

1021

# Endometriosis of the Intestine and Genitourinary Tract

CAMRAN NEZHAT, M.D., CLINICAL PROFESSOR  
STANFORD UNIVERSITY SCHOOL OF MEDICINE, STANFORD, CA  
DIRECTOR, THE CENTER FOR SPECIAL PELVIC SURGERY  
ATLANTA, GA

FARR NEZHAT, M.D., CLINICAL PROFESSOR  
STANFORD UNIVERSITY SCHOOL OF MEDICINE, STANFORD, CA  
DIRECTOR, THE CENTER FOR SPECIAL PELVIC SURGERY  
ATLANTA, GA

CEANA NEZHAT, M.D., ASSOCIATE CLINICAL PROFESSOR  
STANFORD UNIVERSITY SCHOOL OF MEDICINE, STANFORD, CA  
DIRECTOR, THE CENTER FOR SPECIAL PELVIC SURGERY  
ATLANTA, GA

As with other organs, the etiology of bowel endometriosis is unknown. Its occurrence was reported as early as 1922 by Sampson.<sup>1</sup> Following his investigation of nineteen cases, he proposed that "implantation adenoma of endometrial type of some portion of the intestinal tract may be present in at least one half of the cases of perforated ovarian hematoma of endometrial type with peritoneal implantations."<sup>1</sup>

Intestinal endometriosis has been reported to affect between 3 and 37% of women with endometriosis. In a series of 1,573 women treated consecutively for endometriosis, 5.4% had gastrointestinal involvement; of these, 65% had endometriosis of the rectum and rectosigmoid colon.<sup>2</sup> In another series of 1,000 celiotomies, Williams and Pratt found that 485 women had endometriosis of which 181 (37%) had gastrointestinal involvement. Of these, 172 (95%) had rectosigmoid involvement, 9 (5%) had ileal involvement, and 19 (10%) had appendiceal involve-

ment.<sup>7</sup> Bowel resection with or without castration has been suggested to treat symptomatic patients.<sup>2,6</sup> Coronado et al.<sup>8</sup> have reported satisfactory pain relief and pregnancy rates following anterior wall resection of the colon by laparotomy for deeply infiltrating lower colorectal endometriosis.

Bowel involvement is suggested by palpable tumor in the rectovaginal septum, gastrointestinal symptoms such as rectal bleeding, constipation, or diarrhea associated with menses, or pain that persists after surgical removal of all recognizable lesions.

Endometriotic nodularity of the bowel and rectovaginal septum is one of the most difficult aspects of this disease to approach surgically. Because gynecologists are uncomfortable operating on the bowel and general surgeons may not be familiar with endometriosis, these cases have frequently required bowel resection or temporary colostomy. Some have shown that when full-thickness bowel resection and immediate reanastomosis are performed by a surgical team familiar with the disease, low morbidity and good long-term relief of symptoms can be expected.<sup>8</sup>

Because colorectal endometriosis is generally superficial, we feel that bowel resection should remain the last resort. We have been able to treat most cases involving the rectum and rectovaginal septum laparoscopically.

Women with endometriosis of the lower colon, rectum, uterosacral ligaments or rectovaginal septum often present with chronic pelvic pain, and dysmenorrhea, dyspareunia, back pain, dyschezia, constipation or diarrhea, or infertility with pelvic pain. Most women with small bowel or appendiceal endometriosis are asymptomatic, and rarely experience bowel obstruction.

### Surgical Procedures

Operative laparoscopy of the GI tract is performed for the treatment of endometrial implants on the intestinal wall, appendix, or rectovaginal space. Surgical repair of the bowel may be necessary, even in patients whose endometriosis does not invade the lumen of the GI tract, for the repair of incidental injuries occurring during laparoscopic treatment of endometriosis in other areas of the pelvic/abdominal cavity.

Operative videolaparoscopy of the GI tract includes lysis of bowel adhesions, as well as the treatment of superficial, infiltrative and full thickness involvement with or without stricture of the appendix, rectosigmoid colon, rectovaginal septum or small bowel.

