

## SURGICAL TREATMENT OF ENDOMETRIOSIS

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In the past decade, it has become increasingly possible to treat endometriosis at the time of diagnostic laparoscopy. Surgical resection previously possible only by means of laparotomy can be accomplished through therapeutic laparoscopic techniques using scissors, electro-surgical instruments, lasers, suture, and staplers.<sup>57</sup>

This article summarizes the indications, principles, and techniques of surgical treatment, emphasizing the laparoscopic approach. Some techniques are simple and can be performed by most gynecologists. With the appropriate facilities, the experienced surgeon can perform complex endometriosis operations, including:

1. Extensive peritoneal dissection
2. Cul-de-sac and rectovaginal dissection
3. Resection of invasive bowel endometriosis
4. Appendectomy
5. Treatment of invasive ovarian endometriosis and endometriomas
6. Oophorectomy
7. Removal of tubal endometriosis
8. Resection of bladder endometriosis
9. Resection of ureteral endometriosis
10. Removal of uterine endometriosis
11. Uterosacral nerve ablation

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12. Presacral neurectomy
13. Laparoscopy-assisted vaginal hysterectomy
14. Adhesiolysis

Requirements for surgery, surgical principles, operative techniques, and results must be considered to provide optimal surgical treatment.

## INDICATIONS AND CONTRAINDICATIONS

Indications for laparoscopy to diagnose endometriosis include infertility of more than 1 year's duration without other symptoms, or possibly after 6 months if the patient has symptoms or is older than the age of 35 years. Patients with pelvic pain that has not responded after 3 months of nonsteroidal anti-inflammatory drugs (NSAIDs) and/or 3 months of oral contraceptives (OC) are candidates for laparoscopy. Patients who present with adnexal masses suspicious of being an endometrioma should have laparoscopy if the lesion does not resolve itself by 3 months, or sooner if there are concomitant symptoms such as pain or other factors that make surgery appropriate.<sup>8, 25</sup> The objectives of surgery are to remove or destroy implants, relieve symptoms, maintain or restore fertility, and avoid or delay recurrence of symptoms.

Contraindications to surgery include multiple repeat operations at short intervals to treat lesions. If appropriate surgery is performed, it is uncommon for endometriotic lesions to recur within a few months.<sup>90, 108</sup> Repeat surgery for adhesiolysis is indicated in selected patients, usually those with infertility. Repeat surgery may be indicated after an appropriate interval if symptoms recur and are not treatable with medical therapy. Laparoscopy may be repeated to perform gamete intrafallopian transfer (GIFT) in selected patients. Surgery should not be performed in patients with unacceptably high medical or surgical risks. Laparoscopy should not be performed in patients at high risk for bowel injury, unless an open technique or a technique designed to avoid bowel injury is used. Laparotomy is an appropriate approach for many surgeons when laparoscopy may be too hazardous or the surgeon may not have the requisite skills or facilities to perform operative laparoscopy.

## ALTERNATIVE TREATMENTS

Alternatives to laparoscopic treatment of endometriosis include no treatment for young patients with minimal symptoms, or women who have just completed a course of medical treatment. Minimal or mild pain symptoms may be treated successfully with NSAIDs or OCs. Other endocrinologic treatment includes progestins, danazol, or gonadotropin-releasing hormone (GnRH) agonists. It should be noted that pelvic pain associated with endometriosis is treated effectively by medical therapy, and that all of the different medical treatments have similar

efficacy.<sup>13, 24, 51, 52, 53, 83</sup> Laparoscopic treatment is also effective in treatment of pelvic pain.<sup>36, 110</sup> Danazol and GnRH agonists should not be used in the treatment of endometriosis unless the diagnosis has been confirmed at laparoscopy.

For infertility patients, no treatment is as effective as surgical treatment for minimal and mild disease (Table 1; Fig. 1).<sup>11, 15</sup> Surgical treatment is required for more advanced disease with invasive nodular disease, endometriomas, and adhesions.<sup>25</sup> Medical treatment, either alone or following surgery, does not improve pregnancy rates and should not be used in patients who have only infertility as a symptom.<sup>11, 15, 52</sup>

The approach to each patient must be individualized depending on her symptoms, signs, age, type and extent of disease, and the desire for fertility. Many patients prefer no treatment or medical treatment before surgery; however, surgery is often the most appropriate approach. Most patients prefer to retain as many of their reproductive organs as possible, but for some, oophorectomy or hysterectomy is a better option. Laparoscopy generally is the preferred surgical approach, but laparotomy may be appropriate for some cases, especially those requiring extirpation of large endometriomas, extensive enterolysis, enterostomy, or bowel resection.<sup>68, 93</sup> Alternatives to treatment, or treatment in combination with surgery, such as the use of GnRH agonists preoperatively to treat severe endometriosis, should be considered and implemented as indicated.<sup>105</sup>

## SIMULTANEOUS DIAGNOSIS AND TREATMENT

Diagnostic laparoscopy provides a relatively safe and simple method of diagnosing most anatomic gynecologic disease states. Cur-

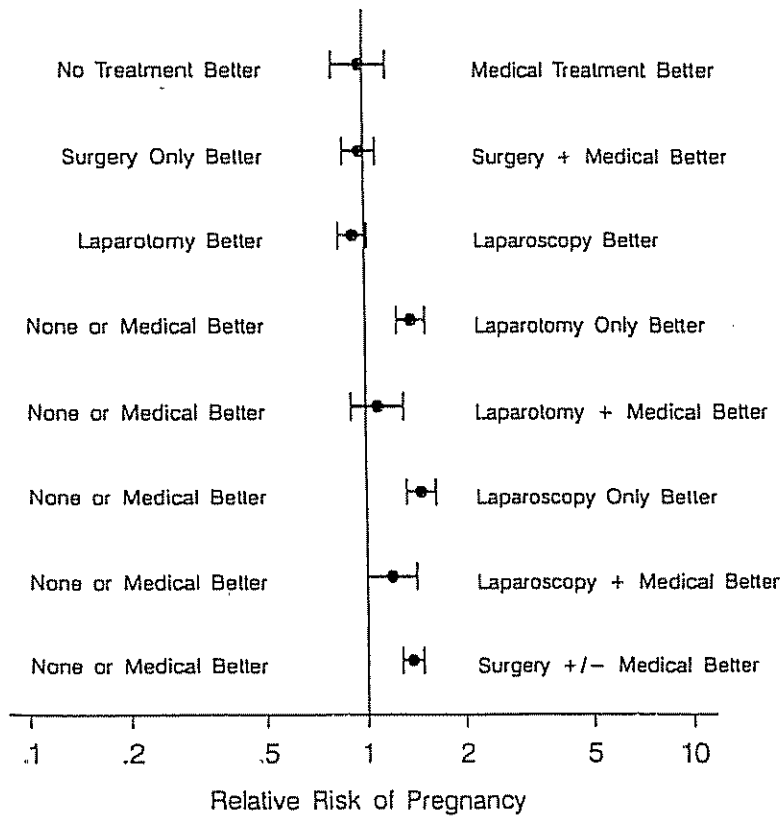
Table 1. LAPAROSCOPIC TREATMENT OF ENDOMETRIOSIS FOR INFERTILITY VERSUS OTHER TREATMENT MODALITIES

Treatment Comparison	Entire Patient Population N = 579		Endometriosis-only Subset* N = 258	
	Increased Pregnancy Rate When Treated Laparoscopically (%)	P Value	Increased Pregnancy Rate When Treated Laparoscopically	P Value
Laparoscopy vs. no treatment	7	0.83	-14	0.64
Laparoscopy vs. medical treatment†	42	0.088	101	0.007
Laparoscopy vs. laparotomy	29	0.13	87	0.031

\* Endometriosis-only subset = At least one fallopian tube and fimbria normal, and normal male factor.

† All patients receiving no treatment or medical treatments had minimal or mild disease.

From Adamson GD, Hurd SJ, Pasta DJ, et al: Laparoscopic endometriosis treatment: Is it better? *Fertil Steril* 59:35, 1993; with permission.



**Figure 1.** Meta-analysis estimates of relative risk of pregnancy (point estimate and 95% confidence interval) for different endometriosis treatment comparisons. (From Adamson GD, Pasta DJ: Surgical treatment of endometriosis-associated infertility: Meta-analysis compared with survival analysis. *Am J Obstet Gynecol* 171:1488, 1994; with permission.)

rently the only definite test for endometriosis is diagnostic laparoscopy. Biopsy of lesions may sometimes be necessary to confirm the diagnosis of endometriosis and should always be performed if the surgeon is uncertain of the diagnosis.

