JSLS

Laparoscopic Management of Bowel Endometriosis: Predictors of Severe Disease and Recurrence

Camran Nezhat, MD, Babak Hajhosseini, MD, Louise P. King, MD, JD

ABSTRACT

Background and Objectives: The identification of high-stage and recurrent cases of bowel endometriosis is critical, because these cases require careful surgical planning. We aim to describe the clinical characteristics of women with bowel endometriosis, our principles in laparoscopic management of this pathology, and to identify predictors of severe disease and recurrence.

Methods: This was a retrospective study of 193 patients with pathologically confirmed bowel endometriosis.

Results: Predictors of higher-stage endometriosis include a history of previous laparoscopic surgery (P=.04) and a presenting complaint of abnormal uterine bleeding (P=.01). The higher the stage of endometriosis, the more likely there would be coexistent urinary tract endometriosis (P=.02), a need for enterolysis (P=.002), ovarian cystectomy (P<.001), and bowel resection (P=.01) performed during laparoscopy. Patients with higher body mass index (BMI) had significantly higher recurrence rates of endometriosis compared to those with lower BMI (P=.002). Within our cohort, 87% of our patients achieved amelioration of symptoms by the end of the first postoperative month.

Conclusions: Our study confirms that laparoscopic management of bowel endometriosis is safe and effective. We found 2 statistically significant predictors of higher-stage disease that should prompt careful surgical planning. Obesity is associated with a higher rate of recurrence of endometriosis.

Center for Special Minimally Invasive and Robotic Surgery, Department of Obstetrics and Gynecology, Stanford University Medical Center, Palo Alto, California, USA (all authors)

Department of Surgery, Keck School of Medicine, University of Southern California, Los Angeles, California, USA (Dr. Hajhosseini).

Address correspondence to: Camran Nezhat, MD, 900 Welch Road, Suite 403, Palo Alto, California USA, 94304, Telephone: (650) 327-8778, Fax: (650) 327-2794, E-mail: cnezhat@stanford.edu

Key Words: Laparoscopic surgery, Endometriosis, Bowel endometriosis, Intestinal endometriosis.

INTRODUCTION

Endometriosis is an estrogen-dependent inflammatory disease[1] that was first described in 1860.[2] It is a progressive disease that affects 10% to 15% of reproductive age women and nearly half of all infertile women. It is defined as the presence of endometrial-like tissue outside of the uterine cavity.[3,4] The condition is commonly associated with chronic pelvic pain and infertility.[5,6] Superficial or deep endometriosis can involve virtually any pelvic or extrapelvic organ.[7] The most common site of extragenital endometriosis is the intestinal tract, which accounts for approximately 80% of all extragenital endometriosis.[3,4]

Although bowel endometriosis may cause severe gastrointestinal (GI) symptoms, these disturbances are frequently not adequately investigated at the time of gynecologic evaluation. As a result, bowel endometriosis may be an unexpected finding at surgery, and the lesions may not be treated due to the lack of preoperative informed consent or surgical inexperience.[8] Moreover, the extent of intestinal wall resection necessary to adequately treat the disease is highly debated. Identifying high-stage and recurrent cases is critical, because they require careful surgical planning.

This article will describe the clinical characteristics of women with bowel endometriosis and will present the results of our own experience in laparoscopic management of the disease. We will identify possible predicting factors for the extent of the disease and its recurrence. It is useful for gynecologists and general surgeons to understand the spectrum of intestinal tract endometriosis so as to be able to anticipate its presence and plan accordingly.

MATERIALS AND METHODS

We reviewed the charts of all patients at our tertiary referral center who underwent laparoscopic surgery between February 2002 and September 2009 and identified all those with pathologically confirmed bowel endometri-

osis. The final cohort consisted of 193 patients. We also reviewed the operative reports to confirm that a diagnosis of bowel endometriosis was made during the surgery and that endometriotic lesions were found to infiltrate beyond the serosal layer of the intestinal wall.