### Preparation for Laparoscopy

To prepare a patient for operative laparoscopy, the surgeon should follow a protocol similar to that for laparotomy, including thorough clinical and laboratory evaluation. Pelvic ultrasound and, in selected cases, hysterosalpingography are recommended to permit the

surgeon to evaluate uterine and adnexal abnormalities. Patients with a history of rectal bleeding should be evaluated by sigmoidoscopy before laparoscopy, and a barium enema may be necessary. The procedure should be explained to the patient and proper consent must be obtained. The evening before surgery, patients with more advanced disease or previous laparotomy receive a bowel preparation consisting of 4 L polyethylene glycol-3350 (Golytely, Braintree Laboratories, Braintree, MA) and are given 1g metronidazole at bedtime. As prophylaxis, 1g cefoxitin is administered preoperatively and postoperatively. Our preferred technique is the room set up and system of videolaseroscopy. In describing our surgical techniques we make frequent reference to the CO<sub>2</sub> laser as a cutting modality. Scissors, electro-surgical devices, and fiber lasers are effective and appropriate alternatives.

### Lysis of Bowel Adhesions

Bowel adhesions may be thin or thick, vascular or avascular, cohesive or not. Noncohesive adhesions are stretched as much as possible without tearing the tissue, excised with laser or electricity at the points of attachment to the pelvic organs, and removed. Cohesive adhesions densely adherent to other structures are excised by scissors or CO<sub>2</sub> laser.<sup>10</sup> The latter device has a more controlled and predictable depth of penetration than either electro-surgery or fiber lasers. The ultrapulse laser may be used in conjunction with hydrodissection for lysis of fibrosis and cohesive adhesions. Structures requiring separation are pulled apart with forceps and a cleavage plane is formed. Hydrodissection, which provides atraumatic pressure, may be especially useful in identifying and developing the dissection plane that is laser ablated or excised. The plane may also be dissected sharply or bluntly by opening the scissors while applying pressure.<sup>11</sup>

### Treatment of Appendiceal Endometriosis

Because approximately 50% of appendiceal lesions are detected only by palpation and may be missed by visual inspection alone, incidental appendectomy is recommended in patients with severe endometriosis.

Preparation for appendectomy includes mobilization and examination after any necessary lysis of periappen-

diceal or pericecal adhesions. The surgeon must proceed carefully in case these are attached to the lateral pelvic wall or retrocecal appendix. The bipolar electrocoagulator and the CO<sub>2</sub> laser are used sequentially to dessicate and cut the mesoappendix 0.2 to 0.5 cm from the ileocecal area. When using the bipolar electrocoagulator in this area, caution should be exercised to prevent thermal damage to the cecum. A backstop is also required when using the CO<sub>2</sub> laser to avoid injuring the external iliac artery and vein.

At this point, the bipolar electrocoagulator is withdrawn, and the Endoloop applicator (Ethicon, Somerville, NJ) is inserted through the suprapubic midline puncture. Two chromic Endoloop sutures (Ethicon) or polydioxanone sutures (Ethicon) are passed over the base of the appendix 2 to 5 mm from the cecum and then tied, one on top of the other. Both suture ends are cut with the CO<sub>2</sub> laser or scissors. A third endoloop suture is applied less than 2 cm distal to the other sutures and a 15 cm tail is left to facilitate retrieval should the appendix inadvertently fall into the pelvic well. Using the CO<sub>2</sub> laser, the appendix is cut between the second and third sutures placed. Luminal portions of the appendiceal stump and the removed appendix are sealed with the CO<sub>2</sub> laser, and the tissues are copiously irrigated with lactated Ringer's solution (Baxter Healthcare, Deerfield, IL). The appendix is removed from the abdomen with a long grasping forceps passed through the operating channel of the laparoscope or suprapubically with a short grasping forceps or with an Endopouch tissue removal bag (Ethicon). If appropriate, an appendix extractor may be placed via the sleeve of the 10 mm trocar, replacing the central 5 mm trocar. Instruments that may be contaminated are removed from the surgical area. No adjunctive therapy is necessary. Finally, the appendiceal and other operative sites are inspected for hemostasis and then irrigated with lactated Ringer's solution.<sup>11</sup>

Appendectomies may last from 4 to 21 minutes. Postoperative instructions should include avoiding solid food for 24 hours. Otherwise, instructions are the same as for gynecologic procedures, including an outpatient evaluation the day after surgery. In a series of 100 consecutive appendectomies using the technique of videolaseroscopy, we did not have any major intraoperative complications.<sup>12</sup> One patient had a transient

elevated temperature, and one had mild periumbilical ecchymosis. All were discharged within 24 hours.<sup>12</sup> In another series of 254 laparoscopic appendectomies, no major intraoperative complications were noted and again, all were discharged within 24 hours. Intraoperatively, one patient developed a small pelvic abscess that required surgical intervention.