It has been estimated that the diagnosis of endometriosis at the time of surgery has been missed in more than 7% of patients, and the extent of disease has been underestimated in as many as 50% of patients.<sup>74</sup> Subtle lesions can be missed even by experienced surgeons.<sup>63, 107</sup> Other lesions, such as old suture, ovarian cancer, carbon deposits from prior laser surgery, and hemangiomas, may resemble endometriosis.<sup>55, 75</sup> The surgeon must recognize the classic "powder burn" or "blueberry" lesion, white scar tissue that may be older, less endocrinologically active disease, clear or slightly brown papillary lesions, or "strawberry" or

flamelike lesions of recently developed, highly active endometriosis. Peritoneal pockets may also be associated with endometriosis.<sup>30</sup>

A thorough and systematic examination of the pelvis and abdomen under direct vision at the beginning of surgery is essential in all patients to identify and document all endometriotic lesions.<sup>55, 89, 107</sup> A probe should be used to palpate carefully all surfaces to determine depth of invasion. Contraction and scarring can be identified by tethering of the surrounding tissue to nonpliable tissue. All areas to be treated should be identified for subsequent treatment. Biopsy of peritoneum with frozen section may be helpful in confirming the diagnosis and determining optimal treatment. Findings should be recorded carefully even though current staging systems do not always accurately predict postoperative pain relief or pregnancy rate.<sup>10, 17, 34, 82</sup>

The choice of therapy can also be determined at the time of diagnostic laparoscopy. When appropriate, operative laparoscopy enables treatment to be initiated and possibly completed at the same time. Medical and surgical treatment modalities sometimes have the same results, but surgical treatment completed at the time of diagnosis has a distinct advantage over medical therapy because of decreased time, cost, and side effects.<sup>11, 67, 122</sup> The patient can also be spared a second operation (laparotomy) if operative laparoscopy can be performed at the time of diagnosis.<sup>27</sup> However, it is more important that the patient receive the best procedure possible in the particular surgeon's hands, rather than her being compromised by a poor operation's being performed at laparoscopy.

## VISUALIZATION

Careful systematic initial evaluation of the pelvis and abdominal cavity is mandatory prior to performing surgical resection of endometriosis. Important anatomic landmarks and structures need to be identified; these include the ureters, uterine vessels, uterosacral ligaments, infundibulopelvic ligaments, external iliac vessels, bowel, bladder, fallopian tubes, ovaries, and uterus. The surgeon should appreciate the normal and abnormal anatomy and areas of greatest surgical risk. The type and degree of endometriosis should be determined and optimal surgical approach decided on. Potential increased equipment needs for the operation can be given to the circulating staff who can then anticipate the surgeon's requirements. Additional puncture sites should be placed as soon as the surgeon thinks they may be necessary. Having adequate puncture sites is critical to the success of operative laparoscopy. For treatment of advanced endometriosis, three lower quadrant incisions are often appropriate.

Laparoscopic visualization of the pelvis under direct vision without the camera at the beginning and end of surgery will facilitate diagnosis of subtle disease, such as various types of endometriotic lesions, and confirm their removal. The laparoscope magnifies tissue, so that when

the laparoscope is about 1 cm from the tissue, the magnification is approximately six times, at 2 cm four times, at 3 cm two times, and at 4 cm no magnification. At greater than 4 cm, demagnification or the appearance of a smaller structure appears through the laparoscope. As magnification increases, visualization is improved in the observed area, but the overall perspective of the surgical field is decreased. The six-to-eight times magnification provided by the laparoscope when proximal to lesions may be particularly important for diagnosis of the multiple morphologic presentations of endometriosis, for operating on the bowel, ureter, or vessels; or for salpingolysis, ovariolysis, fimbrioplasty, and salpingostomy.<sup>4, 74, 89</sup> Although magnification is not as great as that provided by the operating microscope, this is probably only a limiting factor in performing tubal reanastomosis and possibly fimbrioplasty. The laparoscope's angle of view of the pelvis affords superior visualization in the cul-de-sac, under the ovaries, and in the upper abdomen relative to laparotomy. A very high level of operative precision can be attained because of this improved visualization, and this can be enhanced by palpation with instruments to ascertain tissue consistency. Contemporary laparoscopes, light sources, and video equipment afford an excellent view of the pelvis for the surgeon, operative assistants, and other operating room personnel.<sup>76</sup>

Operative laparoscopy has associated with it some unique disadvantages and complications not associated with laparotomy. The laparoscopic view is two-dimensional rather than three-dimensional as in laparotomy, and the resolution of the video monitor is not as good as direct vision at laparotomy. The surgeon must control the surgical field almost entirely through the two-dimensional video monitor, a more difficult process than laparotomy. Coordination of intraoperative movements with the assistant surgeon is also more difficult. Fatigue can occur more easily because of the need to view the monitor in one place at all times.<sup>2</sup>

## PRINCIPLES OF SURGICAL TECHNIQUES

Surgical techniques attempt to maximize exposure, minimize trauma, and produce the desired result in the minimum amount of time. Hemostasis must be carefully maintained at all times, and the appropriate instruments freely used in the different sites as necessary. Irrigation and aspiration can assist significantly in good visualization and in the maintenance of a clean surgical field. Irrigation fluid should be physiologic, such as Ringer's lactate solution. Irrigation with nonelectrolytic solutions, such as glycine, through the coagulating instruments greatly facilitates identification and coagulation of vessels because the blood can be irrigated away while it is coagulating.

The most important principle in surgical treatment of endometriosis is control of the surgical field. This requires good visualization of all the pelvic structures and awareness of all anatomic structures and normal

tissue, as well as the location and extent of diseased tissue. For increased-risk procedures, it is necessary to evaluate whether the benefit of the procedure outweighs the risk. For some surgeons this may occur relatively frequently, and therefore alternative methods of treatment should be carried out in such situations. It is important to recognize that at operative laparoscopy the surgeon is working without binocular vision and also with a camera that is placed at a distance from the surgical field. In addition, instruments rather than hands are being used to grasp. Laser energy effects have to be appreciated in advance on a theoretic basis and are not directly related to usual surgical senses. Therefore, the apparent control of the surgical field is less than one has at laparotomy, although the actual degree of control can be maximized significantly with surgical experience.

#### TISSUE TRAUMA AND ADHESION FORMATION

Operative laparoscopy offers several advantages to laparotomy with respect to surgical tissue trauma. The abdominal cavity is not open to the drying air of the operating room, preserving tissue integrity. (This is especially true when copious irrigation is performed throughout the procedure.) The tissue also is not cooled by room air at laparoscopy, further reducing tissue trauma; however, at laparoscopy tissue can be cooled by CO<sub>2</sub> gas at room temperature if constant irrigation is not implemented. Tissue is not exposed to foreign bodies such as talc from gloves. Most importantly, under ideal circumstances, tissue is not grasped, squeezed, or abraded by handling and packing off of the bowel as occurs during laparotomy, which maintains serosal integrity and probably reduces the risk of *de novo* adhesion formation. These advantages are especially pronounced when treating disease that is difficult to visualize at laparotomy, such as under the ovaries and deep in the cul-de-sac. Although palpation of structures can be performed with instruments, tactile sense is less than at laparotomy.

Operative laparoscopy may produce superior results to laparotomy with respect to the reformation of adhesions removed at the initial surgery, but this has not yet been conclusively demonstrated.<sup>85</sup> Studies strongly suggest, however, that *de novo* adhesion formation is less common after operative laparoscopy compared with laparotomy.<sup>39, 45, 85</sup> The apparent reduced *de novo* adhesion formation may be due to reduced tissue trauma or to a reduction in oozing from small vessels immediately after surgical injury owing to the increased intra-abdominal pressure created by the pneumoperitoneum. Earlier ambulation and absence of packing off the bowel theoretically could result in less ileus and subsequent mechanical disruption of early-forming adhesions by bowel peristalsis. Perhaps the single most important preventive measure is meticulous surgical technique at the initial procedure.<sup>50</sup> Second-look laparoscopy remains the primary method of diagnosing and treating reformed or *de novo* adhesions.<sup>29, 54</sup>

## SURGICAL EXPERIENCE

As mentioned previously, laparoscopic treatment of endometriosis requires a surgeon who is familiar with the pathophysiology of endometriosis and possible therapeutic options, including no treatment, medical therapy, laparotomy, or laparoscopic surgery, and who can integrate this knowledge with surgical judgment and technique (Table 2).

Initially, didactic and hands-on experience through residency and fellowship training, courses, preceptorships, and assisting in the operating room are needed. Each surgeon then must acquire laparoscopic experience in treating minimal, mild, and moderate endometriosis before advancing to more complex procedures. Surgeons must have a comprehensive understanding of normal and diseased pelvic anatomy; different surgical techniques; and the principles and application of mechanical, electrosurgical, and laser energy. Surgeons need to develop hand-eye coordination working from a video monitor with different instruments. Most important, each surgeon must develop an appreciation of the limitations of operative laparoscopy in his or her hands because surgical procedures are usually more complex and difficult to perform at laparoscopy than at laparotomy.<sup>2</sup>

## FACILITIES, PERSONNEL, AND EQUIPMENT FOR LAPAROSCOPIC SURGERY

Several principles about the setting for laparoscopic treatment of endometriosis can be stated. Laparoscopic technology has increased dramatically in the past few years. The facility must have an adequate-sized operating room for the equipment, and adequate time for perfor-

Table 2. SURGICAL PRINCIPLES IN THE TREATMENT OF ENDOMETRIOSIS

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Knowledge of disease and treatment modalities
Experienced surgeon
Adequate facilities, personnel, and equipment
Appropriate patient selection
Informed consent
Proper patient position
Careful pelvic evaluation
Maximum exposure
Use of magnification
Minimum tissue trauma
Excellent hemostasis
Removal of all diseased tissue
Avoidance of foreign body material
Confirmation of tissue pathology

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From Adamson GD: Laparoscopic treatment of endometriosis. In Adamson GD, Martin DC (eds): Endoscopic Management of Gynecologic Disease. Philadelphia, Lippincott-Raven, 1996, p 152; with permission.

mance of the operation. Backup support, such as the ability to perform a laparotomy, provide blood transfusion, or transfer the patient to an acute care hospital from an ambulatory care facility, is mandatory.