We then abstracted data from the charts of all 193 patients with respect to age, body mass index (BMI), previous surgery, presenting symptoms and their timing, intraoperative findings and procedures, sites and stage of endometriosis, short- and long-term follow-up and pain relief, perioperative morbidity, and recurrence of endometriosis. The disease was staged according to the 1996 American Society for Reproductive Medicine classification, based on the operative findings.[9]

Before surgery, each patient underwent a routine gynecologic and rectovaginal examination and a transvaginal ultrasound. Each patient also underwent mechanical bowel preparation and received perioperative intravenous antibiotics. The lesion distribution, depth of invasion, and level of stricture dictated the laparoscopic method of treatment of intestinal endometriosis. Superficial lesions that did not invade the muscularis were shaved with CO_2 laser. Disc excision was performed when endometriotic lesions partially invaded the muscular layer, but not the mucosa of the bowel.[10–12] When infiltrative lesions involved more than one-third of the circumference of the bowel or caused partial bowel obstruction, a segmental resection with end-to-end anastomosis was performed. We removed all visible endometriotic foci in other parts of the pelvis, abdomen, and thoracic cavity as needed.[13] Preoperative and intraoperative consultation with a colorectal surgeon, urologist, or thoracic surgeon was obtained as appropriate.

Descriptive statistics were calculated and tabulated. Normally distributed data are presented as mean ± standard deviation (SD). Associations between study outcomes and potential predictors were explored using the independent sample t test for continuous variables and the chi-square test for categorical variables. A P value <.05 was considered to be statistically significant. All analyses were conducted using SPSS statistical software version 15 (SPSS Inc., Chicago, IL). The Institutional Review Boards of the Stanford University Medical Center and El Camino Hospital approved this study.

RESULTS

During the 7 and ½ year study period, 193 patients with pathologically confirmed bowel endometriosis were identified. The mean age of the study group was 36±7 years (range, 17 to 52) with a mean BMI of 23.2±3.1kg/m² (range, 18.2 to 34.3). The most common preoperative presenting symptom was chronic pelvic pain. At the time of presentation, 59% of patients had GI symptoms, but only 36% (n=70) included it as one of their chief complaints. Of those with GI symptoms, constipation and dyschezia were the most common. Urinary frequency was the most common urinary complaint at the time of presentation. A complete list of presenting symptoms can be found in **Table 1** along with baseline characteristics. A total of 45% of patients described their symptoms as cyclic in nature, occurring at or around the time of menstruation. A total of 44% (n=85) had a history of laparoscopic surgery at other medical centers; these were mainly for treatment of endometriosis. Of patients, 11% (n=22) had a history of depression, and 6% (n=11) had some type of uterine anomaly (bicornuate or septate uterus).

Table 1.
Baseline Characteristics

Age	36±7 years (range, 17–52)
BMI	23.2 ±3.1 kg/m² (range, 18.2–34.3)
Presenting Symptoms	**No. (%)ᵃ of Patients**
Chronic pelvic pain, not otherwise specified	159 (82)
Abnormal uterine bleeding	128 (66)
Dysmenorrhea	101 (52)
Dyspareunia	34 (18)
Gastrointestinal symptoms (total)	70 (36)
Constipation	65 (34)
Dyschezia	54 (28)
Diarrhea	43 (22)
Nausea/vomiting	41 (21)
Melena	3 (1.6)
Urinary symptoms	55 (28)
Stage of endometriosis	
Stage 1	13 (6)
Stage 2	36 (19)
Stage 3	27 (14)
Stage 4	117 (61)

ᵃTotal >100% because most patients presented with more than 1 symptom.

Stage IV endometriosis was present in 61% (n=117) of patients **(Table 1)**. More than half of the patients (58%) had multiple sites of intestinal endometriosis, with the recto-sigmoid colon, recto-vaginal septum, and appendix being the most common sites in descending order of frequency. A total of 97% (n=187) of patients also had endometriotic lesions at sites other than the intestinal tract, with ovaries being the most common nongastrointestinal site of endometriosis lesions. Coexistence of urinary tract (bladder and/or ureter) endometriosis was seen in 62% (n=119) of patients and was treated at the time of surgery. The complete list of sites of endometriosis is provided in **Table 2**. During surgery, 11% (n=22) of patients were concomitantly diagnosed with adenomyosis.