We have recently modified our technique for the performance of appendectomy using a single Endoloop suture. The suture is placed over the base of the appendix 2 to 5 mm from the cecum and tied. Using the CO<sub>2</sub> laser, the appendix is cut about 5 mm distal to the suture. Sealing of the luminal portion of the appendiceal stump and the removed appendix, irrigation, and removal of the appendix are as described above. Results are comparable to those achieved with our previous technique.

Several other laparoscopic appendectomy techniques have been described. In 1983, Semm reported a procedure incorporating the use of sutures and crocodile forceps.<sup>13</sup> The difference between Semm's technique and ours is that he uses suture ligation and scissors for the appendiceal artery rather than bipolar electrocoagulation and/or laser. Laparoscopic appendectomy may also be accomplished using a stapling device. The Endo-cutter (Ethicon) passes through a 12 mm trocar and allows placement of two overlapping lines of staples with a simultaneous cut. The close approximation of the two staple lines to the cutting blade in the cartridge head reduces the risk of spillage from the appendiceal lumen into the peritoneal cavity. The stapling device requires a 12 mm trocar.<sup>14</sup>

#### Endometriosis of the Rectosigmoid, Rectovaginal Septum, and Cul-de-sac

Most cases of rectal and rectovaginal septum endometriosis can be managed with outpatient videolaparoscopy and do not require bowel resection.<sup>15</sup> The procedure is performed as follows. An assistant standing between the patient's legs uses one hand to perform rectovaginal examination and the other hand to hold the uterus up with a curette, a dilator, or the Humi rigid uterine elevator. An uninvolved area of peritoneum is identified and injected with 5 to 8 ml of diluted vasopressin (10 units in 100

to 200 ml of lactated Ringer's solution) with a 16-gauge laparoscopic needle. Using the CO<sub>2</sub> laser, an opening is made in the peritoneum. Hydrodissection is performed with SmoKovac Trumpet Valve and Nezhat-Dorsey Endopool probe (American Surgical Instruments, Inc., Delray Beach, FL) forming a plane in the rectovaginal septum.<sup>16</sup>

While the assistant examines the rectum, areas of involvement are identified by palpation. CO<sub>2</sub> laser vaporization or excision of rectovaginal implants is continued until no palpable nodules exist. Between 40 and 80 W of CO<sub>2</sub> laser are used to vaporize or excise the endometriosis. An assistant examines the rectum as the involved area is completely excised or vaporized until the loose areolar tissue of the rectovaginal space or normal muscularis layers of the rectum are reached. In patients whose rectum is pulled up and attached behind the cervix between the uterosacral ligaments, the uterus is first anteflexed sharply. Then an incision is made at the right or left pararectal area and extended to the junction of the cervix and rectum. This plane of dissection is continued until the rectovaginal septum is reached. If the rectal involvement is more extensive, a sigmoidoscope may be used to guide the surgeon, as well as to rule out bowel perforation. The cul-de-sac is filled with irrigation fluid and is observed through the laparoscope while air is introduced into the rectum through the sigmoidoscope. Air bubbles observed in the cul-de-sac fluid indicate perforation. With the assistant guiding the surgeon by rectovaginal examination, the rectum is freed completely from the back of the cervix. At times, generalized ooze or bleeding may occur and can be controlled with an injection of 3 to 5 ml diluted vasopressin solution (1 ampule in 100 ml), laser, or bipolar electrocoagulator. Occasional bleeding from the stalk vessels caused by dissection or vaporization of the fibrotic uterosacral ligaments and pararectal areas is controlled with bipolar electrocoagulator.

Location and assessment of the ureters before proceeding with this procedure is of paramount importance, especially when they are infiltrated by endometriosis. Any alteration in the direction of the ureters should be identified prior to surgery. Because ureters are lateral to the uterosacral ligament, we try to stay between the ligaments as

much as possible. Using hydrodissection and making a relaxing incision lateral to the uterosacral ligament allows the ureter to retract laterally. This increases protection of the ureters.

For cases in which there is nodularity in the posterior cul-de-sac and infiltration of the endometriosis toward the vagina, vaporization and dissection of the nodularity are continued as an assistant evaluates the nodule by palpation until it is gone.<sup>15,17</sup> Endometriosis rarely penetrates the mucosa of the colon but it commonly involves the serosa, subserosa, and muscularis. The disease can be excised or vaporized thoroughly by an experienced videolaparoscopist. When major portions of both muscularis layers have been excised or vaporized, and the mucosa is reached, the bowel wall may be reinforced by one to three 4-0 polydioxanone sutures. The procedure is very demanding and requires maximal cooperation between the assistant and the surgeon.