Trained and motivated personnel, preferably who have worked together with the surgeon, are important for more complex cases. An anesthesiologist familiar with laparoscopic anesthesia also is required. More complex cases can almost always be performed faster, better, and more safely with an assistant surgeon, preferably one who is also an experienced laparoscopist and who has worked with the surgeon. Facilities for frozen-section tissue diagnosis also should be available.

Necessary equipment includes an operative laparoscope with good optics, a high-resolution video camera with appropriate light source, and at least one (preferably two) high-resolution video monitors. Other equipment includes a hand-operated irrigation and aspiration system; high-flow automatic regulating CO<sub>2</sub> insufflator; and 5-mm instruments for probing, grasping, cutting, unipolar and bipolar coagulating, irrigating, hydrodissecting, needle aspirating, ligating, suturing, and stapling. It is generally preferable to have the instruments mostly 5 mm so that they can be moved from one puncture site to another during the operation; however, several techniques require (or are easier with) 10- to 12-mm instruments, including CO<sub>2</sub> gas recirculators (Sun Medical, Arlington, TX), scissors, sutures, graspers, morcellators, staplers, and plastic bags for tissue removal. Adapters to reduce a 10- to 12-mm sheath opening to 5-mm increase the versatility of the larger ports. Instruments to perform open laparoscopy, minilaparotomy, and colpotomy also should be available. Rectal probes, ring forceps for the vagina, Valtchev retractor, and Foley catheters for rectal injection of dilute povidone-iodine (Betadine) solution or for occluding the vagina are sometimes needed when bowel endometriosis is being treated. Indigo carmine for intravenous injection when ureteral or bladder injury is suspected should also be available. Sterile milk can be used to test the small bowel for perforations.

The choice of energy source used to perform surgery depends primarily on the surgeon. The CO<sub>2</sub> laser has the advantage of being very precise and not causing thermal injury away from the site of impact. The new Ultrapulse laser (Coherent, Palo Alto, CA) also provides very high power, which allows faster dissection and the ability to vary the amount of power and the amount of coagulating effect. This laser is therefore very desirable for precise work around the bowel, ureter, and other critical structures. Some surgeons prefer the neodymium:yttrium-aluminum-garnet (Nd:YAG), argon, or potassium deuterium phosphate (KTP532) lasers because of the ability to use fibers and their coagulating effect.<sup>40</sup> This coagulating effect would seem to be much less desirable when performing more precise dissection. Many surgeons prefer electro-surgery because of their familiarity with it and its easy availability; however, a major difficulty with unipolar electro-surgery is the risk of injury to other organs from unrecognized electrical energy burns. Some surgeons prefer scissors dissection, which is widely available but can be fairly hemorrhagic. A common difficulty with scissors is that they do

not cut well, although this has been overcome with the use of disposable instruments; these can be very expensive, however.<sup>57</sup> Several innovative instruments for stapling, suturing, and bowel anastomosis currently are available only as disposable instruments, but their cost is sometimes justified by the benefits provided to the patient through their use.

### LAPAROSCOPIC ABDOMINAL APPROACHES AND PATIENT POSITION

The patient undergoing endometriosis surgery who is at risk for moderate, severe, or bowel disease requires an empty bowel and bladder, as well as an empty stomach, at the time of surgery. The patient's history should be evaluated for indications for open laparoscopy, which could include previous laparotomy with complications, abdominal adhesions, previous bowel disease or peritonitis, colostomy, obesity, pelvic kidney, or metastatic disease. A few gynecologists prefer routine use of open laparoscopy because of theoretically increased safety of the procedure; however, open laparoscopy does increase the time required to enter the abdominal cavity and can hinder mobility of the laparoscopic sheath. Alternatives include new transparent trocars, with cutting blades that function under direct vision. Pneumoperitoneum can be created in the upper abdominal midaxillary lines, suprapubically, or through the posterior vaginal fornix in selected patients. Direct trocar insertion also may be an appropriate technique in some circumstances.

At laparoscopy the patient is placed in a modified lithotomy position with her arm at her side on the side at which the surgeon stands. The other arm may be extended if carefully supported in the appropriate position. Trendelenburg position will help to move the bowel out of the pelvis after the Veress needle and pneumoperitoneum have been established. The legs need to be well supported and padded, and, if supported under the knees, mobilized approximately every 2 hours to help prevent nerve compression injury.

### LAPAROSCOPIC TREATMENT OF ENDOMETRIOSIS LESIONS

#### Treatment of Peritoneal Disease

The first step in treating peritoneal lesions is to obtain adequate visualization. Mobilization of the uterus may be assisted by using weights on a cervical tenaculum attached to an intracervical device, as well as with transabdominal probes. Anterior cul-de-sac treatment must be accompanied by continuous bladder drainage, and posterior cul-de-sac treatment requires adequate mobilization of the ovaries and bowel by transabdominal instruments, including probes, fans, and graspers, and use of the Trendelenburg position.

Treatment of peritoneal lesions can be by sharp resection with scissors, although this may be hemorrhagic. Destruction by unipolar electrosurgery carries the risk of damage to deeper structures unless fine-needle tips are used. Microbipolar electrosurgery can destroy small lesions effectively, as can fiber laser energy; endocoagulation and fulguration can destroy superficial lesions. The extent of destruction cannot be determined precisely with these thermal but nonvaporizing modalities, however, resulting in potentially inadequate treatment, overtreatment, or risk of injury to contiguous structures.

With the CO<sub>2</sub> laser the endometriotic lesion can be vaporized or resected with precision. A continuous wave, superpulse, or ultrapulse wave form can be used. The laser settings depend on the type of laser, type of wave form, spot size, surgeon's skill, and risk of injury to contiguous structures. *Hydrodissection*, which involves the injection of irrigating fluid under the peritoneum or other structures, can help to protect deeper structures from injury by the CO<sub>2</sub> laser beam and also allow higher-power settings and faster dissection to be performed safely. Hydrodissection does not protect against injury when fiber lasers such as argon, KTP532, or Nd:YAG are used because the energy from these lasers will pass through fluid.

Hydrodissection may also allow easier identification of tissue planes. A small hole is initially made in the peritoneum, through which irrigating fluid is injected under high pressure. The next step after hydrodissection is to circumscribe the lesion with the laser beam, scissors, or electrosurgical instrument. With the CO<sub>2</sub> laser the depth of penetration can be controlled by pulsing the beam with the foot pedal to vary the amount of energy delivered to the tissue. This circumscription ensures that all of the diseased tissue will be removed and that only healthy tissue will be at the edges of the treated region. Smaller lesions can then be completely vaporized inside the circumscribed area; larger lesions can be removed faster and more cleanly by sharp resection of the entire peritoneum. At least one and sometimes two graspers can be used to elevate the edge of the peritoneum from the subperitoneal tissues, thereby identifying a plane for dissection. Both standard and micrograspers or alligator graspers can be used.

When endometriosis is deeply invasive over the ureter or broad ligament vessels, planes may be difficult or impossible to identify, and the surgeon must dissect extremely carefully. Hydrodissection, although frequently helpful, often does not create a clear plane when endometriosis invasion is severe. In addition, traction on the peritoneum can cause underlying structures, such as ureter or blood vessels, to be elevated toward the area of dissection. Lower power density for continuous wave or energy density per pulsed wave, and greater caution, should be exercised when one is performing such dissection. Short pulses of laser or electrical energy can be delivered by the foot pedal, or small bites can be taken with scissors. When normal anatomy is difficult to identify, a helpful approach is to begin dissection away from the lesion at a point where normal anatomy can be ascertained. Sometimes it is useful to

identify the ureter and vessels at the pelvic brim and dissect inferiorly, with the ureter under direct vision. Areas of greatest risk while performing peritoneal vaporization and resection include the ureters throughout their course, the internal iliac vein near its bifurcation, the external iliac vessels, the superior aspect of the broad ligaments just beneath the ovary, and the cardinal ligament, where the ureter and vessels have changing anatomic relationships. The goal is always to remove all diseased tissue. Both visual inspection and palpation with instruments help to confirm that only healthy, pliable, nonindurated tissue is left in the bed of the resection.

Adhesiolysis should be performed using a titanium rod as backstop if possible, using hydrodissection of deeper tissues when not possible, or very carefully using short pulses of energy when neither technique is feasible because of dense adhesions. Traction should be obtained through use of probes to improve visualization. Whenever possible, graspers should be used only on tissue that is to be removed, to minimize tissue injury to structures that are not being removed. When graspers are used on tissue that is not going to be resected, the tissue least vulnerable to forming adhesions, or having its function reduced because of subsequent adhesion formation, should be grasped.