Disc excision, segmental bowel resection, and appendectomy were performed on 73% (n=141), 1.6% (n=3), and 37% (n=72) of patients, respectively. Of 72 appendecto-

mies, pathology reports indicated an abnormal appendix (endometriosis/fibrotic obliteration) in 65% of cases. Varying degrees of enterolysis were required in 65% (n=126) of patients. One patient underwent a combination of laparoscopy for treatment of abdominopelvic endometriosis and thoracoscopy for treatment of thoracic endometriosis. The operative procedures performed on patients in the study are listed in **Table 3**. All procedures were carried out successfully by laparoscopy without conversion to laparotomy. We used a combination of conventional and robot-assisted laparoscopy in 7 cases (4%).

No major complications occurred. These were defined as rectovaginal fistula, anastomotic leakage/stenosis, inadvertent ureteral damage, accidental bowel perforation, and pelvic abscesses. Minor complications occurred in 7% (n=13) of patients and included 4 cases of transient urinary retention and 9 cases of incision-site infection. All of these minor complications were treated in an outpatient setting. Short-term follow-up visits in the outpatient setting were routinely conducted 1, 3, and 6 months postoperatively. Overall, 87% (n=167) of the entire study group achieved amelioration of symptoms by the end of the first postoperative month. Long-term follow-ups were con-

Table 2.
Sites of Endometriosis (n=193)

Site	No. (%)[a] of Patients
Intestinal Sites	
Rectosigmoid Colon	144 (75)
Rectovaginal Septum	110 (57)
Appendix	47 (24)
Large Intestine, not otherwise specified	20 (10)
Small Intestine	10 (5)
Nonintestinal Sites	
Posterior cul-de-sac	90 (47)
Anterior cul-de-sac	38 (19)
Pelvic sidewall	87 (45)
Uterosacral ligaments	51 (26)
Ovaries	134 (69)
Fallopian tubes	31 (16)
Uterus	52 (27)
Ureters	84 (43)
Bladder	76 (39)
Diaphragm	15 (8)
Vagina	3 (1.6)
Cervix	3 (1.6)
Liver	3 (1.6)
Inguinal canal	2 (1)

[a]Total >100% because most patients had more than 1 site of endometriosis.

Table 3.
Laparoscopic Procedures Performed (n=193)

Procedure	No. (%)[a] of patients
Treatment of superficial endometriosis	193 (100)
Disc excision	141 (73)
Segmental bowel resection	3 (1.6)
Appendectomy	72 (37)
Enterolysis	126 (65)
Ovarian cystectomy	86 (45)
Salpingo-oophorectomy	22 (11)
Hysterectomy	13 (7)
Myomectomy	56 (29)
Cystoscopy	139 (72)
Ureterolysis	148 (76)
Partial vaginectomy	1 (0.5)
Presacral neurectomy	6 (3)
Thoracoscopy for treatment of diaphragmatic endometriosis	1 (0.5)
Robot-assisted laparoscopy	7 (4)

[a]Total >100% because all patients had more than 1 procedure performed.

ducted by either office visits or phone calls on a yearly basis. During 1 to 8 years of long-term follow-up (mean, 4.5 years), 10% (n=19) had recurrence of endometriosis that necessitated a second laparoscopic intervention. Similarly to their initial laparoscopic evaluation, the majority of patients with recurrent cases were diagnosed with multiple sites of endometriosis at the time of the second surgery. The 3 most common sites of recurrent endometriosis in decreasing order of frequency were genital tract (8%), urinary tract (6%), and GI tract (4%).

We divided our cohort into 2 groups for further analysis: 1 group with lower-stage endometriosis (stages I, II, & III) and 1 group with high-stage endometriosis (stage IV). There were 2 preoperative factors significantly related to higher stage disease: a presenting complaint of abnormal uterine bleeding (P=.01) or a history of laparoscopic surgery (P=.04). There was also a significant association between the stage of endometriosis and some of the operative procedures performed. Patients with stage IV endometriosis were more likely to need enterolysis (P=.002), ovarian cystectomy (P<.001), and segmental bowel resection/disc excision (P=.01) performed during their surgeries, as com-

pared with those with less advanced stages of disease. Coexistent urinary tract endometriosis was significantly more likely in patients with more advanced stages of endometriosis (P=.02). A complete list of variables and their associations with stage of endometriosis is shown in **Table 4**. No significant associations were noted between the stage of endometriosis and the patients' BMI, type of surgery (conventional vs. robot-assisted laparoscopy), or frequency of postoperative complications.