This approach was applied to 185 women, aged 25 to 41 years, who had deep, infiltrative endometriosis of the rectovaginal septum, uterosacral ligaments, posterior cul-de-sac, and anterior wall of rectosigmoid colon.<sup>15</sup> Of the 185 patients, 33 had rectovaginal septum involvement only, 22 had fibrotic and nodular uterosacral ligaments, and 130 had partial or complete obliteration of the cul-de-sac. Small vaginal perforations, which did not require suturing, occurred in 11 patients who had severe nodularity of the rectovaginal septum. The lumen of the rectosigmoid colon was entered in nine patients. In eight, the repair was performed laparoscopically; in one, repair was performed after prolapsing the bowel through the anus (this technique is further described below in the section on bowel resection). Of 185 patients, 174 were available for follow-up after 1 to 5 years. Of 31 patients who have undergone second-look laparoscopies for persistent infertility or recurrent pain, 12 (38%) had complete healing of the rectovaginal septum with few filmy adhesions. Nineteen (61%) had dense, vascular adhesions and 7 (23%) in this group had persistent endometriosis. Moderate to complete pain relief was reported by 162 (93%) of the 174 patients.

#### Bowel Resection

In cases of severe disease of the bowel wall, bowel resection may be necessary. We first described laparo-

scopic assisted anterior rectal wall resection and anastomosis in 1991 to treat symptomatic infiltrative rectosigmoid endometriosis.<sup>11</sup> In 1992, we published the first report of total rectal wall resection by advanced operative laparoscopy.<sup>18</sup> The patient is given a preoperative mechanical bowel preparation as described previously. Three 5 mm suprapubic trocars, one each in the midline, right, and left lower quadrants, are used to place grasping forceps, Endoloop suture applicators, a suction-irrigator probe, and a bipolar electrocoagulator.

The technique includes laparoscopic mobilization of the lower colon, transanal prolapse, resection, and reanastomosis.<sup>17,18</sup> When the lesion involves only the anterior rectal wall near the anal verge, the rectovaginal septum is delineated by simultaneous vaginal and rectal examinations performed by an assistant. The rectum is mobilized along the rectovaginal septum anteriorly to within 2 cm of the anus, using the CO<sub>2</sub> laser and hydrodissection. Mobilization continues along the left and right pararectal spaces by electrodesiccating and dividing branches of the hemorrhoidal artery, and partially posteriorly, as well. When the rectum is sufficiently mobilized, the tumor is prolapsed to the level of the anus, the perineal body is retracted, and an RL 30 (Ethicon) multifire stapler is applied across the segment of the anterior rectal wall containing the nodule. Two staple applications may be required to traverse the width of the involved mucosa. The tumor nodule is excised using electrosurgery, and two additional interrupted 2-0 polyglactin sutures are inserted along the staple line. The rectum is returned to the pelvis under direct visualization, and closure is confirmed by insufflating the rectum while the cul-de-sac is filled with lactated Ringer's.

In patients with more extensive involvement and circumferential lesions, the entire rectum is mobilized, the lateral rectal pedicles are electrodesiccated, and the presacral space is entered to the level of the levator ani muscles to be able to mobilize the bowel. The branches of the inferior mesenteric vessels of the bowel segment to be resected are electrodesiccated and cut. The rectum is transected proximal to the lesion, and the proximal limb is prolapsed into the distal limb, using Babcock clamps. A 2-0

purse-string suture is inserted to the end of the proximal bowel to secure the opposing anvil of an ILS 29 or 33 stapler (Ethicon). The anvil is then replaced transanally into the pelvis along with the proximal bowel. The rectal stump containing the endometrial lesion and fibrosis is then prolapsed out of the anus by grasping the transected end of the rectal stump with Babcock clamps (Baxter Mueller, Chicago, IL) and pulling it through the anal canal. The rectum is stapled shut with a RL60 linear stapler (Ethicon) and the rectal specimen is resected and sent to surgical pathology. The rectal stump is reduced inside the pelvis and an end-to-end double stapled anastomosis is performed with the ILS 33 stapler (Ethicon). A trocar in the gun is passed through the stapled end of the rectum. The laparoscope is then used to attach the opposing anvil in the proximal bowel. The bowel ends are approximated, and the stapler is fired to complete the anastomosis. Intact "doughnut" margins should be present. A proctoscope is used to examine the anastomosis for structural integrity and bleeding. Lactated Ringer's solution is inserted into the pelvis and visualized with the laparoscope as air is insufflated into the rectum to check for leakage. Air leaks may be corrected using transanally placed 2-0 Vicryl sutures. Laparoscopic bowel resection by this technique is identical with resection at laparotomy with the bipolar electrocoagulator and laser replacing the suture and scissors.<sup>19</sup>