After all the endometriosis has been resected and hemostasis obtained, the patient should be placed in reverse Trendelenburg position to allow any fluid in the upper abdomen to flow into the pelvis where it can be evacuated. Then, the pneumoperitoneum should be evacuated so that the intra-abdominal gas pressure is zero. This allows "bleeders" that may have been tamponaded by the pneumoperitoneum to bleed. After 3 minutes, the pneumoperitoneum should be reestablished and bleeding vessels identified and coagulated before terminating the operation. The identification of bleeding vessels is facilitated by placing fluid in the cul-de-sac and looking for "trailers" of blood in the fluid from bleeding vessels.

Evaluation of results of treatment of peritoneal disease is difficult because published studies do not address this aspect of surgical treatment directly, and the studies suffer from methodologic weaknesses.<sup>45</sup> Recent review of laparoscopic treatment of endometriosis reported pregnancy rates for minimal and mild disease after laparoscopic electrocoagulation of 64% and 52%, respectively.<sup>32</sup> Treatment with CO<sub>2</sub> laser vaporization was reported to result in a 59% pregnancy rate for minimal and 58% for mild disease.<sup>32</sup> The author's experience is reflected in Table 3.<sup>11</sup> It is not known whether patients with extensive or invasive peritoneal disease alone will have pregnancy rates higher or lower than those reported in these studies.

The amount of pelvic pain reduction after peritoneal disease resection is even more difficult to evaluate because of the additional problem of quantifying pain and isolating its causes. One study reported a 41% total relief of pain, 35% partial, and 24% failure rate overall. The nature and location of lesions and the grading scale were not reported, however.<sup>28</sup> Another study reported 67% of patients were pain free.<sup>108</sup> Pain

Table 3. ESTIMATED CUMULATIVE LIFE-TABLE: PREGNANCY RATES BY STAGE OF ENDOMETRIOSIS

	Entire Patient Population						Endometriosis-Only Subset*					
	No.	Pregnant in 3 Years	Percent Pregnant			No.	Pregnant in 3 Years	Percent Pregnant				
			1 Year	2 Years	3 Years			1 Year	2 Years	3 Years		
All	579	274	36.9 ± 2.2	53.6 ± 2.4	61.7 ± 2.6	258	130	39.7 ± 3.3	57.4 ± 3.6	65.8 ± 3.8		
Minimal	161	91	49.8 ± 4.3	64.9 ± 4.5	73.7 ± 4.6	91	49	44.8 ± 5.7	61.2 ± 6.0	70.5 ± 6.1		
Mild	185	89	38.0 ± 3.8	55.6 ± 4.3	62.3 ± 4.6	101	49	40.9 ± 5.2	54.9 ± 5.7	63.1 ± 6.4		
Moderate	142	63	31.1 ± 4.2	50.5 ± 4.9	57.4 ± 5.1	49	26	35.6 ± 7.5	60.3 ± 8.3	71.1 ± 8.1		
Severe	91	31	22.0 ± 4.6	35.8 ± 5.9	46.7 ± 6.6	17	6	18.6 ± 9.7	42.6 ± 13.6	42.6 ± 13.6		
All Minimal/Mild	346	180	43.4 ± 2.3	59.8 ± 3.1	67.7 ± 3.3	192	98	42.7 ± 3.9	58.0 ± 4.2	66.8 ± 4.4		
All Moderate/ Severe	233	94	27.5 ± 3.1	44.7 ± 3.8	53.2 ± 4.0	66	32	30.9 ± 6.1	55.4 ± 7.2	63.2 ± 7.2		

\* Endometriosis-only subset = At least one fallopian tube and fimbria normal, and normal male factor.  
From Adamson GD, Hurd SJ, Pasia DJ, et al: Laparoscopic endometriosis treatment: is it better? Fertil Steril 55:35, 1993; with permission.

symptomatology appears to be related to the dimension of invasive endometriotic lesions.<sup>99</sup> Sutton has reported a prospective randomized trial of laser laparoscopy in the treatment of pelvic pain associated with endometriosis that showed 62.5% improved at 6 months in the treated group compared with 22.6% in the control group.<sup>109</sup>

It is not yet clear what the effect will be of the increasing trend to resect all disease completely rather than treat it simply by coagulation, fulguration, or laser without resection.<sup>64</sup> In a recent study, 61% of patients had clinically recognized lesions penetrating deeper than 2 mm, 43% had lesions penetrating deeper than 3 mm, and 25% had lesions penetrating deeper than 5 mm. The deepest lesion was 15 mm. Coagulation or laser vaporization to 5 mm would have missed endometriotic lesions in one quarter of the patients.<sup>73</sup> Another study confirmed the frequent presence of deep lesions, which were active 68% of the time. Deep lesions infiltrated through loose connective tissue septa into the fibromuscular tissue and always stopped at the underlying fat tissue. Very deep implants (> 10 mm) were found exclusively in patients with pain, whereas superficial implants were found most frequently in patients with infertility (83%).<sup>33</sup> The results of these studies suggest that the most precise energy source available, namely, the CO<sub>2</sub> laser, should have some advantages in the performance of complete resection and vaporization of peritoneal lesions. Good surgical technique should enable the surgeon to effect adequate and safe resection with other energy sources, however.

### Treatment of Noncystic Ovarian Endometriosis

The ovary frequently has superficial lesions similar to those on the peritoneum or invasive endometriosis lesions less than 1 cm in diameter and not classically defined as endometriomas. These superficial lesions should be vaporized or coagulated with the minimal amount of thermal injury created in the surrounding ovary because adhesions form easily following ovarian injury. Intermittent pulsing of the laser beam by using the foot pedal can facilitate this technique. Care should be taken not to create serious thermal injury near the fimbria or fimbria ovarica because this may compromise distal tubal mobility or function. Power density of laser or electrosurgery should be reduced if necessary to minimize thermal injury. Deeper lesions should be completely resected or vaporized using appropriate meticulous technique to minimize ovarian injury. All suspicious lesions should be evaluated to ensure that all endometriosis is ablated, especially deeper, noncystic lesions, which must be completely extirpated. Injury to the vascular supply of the ovary should be avoided. It is always necessary to elevate the ovary to visualize the lateral surface lying against the upper surface of the broad ligament. Inability to elevate the ovary almost always implies that adhesions or endometriosis lesions are under the ovary. Such disease should be

treated by vaporization, resection, or coagulation until all disease is removed and complete mobilization of the ovary is possible.

### Cul-de-Sac and Rectovaginal Dissection

An area where some of the deepest invasion and most difficult dissection may occur is the posterior cul-de-sac and rectovaginal septum. Here, active endometriosis can be found deep in the fibromuscular tissue.<sup>33, 63</sup> Such disease can cause both pain and infertility. Peritoneal pockets may sometimes be caused by invasive endometriosis and should be resected in patients with pelvic pain. These pockets may be deeper than initially appreciated, and dissection should be performed carefully with copious hydrodissection to avoid injury to deeper structures. Martin pioneered the use of excisional techniques for endometriosis resection and first reported on the laparoscopic approach to infiltrating cul-de-sac endometriosis.<sup>72</sup> As experience was gained, more of the procedure was performed laparoscopically rather than vaginally. Two of seven patients had deep sigmoid colon lesions requiring laparotomy for focal colon excision and repair.<sup>98</sup> Redwine also reported new techniques for laparoscopic *en-bloc* resection of obliterated cul-de-sac endometriosis.<sup>92</sup> Reich et al reported on 100 patients with partial or complete cul-de-sac obliteration secondary to deep fibrotic endometriosis and described their technique in detail.<sup>98</sup> These techniques and this author's are similar, first circumscribing the entire lesion, then freeing the anterior rectum from the uterus and loose areolar tissue of the rectovaginal septum. The visible and palpable deep fibrotic endometriosis on the bowel is then vaporized or excised, working from the perimeter with healthy tissue towards the endometriotic lesion. Use of a sponge on a ring forceps inserted into the posterior vaginal fornix, placement of a rectal probe, use of a Valtchev retractor for anteversion of the uterus, and frequent intraoperative rectovaginal examinations help to determine pelvic anatomy. Blunt dissection is carried out with scissors, electrosurgery, or laser, with copious use of aquadissection (hydrodissection) helping to identify tissue planes and perform dissection. Lesions extending through the posterior vaginal wall can be dissected *en bloc* with a 30-mL Foley bag in the vagina to maintain the pneumoperitoneum. The vagina can be closed vaginally or laparoscopically. Deep rectal muscularis defects can be closed with 2-0 suture. Reich sometimes plicates the uterosacral ligaments and lateral rectal peritoneum across the midline to re-peritonealize the anterior rectum. If there is any question regarding bowel integrity, a 30-mL Foley catheter can be passed per rectum, the rectosigmoid compressed with a laparoscopic bowel clamp above the site of dissection, and a dilute solution of Betadine injected while the pelvis is filled with irrigating solution. Reich reported an average operating time of 3 hours, with one case lasting 8 hours.

Pregnancy was achieved in 34 of 46 infertile couples (74%).<sup>98</sup> Of the women who conceived, 13 of 34 (38%) had more than one laparoscopy.