We conducted a subanalysis of 19 patients with recurrent endometriosis to identify possible predictors of recurrent disease. Patients with higher BMI had significantly higher recurrence rate of endometriosis compared to those with lower BMI (P=.002). No significant correlations existed between recurrence rate and age, presenting symptoms, or history of previous laparoscopic surgery. Although a higher recurrence rate was seen in patients with stage IV endometriosis compared to patients with less advanced stages, the relationship did not reach statistical significance. There was no significant difference between recurrence rate and the type of surgery performed (conventional vs. robot-assisted laparoscopy).

Table 4.
Variables Associated with Stage of Endometriosis

	Low Stage (I, II, & III)	High Stage (IV)	P Value
Age	35 ± 7.6	35.8 ± 6.2	.4
BMI	23 ± 3.3	23.3 ± 3.1	.6
Presenting with irregular bleeding	59%	70%	.04
Presenting with GI symptoms	34%	41%	.4
Presenting with urinary symptoms	32%	30%	.7
Depression	10%	12%	.8
Uterine anomalies	4%	7%	.7
Past laparoscopy	29%	53%	.003
Ovarian cystectomy performed during surgery	24%	57%	<.001
Enterolysis performed during surgery	51%	79%	<.001
Myomectomy performed during surgery	35%	27%	.2
Hysterectomy performed during surgery	6%	8%	.7
Appendectomy performed during surgery	35%	41%	.5
Segmental bowel resection/Disc excision performed during surgery	40%	85%	.01
Presacral neurectomy performed during surgery	0%	5%	.1
Endometriosis of appendix	22%	28%	.4
Endometriosis of urinary tract	51%	70%	.02
Concomitant adenomyosis	6%	13%	.1
Recurrence of endometriosis	7%	11%	.4

DISCUSSION

Bowel endometriosis was first described in 1922 by Sampson.[14] It affects between 3% and 37% of patients with a diagnosis of endometriosis. It can present at any level from the anal canal to the small intestine; however, the most frequent locations of involvement are the rectum and sigmoid colon.[3,4,15,16] Intestinal implantation begins on the serosa and sometimes invades the muscularis propria but rarely affects the mucosa.[4,8,17]

Patients with endometriosis present with different clinical complaints at various stages of disease.[5] The majority of those with bowel involvement develop a variety of GI complaints including constipation, diarrhea, abdominal bloating, tenesmus, lower abdominal pain, and occasionally rectal bleeding.[3,5,8] Symptoms usually occur cyclically at or about the time of menstruation.[5] Appendiceal endometriosis can mimic acute appendicitis, or it may contribute to chronic pelvic pain.[18–23] Bowel obstruction is a rare complication that can be confused with carcinoma[3,17,24] The differential diagnosis of bowel endometriosis includes irritable bowel syndrome, inflammatory bowel disease, diverticulitis, and bowel carcinoma.[8,17,25]

Several techniques have been proposed to aid in the diagnosis of bowel endometriosis. These include barium enema, transvaginal ultrasound, transrectal ultrasound, colonoscopy, computed tomography, and magnetic resonance imaging.[8] Although studies have shown varying levels of success using these methodologies,[23,26–28] it is generally believed that they are of little diagnostic value.[3,7,29,30] In short, no clear guidelines exist for the evaluation of patients with suspected bowel endometriosis. When clinical evidence suggests the presence of deeply infiltrating endometriosis, we use imaging studies to map the extent of disease. Nevertheless, laparoscopic assessment in combination with histological examination of excised lesions remains the gold standard for diagnosis of any type of endometriosis including that of the bowel.[4–5,30]

