO₂ laser laparoscopic excision of deep infiltrating colorectal endometriosis. *Reprod Biomed Online* 2009;18:282–9.
 - 43 Fleisch MC, Xafis D, De Bruyne F, Hucke J, Bender HG, Dall P. Radical resection of invasive endometriosis with bowel or bladder involvement – long-term results. *Eur J Obstet Gynecol Reprod Biol* 2005;123:224–9.
 - 44 Kavallaris A, Kohler C, Kuhne-Heid R, Schneider A. Histopathological extent of rectal invasion by rectovaginal endometriosis. *Hum Reprod* 2003;18:1323–7.