Five of six women who underwent three laparoscopies conceived. Of women with pelvic pain, 41 of 46 (89%) had significant relief 6 months after laparoscopy. Complications included anemia in two patients, corneal abrasion in one, and transient unilateral brachial plexus injury in one. A complete 3-day bowel preparation with soft diet, fluid diet, or clear liquid diet (Golytely or Colyte) is mandatory for mechanical cleansing of the bowel before attempting this type of dissection. Reich emphasized the need to remove all evident endometriosis, or at least as much as possible, and the desirability of avoiding bowel resection, a potentially morbid procedure. The author has compared laparoscopy versus laparotomy for treatment of complete endometriotic posterior cul-de-sac obliteration.<sup>12</sup> In a series of 27 patients with extensive disease and infertility, life-table pregnancy rates were 29.6% at 1 and 2 years in 11 patients treated laparoscopically, compared with 0% at 1 year, and 23.7% at 2 years in 16 patients treated at laparotomy (Table 4). No serious complications occurred in the author's reported series or subsequent cases to date involving cul-de-sac and rectovaginal dissection, including those in which the bowel has been sutured following enterostomy. No patients have required transfusion, management in intensive care, or reoperation. One patient was readmitted for 24 hours for intravenous antibiotics because of suspected infection. Thorough informed consent, adequate bowel preparation, and surgical skill and experience are mandatory before such operations should be attempted because they can be technically demanding.<sup>7</sup> The literature results support the conclusion that laparoscopic treatment of advanced endometriosis requiring cul-de-sac and rectovaginal dissection can provide satisfactory results equivalent to those obtained at laparotomy when performed by experienced endoscopists.<sup>12, 72, 78, 92, 98</sup> All of the surgeons reporting on this technique emphasize the need for complete resection of the diseased tissue.

### Resection of Invasive Bowel Endometriosis

Superficial and mildly invasive large bowel endometriosis lesions can be treated effectively and safely with the CO<sub>2</sub> laser because of its great precision. Use of other energy sources for more than superficial

**Table 4. COMPLETE ENDOMETRIOTIC POSTERIOR CUL-DE-SAC OBLITERATION: ESTIMATED LIFE-TABLE PREGNANCY RATES**

Percent Pregnant	Laparoscopy	Laparotomy
1 year	29.6 ± 14.4	0 ± 0.0
2 years	29.6 ± 14.4	23.7 ± 12.2

*P* = 0.084 (Breslow statistic)

From Adamson GD, Hurd SJ, Rodriguez BD, et al: Laparoscopy versus laparotomy for treatment of posterior cul-de-sac obliteration [abstract]. American Association of Gynecologic Laparoscopists, Chicago, IL, September 24-27, 1992; with permission

lesions carries a high risk of unrecognized transmural thermal injury with subsequent bowel perforation. Only superficial small bowel lesions should be treated unless the surgeon is prepared to perform laparoscopic resection and repair. The potential catastrophic consequences of unrecognized transmural bowel injury mandate such a cautious approach.

Aggressive surgical management of advanced colorectal endometriosis has been shown to be effective and safe when performed at laparotomy.<sup>19</sup> Martin reported in 1988 on two patients who required focal colon excision and repair at laparotomy as a result of significant endometriotic bowel lesions found at the time of laparoscopic treatment of invasive cul-de-sac disease.<sup>72</sup> It is increasingly possible to resect endometriotic nodules infiltrating the anterior rectus muscularis, however.<sup>98</sup> An assistant's finger in the rectum can help with dissection. Repair can be performed laparoscopically with suture when the rectal lumen is not entered; when it is entered, the bowel should be repaired in two layers in the usual fashion. If the hole in the rectum is low and the vagina has also been entered, transvaginal closure also may be performed, assuming, of course, that a complete mechanical bowel preparation has been performed before surgery. In some cases, a single suture layer of 2-0 Vicryl (or similar suture) with large bites may be appropriate.

Recently, cases have been reported of complete bowel resection of severe endometriosis and reanastomosis performed endoscopically using suture or staplers.<sup>88, 94</sup> These procedures have been performed by or with the assistance of general surgeons. Problems with misfiring of the stapling instrument, requirement for laparotomy, anastomosis failure with resultant morbidity, and long-term sequelae requiring permanent colostomy mandate that this procedure still be considered investigational unless traditional abdominal general surgical techniques are duplicated at the laparoscopy. Technologic advances and increased clinical experience undoubtedly will ensure that laparoscopic bowel resection and reanastomosis will become a commonly performed procedure for rectosigmoid endometriotic disease. Resection and repair of small or large bowel endometriotic lesions higher in the gastrointestinal tract will also become more amenable to laparoscopic treatment, as more gynecologists and general surgeons become familiar with performing these procedures in a routine fashion endoscopically rather than at laparotomy. When considering surgical treatment of bowel lesions, gynecologists should consider their own expertise and consult general surgeons and gastroenterologists preoperatively and intraoperatively as dictated by the patient's best interests.

### Appendectomy

Many gynecologists perform appendectomy for benign conditions, including appendiceal endometriosis. The role of incidental appendectomy in the routine gynecology patient without appendiceal disease is

more controversial, and few reproductive surgeons recommend incidental appendectomy in the infertility patient. Appendectomy can be performed safely and quickly at laparoscopy using automatic stapling devices,<sup>35</sup> although a more traditional approach also can be used. The appendix is grasped at its tip and bipolar electrocautery, clips, or suture used to obtain hemostasis before cutting the appendiceal vessels at the base of the appendix. Care must be exercised not to injure the cecum. Two endoloops are then placed at the base of the appendix on top of each other, and a third 5 mm distally. A grasper or endoloop can then be placed at the appendiceal tip, the appendix transected between the ligatures, and removed. Microbipolar electrocautery carefully applied to the residual stump will sterilize the raw surface; the stump need not be buried. Routine postappendectomy care should be provided. Results have been reported to be equivalent to those at laparotomy.<sup>79</sup>

### Ovarian Endometriectomy

Laparoscopic treatment of ovarian endometriomas has been controversial because of concern that diagnosis of an ovarian cancer could be missed, that contamination of the pelvis with an ovarian cancer could result in reduced survival, and that unnecessary laparoscopic surgery might be performed in a cancer patient needing laparotomy.<sup>18, 112</sup> This issue was highlighted by a questionnaire review that collected 42 cases of ovarian masses treated laparoscopically that were eventually determined to be malignant.<sup>69</sup> Capsule rupture and delay of treatment raised concern about the appropriateness of the laparoscopic approach to adnexal masses. Although delay of treatment can be avoided, capsule rupture will inevitably occur in at least some patients who have an ovarian malignancy treated laparoscopically. Whether such rupture affects prognosis is actively debated.<sup>38, 117</sup> A set of guidelines for laparoscopic surgery in the management of ovarian cysts has recently been presented by a group of gynecologic oncologists, reproductive endocrinologists, and ultrasonographers.<sup>104</sup> These are summarized in Table 5. Ultrasonography may be the most helpful technique.<sup>70, 80</sup> It should be noted that CA-125 is neither very sensitive nor specific and is most useful as a marker of disease progression. Additional studies that some consider helpful include MRI or CT scan, carcinoembryonic antigen, needle aspiration for cytology, and ovarian cystoscopy and biopsy; however, such diagnostic procedures are not infallible.<sup>71</sup> The patient should be informed that the risk of an ovarian neoplasm being malignant increases with age from 8% at less than 20 years, to 35% at ages 40 through 49 years, with the risk of low malignant potential neoplasms being 0% and 6%, respectively.<sup>65</sup> Other problems with laparoscopic ovarian cystectomy include possible sequelae such as adhesions or seeding from dermoid cysts, or mucinous cystadenomas.

Most adnexal masses are not malignant, however. Many experienced laparoscopists therefore believe that, by following careful guide-

**Table 5. GUIDELINES FOR LAPAROSCOPIC SURGERY IN THE MANAGEMENT OF OVARIAN CYSTS**


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<b>History</b>
Differential diagnosis
Cancer (personal and family)
<b>Physical Examination</b>
Size, consistency, fixation
<b>Ultrasonography</b>
Size, unilocular, unilateral, completely cystic, smooth border, peritoneal fluid
<b>Tumor Markers</b>
CA-125, alpha-fetoprotein, HCG
<b>Informed Consent</b>
<b>Intraoperative</b>
Peritoneal washings
Exploration of all peritoneal surfaces and biopsy as indicated
Exploration of ovarian mass for external excrescences or other suspicious findings
Frozen section
<b>Laparotomy</b>
Immediate for suspicious or confirmed malignant masses
Avoidance of cyst rupture