Historically, 2 major approaches exist for management of bowel endometriosis: medical and surgical. Medical treatments are focused on hormonal manipulation of the menstrual cycle in an attempt to produce a pseudo-pregnancy, pseudo-menopause, or chronic anovulation.[6] Alternatively, targeting aromatase, cyclooxygenase-2, estrogen receptor β, or progesterone receptors may reduce pelvic pain and decrease visible endometriotic tissue.[31–33] Although hormonal modulation may be useful in some settings like preoperative preparation,[23,34–35] it rarely yields satisfactory long-term results.[5,8,36,37] This may be because of fibrotic changes and scar tissue, resulting in pelvic pain that is refractory to medical therapy.[3] Currently, surgical removal of endometriotic lesions appears to be the most effective treatment, because it is associated with a significant improvement in pain, quality of life, and fertility status.[8,38,39]

Successful laparoscopic bowel resection for the treatment of bowel endometriosis was first described in 1988.[10,40,41]

Over the last 2 decades, a variety of laparoscopic techniques have proven effective in the treatment of intestinal endometriosis. These include laser vaporization, shaving, disc excision, segmental bowel resection, and appendectomy, all of which can be performed successfully via laparoscopy.[11,12]

Advances in laparoscopic management of severe bowel endometriosis would not have been possible without multiple advances in instrumentation and the introduction of videolaparoscopy.[42–45] Before the introduction of videolaparoscopy, the utility of operative laparoscopy was diminished by two major drawbacks: poor visualization into the intra-abdominal cavity with one eye and the inability of the operative team to view the operative field. Both of these limitations were rectified with the incorporation of the videolaparoscope.[43,44] These advances made it possible to treat even the most extensive pathology laparoscopically.

Several authors agree that laparoscopic bowel resection is feasible and can be performed safely when needed.[46–49] However, a debate exists regarding the extent of intestinal wall resection necessary to adequately treat the disease.[36] Segmental bowel resection represents the most radical approach but is characterized by a specific pattern of major postoperative complications and lower pregnancy rates compared with less aggressive methods, such as disc excision.[11,12,50] Those in favor of segmental resection argue that the wide margin of excision achieved results in a lower recurrence rate of the endometriosis.[37,51–53] However, the dissection necessary to achieve mobilization for a segmental bowel resection poses a greater risk of inadvertent trauma to the superior and especially inferior hypogastric plexus. Injury to these plexus could cause persistent bowel and urinary symptoms postoperatively.

The majority of our patients were managed without segmental bowel resection. They achieved high levels of pain relief and excellent long-term outcome with low recurrence rates and no major complications. Because colorectal endometriosis is considered a benign disease,[22] we feel

that segmental bowel resection should remain the last resort, appropriate only for those with lesions involving more than one-third of the circumference of the bowel or those with partial bowel obstruction. In addition, intraoperative proctosigmoidoscopy should be performed when necessary. This procedure has been shown to be effective in assessment of bowel wall invasion, detecting bowel injuries during laparoscopy and evaluating anastomosis.[54]

Similarly to other studies,[55] we found that concomitant genital and urinary tract endometriosis are frequently seen in patients with bowel endometriosis. Therefore, a careful and systematic inspection of the pelvic and abdominal cavity is necessary to detect and treat all possible lesions. Moreover, in findings that echo those of Redwine and Chapron et al,[56,57] we found that a large portion of our patients had multifocal endometriosis lesions of the intestines; however, in contrast to their opinions, we believe that even multifocal cases of bowel endometriosis can be managed successfully by laparoscopy with no need for conversion to laparotomy.

We found that obese or overweight women had a significantly higher rate of recurrence compared with patients with normal BMI. It is unlikely that the higher recurrence rate in this subgroup is due to incomplete treatment of endometriosis, as it has been demonstrated that laparoscopic approach in treatment of endometriosis is not significantly influenced by BMI in terms of surgical outcome or complications rate.[58] Instead, this could be partly due to the fact that obese women have more adipose tissue and consequently higher output of estrogen produced by the aromatase activity in those tissues. This would be consistent with the estrogen-dependent nature of the disease. However, we did not find any significant association between BMI and disease stage.

Although not clinically specific, we demonstrated 2 statistically significant preoperative predictors of severe disease: a presenting complaint of abnormal uterine bleeding, a history of gynecologic laparoscopy, or both of these.