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*From Adamson GD: Laparoscopic treatment of advanced endometriosis: Infertility. Infertil Reprod Med Clin North Am 4:345, 1993*

lines, they can reduce the risk of unwittingly treating an adnexal malignancy at laparoscopy to one in several hundred patients. Because the actual extent of injury to the patient should a malignancy be opened is controversial, many laparoscopists believe that adnexal masses, and in particular endometriomas, can reasonably be approached laparoscopically.<sup>16, 23, 25, 29, 121</sup> Some surgeons have recommended simple puncture and drainage of endometriomas, but this approach fails approximately one half of the time.<sup>1, 44, 46</sup> A more successful approach involves drainage of the cyst followed by electrosurgical or laser ablation of the cyst wall using argon or Nd:YAG lasers.<sup>61, 62</sup> Brosens has suggested that only the base of the endometrioma must be coagulated or vaporized, resulting in loss of blood supply to the endometriotic cyst wall and its resolution.<sup>25, 26</sup> Others have recommended complete resection of the cyst wall because this can result in less thermal injury to the ovary and greater assurance of complete removal of the endometriotic tissue as well as a pathology specimen.<sup>16, 29, 97</sup> Resection of an endometrioma is performed after it has been drained to reveal the classic "chocolate" material. Copious irrigation and aspiration should be performed to remove all of the endometrioma fluid from the abdominopelvic cavity. Grasping instruments are placed on the ovarian cortex and on the cyst wall to establish a tissue plane. Hydrodissection can be helpful in developing tissue planes, especially in larger endometriomas. Blunt dissection, if possible without

creating bleeding, or sharp dissection can be performed. Traction placed on the cyst wall and ovarian cortex should be gentle to prevent tearing. Copious irrigation and microbipolar coagulation of small bleeding vessels enhances the ease of dissection by improving visualization of the tissue plane. The incision in the cyst wall should be made at the weakest point of the cyst, usually the inferior aspect of the ovary. Dissection should attempt to leave healthy uninjured ovary in apposition to tubal fimbria. The dissection is optimally performed with the cyst in a pouch to ensure that contents of the cyst cannot leak into the pelvic cavity. After resection, the base of the ovary can be vaporized or coagulated if any small fragments of cyst wall remain. Although some surgeons have recommended suture closure of the ovary, most believe this is unnecessary.<sup>121</sup> Use of sutures generally is associated with greater adhesion formation. Should an ovary be widely opened, one or two deep resorbable sutures may help bring the ovarian edges into closer apposition.

For large endometriomas, one possible approach is drainage at laparoscopy followed by 3 months of ovarian suppression with danazol or a GnRH agonist, and a second laparoscopy for cyst wall resection when the endometrioma is smaller, a technique that has the obvious disadvantage of requiring medical treatment and a second operation, with the attendant costs, risks, and side effects, as well as several months longer to complete treatment. This approach also may not be successful.<sup>114</sup> Another suggested approach is a combination laparoscopy and minilaparotomy.<sup>47</sup>

Results of laparoscopic endometrioma treatment for infertility patients have shown 12 of 23 (52%) pregnant and 26 of 52 (50%) pregnant.<sup>97, 121</sup> These authors' prospective cohort study comparing laparoscopy to laparotomy treatment of endometriomata showed an estimated cumulative percent pregnant at 3 years of 52% for the laparoscopy group and 46% for the laparotomy group (Fig. 2).<sup>16</sup> Pregnancy rates were not affected by the size or number of endometriomata. With respect to pain relief, Reich reported 19 of 31 (61%) patients having pain relief, 9 requiring further extirpative operations, and 3 lost to follow-up.<sup>97</sup> Five additional women with hypermenorrhea had relief of symptoms. Ovarian function after conservational surgery appears to be normal.<sup>101</sup> Recurrence occurs in fewer than 10% of resected endometriomas, with de novo adhesion formation in approximately 20% and partial recurrence of dense adhesions in approximately 80%.<sup>29, 121</sup>

### Oophorectomy

Oophorectomy is rarely indicated for treatment of ovarian endometriosis; however, in cases in which multiple operations for endometriomas have already been performed, when pain has not responded to prior therapies, when extensive adhesions have persisted despite prior surgeries, or when the ovary is functionally destroyed, either unilateral

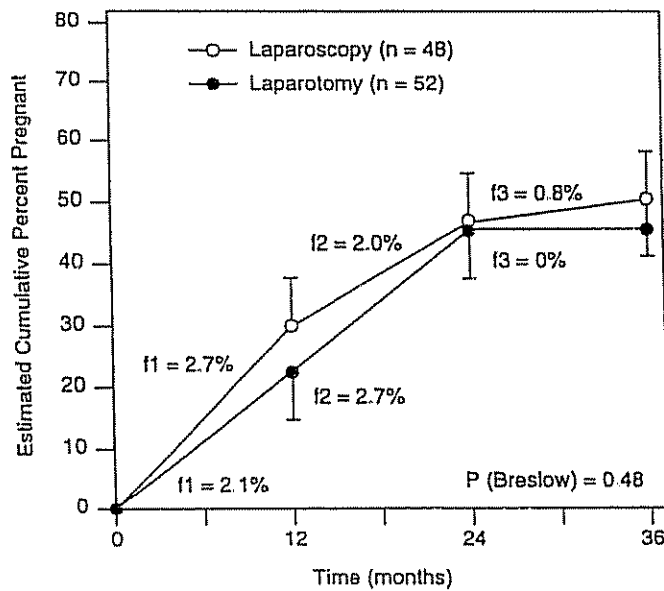


Figure 2. Life-table estimates of cumulative pregnancy rates for CO<sub>2</sub> laser laparoscopy and laparotomy in 12-month intervals after endometrioma resection. Bars indicate standard error. *f* = monthly fecundity for each separate year. (From Adamson GD, Subak LL, Pasta DJ, et al: Comparison of CO<sub>2</sub> laser laparoscopy with laparotomy for treatment of endometriomata. *Fertil Steril* 57(5):965, 1992; with permission.)

or bilateral oophorectomy may be indicated. Complete mobilization of the ovary before removal is necessary. Several methods can be used, including coagulation and incision, endoloop sutures, clips, or a laparoscopic stapling device. Careful identification of the ureter is essential to avoid injury. The ovary can then be morcellated, using a morcellator, scissors, or laser, or brought out through a colpotomy or minilaparotomy incision. Small plastic bags to enclose the ovary can prevent spill of cystic fluid and facilitate removal. Ovarian remnants also can be removed. This surgery can be technically demanding because of extensive adhesions and frequent attachment to the ureter. The fallopian tube can easily be included in the extirpated specimen should this be technically easier and clinically appropriate. Other endometriotic disease should be resected at the time of oophorectomy. Postoperative serum follicle-stimulating hormone (FSH) or estradiol levels can establish that bilateral oophorectomy has removed all the ovarian tissue. This type of surgery must be performed carefully to avoid ovarian remnant syndrome. Fewer than 10% of patients should have ongoing pelvic pain following oophorectomy if patients are appropriately selected and treated by oophorectomy.<sup>91</sup>

### **Tubal Endometriosis Treatment**

Tubal endometriosis is frequently superficial but can also become deeply invasive. In the proximal tube, this may require resection and reanastomosis at laparotomy. More distally, the tube can become grossly distorted and adherent to the ovary, and occasionally obstructed in the ampulla, or distorted in the fimbrial region to create a distal obstruction. Vaporization using power and pulse settings to minimize thermal injury and to control depth of CO<sub>2</sub> laser beam penetration can provide excellent results. Other lasers and mechanical or electrosurgical dissection are not as precise or thorough as the CO<sub>2</sub> laser. Suturing of the tube is rarely required. Results have not been reported, but in the authors' experience appear favorable.

### **Bladder Endometriosis Resection**

The uterovesical fold can have deeply invasive endometriosis because of the presence of fibromuscular tissue and its dependent position.<sup>33</sup> The bladder itself can also have deep lesions. Resection can be performed following circumscription of the lesion with scissors, laser or electrosurgery, copious use of hydrodissection, and sharp resection or vaporization. The bladder can be filled with indigo carmine through the Foley catheter to check for any defects. Partial-thickness defects can be closed with a single layer. Full-thickness defects can then be closed with a standard two-layer closure. Cystoscopy can be performed if necessary. The bladder should be drained with a catheter postoperatively for 7 to 10 days if full-thickness resection has been performed. Care must be taken when dissecting deep lesions laterally not to injure vessels or the ureter. The bladder can be checked postoperatively with an intravenous pyelogram (IVP) or cystoscopy to ensure that appropriate healing has occurred. Successful partial cystectomy has been reported, with subsequent pregnancy.<sup>43</sup> Endometriotic bladder lesions must be differentiated from endocervicosis of the bladder.<sup>31</sup>

### **Ureteral Endometriosis Resection**

Endometriosis is frequently found near the ureter and often causes distortion of its course through the pelvis. Even when endometriosis invasion is extensive and severe, however, only rarely does it actually cause loss of function through kinking or obstruction.<sup>66, 86</sup> In these cases a surgical approach is warranted. Diagnosis is facilitated by preoperative IVP or cystoureteroscopy. Intraoperative intraureteral catheters are preferred by only a few surgeons. Careful dissection using appropriate power setting and energy sources often frees a ureter and allows normal functioning. Ureterolysis should be initiated in an area where normal anatomy is clearly visible, usually around the pelvic brim or just supe-

rior to the uterosacral ligament. The CO<sub>2</sub> laser's precision is particularly useful for this type of dissection and vaporization, using short pulses of laser energy. Complications of ureteral endometriosis resection include pelvic leakage of urine and fistula formation.<sup>106</sup> Ten milliliters of indigo carmine should be injected intravenously and the urinary catheter bag observed for blue dye after approximately 5 to 10 minutes. The ureter should then be carefully evaluated for evidence of perforation by examination under clear irrigating fluid in the cul-de-sac. If complete obstruction exists or a large injury has occurred to the ureter, resection of the diseased tissue and ureteral reanastomosis has been reported at laparoscopy.<sup>77</sup> Urologic consultation in such cases seems mandatory for most gynecologists, however.

### **Uterine Endometriosis Treatment**

The uterus infrequently has endometrial tissue attached to it, except at the uterovesical fold and between the uterosacral ligaments at the posterior aspect of the cervix when posterior cul-de-sac obliteration occurs. Identification of the fibrotic endometriosis lesion from the normal cervical tissue both anteriorly and posteriorly can be difficult. Normal tissue is more pliable, less white, and more vascular. Bipolar electro-surgery can be used to coagulate the small vessels that bleed when normal tissue is resected or vaporized. Hemostasis is more difficult when uterine endometriosis is treated. The usual principles of complete circumscription of the lesion preceding resection or vaporization should be followed.

### **Laser Uterosacral Nerve Ablation**

Laser uterosacral nerve ablation (LUNA) is an operation that developed from Doyle's procedure to destroy the sensory fibers to the cervix and lower uterine segment.<sup>42</sup> The indication for this procedure is midline pelvic pain, and it is frequently considered for patients with endometriosis and pain.<sup>49</sup> Care must be taken to identify and avoid the ureter, which is usually 1 to 2 cm lateral, although possibly closer if cul-de-sac distortion is present. Blood vessels are just lateral to the uterosacral ligament, and medial to the bowel. The uterosacral ligament may be resected in the course of resecting endometriosis involving the ligament. Traction placed on the uterus will help to define the ligaments. The lesion should then be circumscribed before resection because the anatomy changes as the ligament is resected.

### **Presacral Neurectomy**

Presacral neurectomy has been a controversial procedure for many years but is frequently considered for women with endometriosis.<sup>49</sup>

Reported results have varied,<sup>49, 100, 111</sup> possibly because of inappropriate or variable patient selection or incomplete resection of the nerve plexus. Presacral neurectomy is indicated only for severe midline dysmenorrhea.<sup>111</sup>

### Uterine Suspension

Uterine suspension is a controversial procedure used as treatment for deep dyspareunia, chronic pelvic pain, and elevation of the uterus away from extensively resected areas postsurgically. Suspension can be performed by plicating the uterosacral or the round ligaments, or by elevating the round ligaments or uterus to the anterior abdominal wall. No well-controlled studies support the efficacy of this procedure, and reported results vary widely.<sup>48</sup> Postoperative discomfort may result, and care must be taken not to create pockets into which small bowel could pass and result in bowel obstruction. In addition, the effect of suspension is almost invariably temporary. The role of this procedure in laparoscopic treatment of endometriosis is unclear at this time.

### Laparoscopy-Assisted Vaginal Hysterectomy

Laparoscopy-assisted vaginal hysterectomy (LAVH) recently has been reported as a superior method of performing vaginal hysterectomy when significant pelvic pathology, such as endometriosis, requires diagnosis and treatment, or when oophorectomy is desired but adnexal masses or adhesions hinder or prevent their removal at vaginal hysterectomy.<sup>56, 95, 96</sup> This procedure has become controversial because of possible inappropriate use by some surgeons. In addition, LAVH can be technically demanding, and complications occur easily with inexperienced laparoscopists. The usual surgical approaches for laparoscopy and hysterectomy surgery must be followed when performing LAVH. The major benefit of LAVH is its capability of converting an abdominal hysterectomy into a vaginal hysterectomy. Although most patients with endometriosis and pelvic pain obtain pain relief following hysterectomy, some patients do not.<sup>37, 116</sup> All patients need careful preoperative counseling regarding the efficacy of hysterectomy or oophorectomy and the issues involved with hormonal replacement therapy (HRT).

### Adhesiolysis

Endometriosis frequently is associated with significant pelvic adhesions. These can distort fimbrial-ovarian relationships, thereby reducing fertility.<sup>11, 14</sup> Adhesions also can distort normal anatomic relationships, causing organ dysfunction and sometimes pain. Principles of adhesiolysis include operating in the midproliferative phase, good exposure,

gentle tissue handling, removal of adhesions causing dysfunction only, copious irrigation, removal of ischemic tissue, nonuse of sutures, fluid flotation, and early postoperative ambulation. During lysis, hydrodissection and gentle traction can help to identify tissue planes and facilitate dissection. Tissue should be touched only when necessary and then moved with a probe rather than grasped. If grasped, tissue that is being removed should be held rather than tissue being left, and the least traumatic instruments possible should be used. Power settings on energy sources should be set at appropriate levels so that contiguous thermal damage is minimized. Laser beams should be stopped with titanium rods or irrigation fluid as necessary.

Hemorrhage can facilitate adhesion formation when the fibrin clot provides a matrix for invasion by fibroblasts. Use of magnification and bipolar electrosurgery can reduce oozing, as can avoidance of aspirin and NSAIDs for several weeks before surgery. Rapid control of bleeding at laparoscopy is also important because bleeding that would ordinarily be insignificant at laparotomy can quickly obscure the surgeon's view, resulting potentially in the need for laparotomy or transfusion. Hemostasis also can be improved by coagulating or isolating a vessel before cutting it, and facilitated by use of the CO<sub>2</sub> laser as well as fiber lasers. The microbipolar and large bipolar forceps should also be available at all times. Maintenance of hemostasis increases the surgeon's ability to perform the surgery without using clips, staples, sutures, or Roeder loops, which are foreign bodies that can increase adhesion formation. It is possible that the multiple end organ effects caused by the hypoestrogenism associated with GnRH agonist use may result in an improved pelvic milieu and fewer postoperative adhesions (Table 6).

Many adjunctive therapies to prevent adhesion reformation have been used, including dextran, fibrinolytic and anticoagulant regimens, anti-inflammatory agents, progesterone, NSAIDs, antihistamines, and barrier methods. Barriers prevent direct apposition of tissue surfaces, which therefore cannot become fused together by fibrin. Currently two barriers are being extensively studied: oxidized regenerated cellulose (Interceed TC7, Ethicon, Somerville, NJ) and expanded polytetrafluoroethylene (PTFE; Gore-Tex, WL Gore and Associates, Flagstaff, AZ). Both have shown promise in some studies, but the optimal clinical role of these barriers still must be determined.<sup>6</sup>

Operative laparoscopy reduces adhesions, but reformation has been shown to occur at 66% of sites at which adhesions were originally lysed.<sup>85</sup> Laparoscopic treatment of tubal adhesions has been shown to be associated with increased pregnancy rates in endometriosis patients, however.<sup>11</sup> Second-look laparoscopy enables evaluation of results and lysis of any reformed adhesions, with the expectation that on average only one half will recur.<sup>84</sup> It is unknown whether patients undergoing laparoscopic adhesiolysis for endometriosis have similar results. Clinical studies and basic science data show no consistent superiority of laser surgery over conventional adhesiolysis in relief of pain, pregnancy rates, or subsequent adhesion reformation; however, some reconstructive sur-

**Table 6. POTENTIAL BENEFITS OF PREOPERATIVE GnRH AGONISTS ON ADHESION FORMATION FOLLOWING OPERATIVE ENDOSCOPY**

Causes of Adhesion Formation	Potential Benefits of GnRH Agonists
Tissue trauma	Smaller incisions Fewer incisions Decreased tissue dissection Decreased bleeding in tissue Hysterectomy less likely with myomectomy Laparoscopic/hysteroscopic approach more likely Avoidance of uterine cavity at laparotomy for myomectomy
Infection	Shorter operating time with smaller myomas Endoscopic or vaginal approach more likely Decreased tissue dissection
Ischemia	Shorter operating time with small myomas Decreased sutures with smaller myomas Decreased need for coagulation Decreased tissue dissection Decreased operative blood loss Availability of autologous donation
Denuded surface apposition	Decreased tissue dissection Better visualization, decreased tissue manipulation Fewer incisions Smaller incisions
Foreign body	Hysteroscopic approach Decreased need for sutures Laparoscopic/hysteroscopic approach
Hemorrhage	Decreased operative blood loss Decreased dissection Decreased bleeding Reduced operating time Better visualization Laparoscopic/hysteroscopic approach

*From Adamson GD: Use of GnRH agonists to improve results of operative laparoscopy and hysteroscopy. Infertil Reprod Med Clin North Am 4:65, 1993.*

geons think that lasers, especially the newer ultrapulse lasers, provide the surgeon with increased ability to to perform extensive pelvic adhesiolysis with minimal damage to normal tissues.

## RECURRENCE OF ENDOMETRIOSIS

Recurrence rates of endometriosis probably are related to initial stage of the disease, adequacy of initial documentation of disease, adequacy of treatment, occurrence of pregnancy postoperatively, use of concomitant hormonal treatments, risk factors for endometriosis, and adequacy of follow-up. Approximate recurrence rate following medical treatment is 30%.<sup>22, 41</sup> Most studies do not have sufficiently detailed

findings and data to differentiate between the amount of initial and subsequent disease, persistence of lesions or appearance of new ones, and the sequelae of endometriosis, such as pain and infertility, compared with initial symptoms of the disease. The absence of correlation between symptoms and findings further complicates the issue.<sup>102, 119</sup> More recent data suggest that approximately 20% of patients have recurrence over 5 years following complete extirpation of the disease.<sup>90, 118</sup> Superficial disease may occur earlier even in areas where complete extirpation of endometriosis was performed.