Our study has several limitations. Our center is a tertiary referral center for endometriosis; therefore, our patients may not be representative of the population as a whole. The retrospective nature of this study limited our ability to control for confounding factors and thus limited our ability to reliably predict those factors that lead to recurrence. All the presenting symptoms in our study were self-reported. Our study was limited to patients with proven bowel endometriosis, so we were not able to determine

how valuable GI symptoms may be in predicting the presence of bowel endometriosis. To determine the predictive nature of gastrointestinal symptoms and adequately compare disc excision to segmental bowel resection for treatment of bowel endometriosis, further prospective controlled trials are warranted. We also believe that, based on our findings in terms of relation between higher BMI and higher rate of recurrence, future studies are required to investigate the association between preoperative estrogen levels and recurrence of endometriosis.

CONCLUSION

Intestinal endometriosis should be suspected in women of childbearing age who present with gastrointestinal symptoms and a history of endometriosis. High-stage and recurrent cases necessitate careful surgical planning. Our study confirms that laparoscopic management of bowel endometriosis is feasible, safe, and efficient. All patients who undergo laparoscopy for treatment of endometriosis or chronic pelvic pain should be counseled regarding the possibility of bowel involvement and the risk, benefits, and alternatives of treatment. Although it may be technically demanding, removal of endometriotic lesions is critical for symptomatic relief and if carried out in specialist centers by surgeons with proper training and experience, leads to positive results with minimal morbidity.

References:

1. Giudice LC, Kao LC. Endometriosis. *Lancet*. 2004;364(9447): 1789–1799.

2. Rokitansky C. Ueber Uterusdrusen-neubildung in Uterus and Ovarial Sarcomen. *Z Gesellschaft Aertz Wein*. 1860;16.

3. Lewis LA, Nezhat C. Laparoscopic treatment of bowel endometriosis. *Surg Technol Int*. 2007;16:137–141.

4. Nezhat C, Nezhat F. Surgery for endometriosis of the bowel, bladder, ureter, and diaphragm. *Ann N Y Acad Sci*. 1997;828:332–340.

5. Berker B, Hsu THS, Lee KL, Nezhat C, Nezhat F, Nezhat C. Laparoscopic treatment of endometriosis. In: Nezhat C, Nezhat F, Nezhat C, eds. *Nezhat's Operative Gynecologic Laparoscopy and Hysteroscopy*. Hong Kong: Cambridge University Press; 2008; 263–303.

6. Olive DL, Pritts EA. Treatment of endometriosis. *N Engl J Med*. 2001;345(4):266–275.

7. Redwine DB, Sharpe DR. Laparoscopic surgery for intestinal and urinary endometriosis. *Baillieres Clin Obstet Gynaecol*. 1995;9(4):775–794.

8. Remorgida V, Ferrero S, Fulcheri E, Ragni N, Martin DC. Bowel endometriosis: presentation, diagnosis, and treatment. *Obstet Gynecol Surv.* 2007;62(7):461–470.

9. Revised American Society for Reproductive Medicine classification of endometriosis: 1996. *Fertil Steril.* 1997;67(5):817–821.

10. Nezhat C, Nezhat FR. Safe laser endoscopic excision or vaporization of peritoneal endometriosis. *Fertil Steril.* 1989;52(1):149–151.

11. Nezhat C, Nezhat F, Ambroze W, Pennington E. Laparoscopic repair of small bowel and colon. A report of 26 cases. *Surg Endosc.* 1993;7(2):88–89.

12. Nezhat C, Nezhat F, Pennington E, Nezhat CH, Ambroze W. Laparoscopic disk excision and primary repair of the anterior rectal wall for the treatment of full-thickness bowel endometriosis. *Surg Endosc.* 1994;8(6):682–685.

13. Veeraswamy A, Lewis M, Mann A, Kotikela S, Hajhosseini B, Nezhat C. Extragenital endometriosis. *Clin Obstet Gynecol.* 2010;53(2):449–466.

14. Sampson JA. Intestinal adenomas of endometrial type. *Arch Surg.* 1922;5(2):64.

15. Prystowsky JB, Stryker SJ, Ujiki GT, Poticha SM. Gastrointestinal endometriosis. Incidence and indications for resection. *Arch Surg.* 1988;123(7):855–858.