### CONCOMITANT TREATMENT MODALITIES

Laparoscopic treatment of endometriosis appears to be at least equivalent to or superior to no treatment, medical treatment, or laparotomy (see Table 1; Fig. 1).<sup>11, 20, 21, 59</sup>

Laparoscopic treatment of endometriosis sometimes may be combined with medical therapy involving danazol or GnRH agonists. The purpose of combined treatment is to improve treatment success or facilitate the surgical procedures (see Table 6). Preoperative medical treatment suppresses ovulation so that functional cysts will not be present or confused with endometriosis. Potential advantages include a reduced volume of endometriotic tissue, the destruction of which may be effected in shortened operating time. The reduced volume of tissue also may result in less risk of injury to ureters, blood vessels, and bowel. Metastatic or extensive superficial disease will be treated. The reduced vascularity in the pelvis may result in reduced inflammation and postoperative adhesions, although this has not been proven. There may be a slight reduction in endometrioma size. Adenomyosis will be reduced, and filmy adhesions may become lysed. Other uses of GnRH agonists prior to surgery include reduction of symptoms, increased time for adequate preoperative evaluation, easier scheduling of surgery, and even delay or avoidance of surgery for a woman nearing menopause. Potential disadvantages of preoperative medical treatment include the changed appearance of endometriosis (making it more difficult to diagnose), drug cost and side effects, delay of diagnosis, and delay in pregnancy attempt.<sup>9</sup> Postoperative medical treatment may be indicated to accomplish complete resection of disease, to treat microscopic or metastatic disease, or to treat patients with pain.

Pregnancy rates with laparoscopy alone appear to be equal to or higher than those of medical therapy alone (see Fig. 1).<sup>11, 14, 32, 52</sup> Therefore, because of the additional financial and time cost, preoperative medical therapy should probably be reserved for patients with severe symptomatology, for facilitation of surgery scheduling when necessary, or for patients with known severe disease in whom medical treatment may allow for a better pelvic milieu for reconstructive surgery. It is unknown which, if any, effect preoperative medical treatment has on subsequent pregnancy rates. Postoperative medical treatment may be indicated for

patients with severe refractory pelvic pain or in whom disease has not been completely extirpated, but it should be avoided whenever possible in infertility patients because of the patient's inability to conceive while taking the medication. Postoperative medical treatment does not improve pregnancy rates (see Fig. 1).<sup>11, 15</sup> Overall, available data do not support the routine perioperative use of GnRH agonists or other hormonal therapy, but these agents may be of value in selected patients.<sup>58</sup>

## POSTLAPAROSCOPY PATIENT MANAGEMENT

Management plans should be based on the surgical results, prognosis, and patient's desires (Fig. 3).<sup>5, 8, 81, 113, 120</sup> Other infertility factors, such as ovulation, male infertility, and cervical factors, should be treated as clinically indicated. Hysterosalpingogram may be performed 3 to 12 months postoperatively for diagnostic and possibly therapeutic purposes in selected patients. Controlled ovarian hyperstimulation may be used to increase pregnancy rates.<sup>60</sup> A repeat laparoscopy should be performed 9 to 24 months postoperatively if the patient has not conceived, and if the overall clinical situation and prognosis justifies repeat surgery. If the patient had a limited prognosis following the initial surgery, or has additional important fertility problems, then in vitro fertilization, adoption, or child-free living should be seriously considered as alternative approaches.<sup>7, 8, 103</sup>

Patients with chronic pelvic pain frequently need adjunctive therapy. This may be symptomatic, such as analgesics or NSAIDs; hormonal, such as GnRH agonists, progestins, or oral contraceptives; changes in activities of daily living, such as diet and exercise; or referral to a pain clinic for comprehensive diagnosis and treatment, including nerve blocks, analgesic cocktails, biofeedback, and psychological support.<sup>115</sup> This comprehensive approach to the patient's pain should be explained to her before surgery and reinforced postoperatively.

Endometriosis patients with infertility or pain may find helpful educational materials from the Endometriosis Association (Milwaukee, WI) or RESOLVE (Boston, MA).

## CONCLUSION

Even those who are critical of the role of laparoscopy in the treatment of endometriosis and think "there is insufficient evidence to recommend laparoscopy over laparotomy for correction of infertility resulting from tubal injury or endometriosis" have stated that "there was suggestive, but not yet proven, evidence that laparoscopic surgery with laser techniques may be superior to laparotomy in the management of infertility resulting from moderate and severe endometriosis."<sup>45</sup> The author of this article also did not consider economic or postsurgical recovery factors in reaching his conclusions and thought there were no good

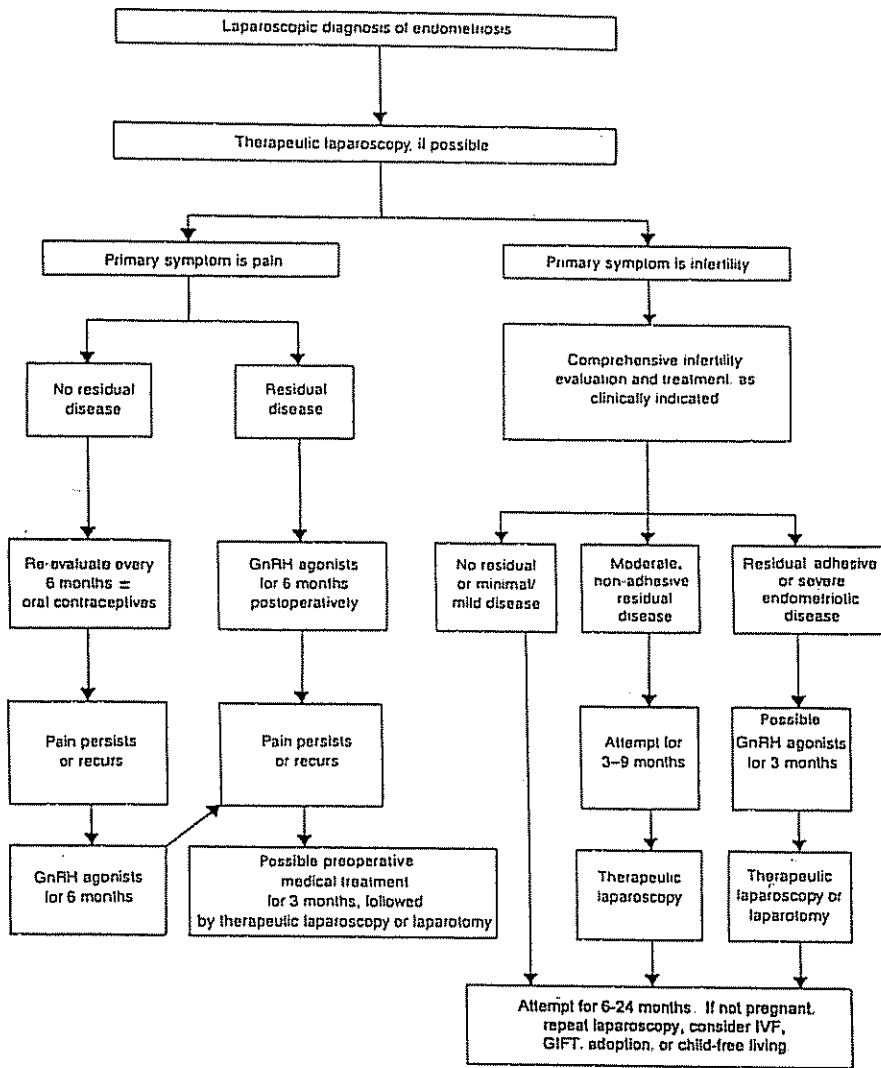


Figure 3. Postlaparoscopy management of endometriosis. (From Adamson GD: Laparoscopic treatment of endometriosis. In Adamson GD, Martin DC (eds): Endoscopic Management of Gynecologic Disease. Philadelphia, Lippincott-Raven, 1996, pp 147-187; with permission.)

studies available to determine the relative merits of laparoscopy or laparotomy for the treatment of pain.

Data subsequent to those available for Gant's 1992 article strongly support the major role of laparoscopic surgery in the treatment of endometriosis. Numerous studies suggest some improvement in pelvic pain following certain surgical procedures for advanced endometriosis,

and some good studies support the potential role of laparoscopy in performing such surgeries. Laparoscopic treatment of endometriosis has become a surgical possibility because of pioneering gynecologic surgeons and technologic developments. Laparoscopic management can produce pregnancy rates equivalent or superior to laparotomy and other treatment modalities (see Table 1; Fig. 1).<sup>3, 11, 12, 14, 16, 76, 84</sup> Complication rates with laparoscopy appear to be equivalent or less frequent than at laparotomy, although strict comparative data are not available.<sup>45, 87</sup>

Overall, it is clear that operative laparoscopy for treatment of endometriosis is appropriate in many clinical situations. These procedures can be complex, however, and it is mandatory that patient selection be based on sound clinical indications and implemented by experienced laparoscopists who have their patient's best interest as their only criteria for operating. Further technologic improvements, more experience, better-designed studies, and responsible discussion of results will enable surgeons to provide even better care for their patients with endometriosis.

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