16. Weed JC, Ray JE. Endometriosis of the bowel. *Obstet Gynecol.* 1987;69(5):727–730.

17. Skoog SM, Foxx-Orenstein AE, Levy MJ, Rajan E, Session DR. Intestinal endometriosis: the great masquerader. *Curr Gastroenterol Rep.* 2004;6(5):405–409.

18. Gustofson RL, Kim N, Liu S, Stratton P. Endometriosis and the appendix: a case series and comprehensive review of the literature. *Fertil Steril.* 2006;86(2):298–303.

19. 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(4):472–479.

20. Berker B, Lashay N, Davarpanah R, Marziali M, Nezhat CH, Nezhat C. Laparoscopic appendectomy in patients with endometriosis. *J Minim Invasive Gynecol.* 2005;12(3):206–209.

21. Abrao MS, Dias JA, Jr., Rodini GP, Podgaec S, Bassi MA, Averbach M. Endometriosis at several sites, cyclic bowel symptoms, and the likelihood of the appendix being affected. *Fertil Steril.* 2010;94(3):1099–1101. Epub 2009 Dec 11.

22. Nezhat C, Nezhat F, Nezhat CH, Seidman DS. Severe endometriosis and operative laparoscopy. *Curr Opin Obstet Gynecol.* 1995;7(4):299–306.

23. Martin DC, O'Conner DT. Surgical management of endometriosis-associated pain. *Obstet Gynecol Clin North Am.* 2003;30(1):151–162.

24. Jenkinson EL, Brown WH. Endometriosis: A study of one hundred and seventeen cases with special reference to constricting lesions of the rectum and sigmoid colon. *JAMA.* 1943;122:6.

25. Yantiss RK, Clement PB, Young RH. Endometriosis of the intestinal tract: a study of 44 cases of a disease that may cause diverse challenges in clinical and pathologic evaluation. *Am J Surg Pathol.* 2001;25(4):445–454.

26. Landi S, Barbieri F, Fiaccavento A, et al. Preoperative double-contrast barium enema in patients with suspected intestinal endometriosis. *J Am Assoc Gynecol Laparosc.* 2004;11(2):223–228.

27. Abrao MS, Goncalves MO, Dias JA, Jr., Podgaec S, Chamie LP, Blasbalg R. Comparison between clinical examination, transvaginal sonography and magnetic resonance imaging for the diagnosis of deep endometriosis. *Hum Reprod.* 2007;22(12):3092–3097.

28. Bazot M, Lafont C, Rouzier R, Roseau G, Thomassin-Naggara I, Darai E. Diagnostic accuracy of physical examination, transvaginal sonography, rectal endoscopic sonography, and magnetic resonance imaging to diagnose deep infiltrating endometriosis. *Fertil Steril.* 2009;92(6):1825–1833.

29. Jerby BL, Kessler H, Falcone T, Milsom JW. Laparoscopic management of colorectal endometriosis. *Surg Endosc.* 1999;13(11):1125–1128.

30. Houtmeyers P, Ceelen W, Gillardin JM, Dhondt M, Pattyn P. Surgery for gastrointestinal endometriosis: indications and results. *Acta Chir Belg.* 2006;106(4):413–416.

31. Bulun SE. Endometriosis. *N Engl J Med.* 2009;360(3):268–279.

32. Machado DE, Berardo PT, Landgraf RG, et al. A selective cyclooxygenase-2 inhibitor suppresses the growth of endometriosis with an antiangiogenic effect in a rat model. *Fertil Steril.* 2010;93:2674–2679. Epub 2010 Jan 13.

33. Matsuzaki S, Canis M, Pouly JL, Wattiez A, Okamura K, Mage G. Cyclooxygenase-2 expression in deep endometriosis and matched eutopic endometrium. *Fertil Steril.* 2004;82(5):1309–1315.

34. Koninckx PR, Martin D. Treatment of deeply infiltrating endometriosis. *Curr Opin Obstet Gynecol.* 1994;6(3):231–241.

35. Martin DC, Batt RE. Retrocervical, retrovaginal pouch, and rectovaginal septum endometriosis. *J Am Assoc Gynecol Laparosc.* 2001;8(1):12–17.

36. Koh CH, Janik GM. The surgical management of deep rectovaginal endometriosis. *Curr Opin Obstet Gynecol.* 2002;14(4):357–364.

37. Minelli L, Fanfani F, Fagotti A, et al. Laparoscopic colorectal resection for bowel endometriosis: feasibility, complications, and clinical outcome. *Arch Surg.* 2009;144(3):234–239, discussion 239.

38. Vercellini P, Frontino G, Pietropaolo G, Gattei U, Daguati R, Crosignani PG. Deep endometriosis: definition, pathogenesis, and clinical management. *J Am Assoc Gynecol Laparosc.* 2004; 11(2):153–161.

39. Gambone JC, DeCherney AH. Surgical treatment of minimal endometriosis. *N Engl J Med.* 1997;337(4):269–270.

40. Nezhat C, Nezhat F. Evaluation of safety of videolaparoscopic treatment of bowel endometriosis, Scientific Paper and Poster Sessions. *44th Annual Meeting of the American Fertility Society.* Atlanta, GA. October 8–13, 1988.

41. Nezhat C, Pennington E, Nezhat F, Silfen SL. Laparoscopically assisted anterior rectal wall resection and reanastomosis for deeply infiltrating endometriosis. *Surg Laparosc Endosc.* 1991; 1(2):106–108.

42. Nezhat C, Crowgey SR, Garrison CP. Surgical treatment of endometriosis via laser laparoscopy. *Fertil Steril.* 1986;45: 778–83.

43. Kelley WE, Jr. The evolution of laparoscopy and the revolution in surgery in the decade of the 1990s. *JSLS.* 2008;12:351–7.

44. Pappas TN, Jacobs DO. Laparoscopic resection for colon cancer–the end of the beginning? *N Engl Med.* 2004;350:2091–2.

45. Page B. Camran Nezhat and the Advent of Advanced Operative Video-laparoscopy. In: Nezhat C, ed. *Nezhat's History of Endoscopy.* Tuttlingen, Germany: Endo:Press; 2011:159–87.

46. 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(2): 358–365.

47. Keckstein J, Wiesinger H. Deep endometriosis, including intestinal involvement–the interdisciplinary approach. *Minim Invasive Ther Allied Technol.* 2005;14(3):160–166.

48. 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(1):63–67.

49. Darai E, Thomassin I, Barranger E, et al. Feasibility and clinical outcome of laparoscopic colorectal resection for endometriosis. *Am J Obstet Gynecol.* 2005;192(2):394–400.

50. Mohr C, Nezhat FR, Nezhat CH, Seidman DS, Nezhat CR. Fertility considerations in laparoscopic treatment of infiltrative bowel endometriosis. *JSLS.* 2005;9(1):16–24.

51. Fanfani F, Fagotti A, Gagliardi ML, et al. Discoid or segmental rectosigmoid resection for deep infiltrating endometriosis: a case-control study. *Fertil Steril.* 2010;95:1109–1112. Epub 2009 Apr 25.

52. Stepniewska A, Pomini P, Guerriero M, Scioscia M, Ruffo G, Minelli L. Colorectal endometriosis: benefits of long-term follow-up in patients who underwent laparoscopic surgery. *Fertil Steril.* 2010;93(7):2444–2446.

53. 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(6):754–758.

54. Nezhat C, Seidman D, Nezhat F. The role of intraoperative proctosigmoidoscopy in laparoscopic pelvic surgery. *J Am Assoc Gynecol Laparosc.* 2004;11(1):47–49.

55. Jatan AK, Solomon MJ, Young J, Cooper M, Pathma-Nathan N. Laparoscopic management of rectal endometriosis. *Dis Colon Rectum.* 2006;49(2):169–174.

56. Redwine DB. Ovarian endometriosis: a marker for more extensive pelvic and intestinal disease. *Fertil Steril.* 1999;72(2): 310–315.

57. Chapron C, Fauconnier A, Vieira M, et al. Anatomical distribution of deeply infiltrating endometriosis: surgical implications and proposition for a classification. *Hum Reprod.* 2003;18(1): 157–161.

58. Camanni M, Bonino L, Delpiano EM, Migliaretti G, Berchialla P, Deltetto F. Laparoscopy and body mass index: feasibility and outcome in obese patients treated for gynecologic diseases. *J Minim Invasive Gynecol.* 2010;17(5):576–582.