A simplified method for resection of severe endometriosis of the anterior wall of the colon<sup>20</sup> is as follows. The extent of the lesion is evaluated visually and by palpation using the tip of the suction-irrigator probe. If the lesion is low enough, an assistant can identify it by performing a rectal examination. A sigmoidoscope is used to further delineate the lesion and guide the surgeon.

After identification of the ureters in order to avoid inadvertent injury, the lower colon is mobilized in all aspects except posteriorly. Depending on the location of the lesion, the right pararectal area, left pararectal area, or both are entered using the CO<sub>2</sub> laser and hydrodissection. The colon is separated from the adjacent organs. Full-thickness excision is carried out, beginning above the area of visible disease. After identifying the normal tissue, the lesion is held at its proximal end with grasping forceps. An incision is made using the CO<sub>2</sub>

laser through the bowel serosa and muscularis, and the lumen is entered. The lesion is excised from the anterior rectal wall. The suction irrigator probe is used as a backstop for the laser and to evacuate the laser plume. After complete excision of the lesion, the pelvic cavity is irrigated and suctioned. Resected pieces of bowel are extracted through the operative channel of the laparoscope using long grasping forceps, or from the anus using polyp forceps, and submitted for pathology. The bowel is repaired transversely in one layer. Two traction sutures are applied to each side of the defect transforming it to a transverse opening. The stay sutures are brought out through the right and left lower quadrant incisions. The sleeves are removed, then replaced in the peritoneal cavity next to the stay sutures, and the sutures are secured outside the abdomen. The bowel is then repaired by placing several interrupted through-and-through sutures in 0.4 to 0.6 cm increments until it is completely reanastomosed. We use O-Vicryl or PDS laparoscopic sutures with a straight or curved needle (Ethicon) with extracorporeal knot tying. When the lesion is not very extensive and the bowel defect after resection is less than 4 cm, the bowel can be repaired vertically without causing stricture. At the end of the procedure, sigmoidoscopy is performed to ensure that the closure is airtight and that there is no bowel stricture.<sup>20</sup>

In a series of 356 women who underwent laparoscopic treatment of bowel endometriosis using different techniques, two patients required intraoperative laparotomy early in our experience. The first patient underwent laparotomy for repair of enterotomy after treatment of infiltrative rectal endometriosis. The other patient required laparotomy for anastomosis due to an unsuccessful attempt to place a purse-string suture around the patulous rectal ampulla. Significant postoperative complications occurred in 1.7% of patients. Two women developed leaks and pelvic infections. One required a Laparoscopic temporary colostomy with subsequent take down and repair by Laparotomy, and one was managed by prolonged drainage. One woman had bowel stricture requiring resection and reanastomosis by laparotomy. One developed a pelvic abscess, which, after failed response to drainage, underwent laparoscopic right salpingo-oophorectomy. One patient who had had anterior

Large resection of anterior rectum had an immediate rectal prolapse which was reduced without surgical management. Her bowel symptoms persisted, and she finally had a colectomy.

Minor complications included skin ecchymosis, temporary urinary retention, temporary diarrhea or constipation, and dyschezia.

#### Small Bowel

The small bowel has the least involvement with endometriosis. The most common location is the ileocecal area. Superficial spots of endometriosis can be vaporized with low power CO<sub>2</sub> laser (15-25 watts). Occasionally, the lesion is deep and entry into the lumen of bowel is necessary. If the entry is less than 1 cm, it can be repaired using one endoloop suture.<sup>21</sup> After thorough irrigation of the perforation is performed, the endoloop is tied over the defect and the perforation is brought inside the loop using anastomotic grasping forceps and tied below the perforation leaving adequate stump. The repair is immersed in the lactated Ringer's and observed for air bubbles to be sure it is airtight.

A defect of more than 1 cm is repaired in one layer using through-and-through O Vicryl or PDS suture as was described before. When the involvement is more extensive and complete resection and reanastomosis is required, the bowel is completely mobilized laparoscopically and brought out through McBurney incision or vaginal posterior colpotomy, resected and reanastomosed.

We have treated three such cases laparoscopically. In the first, the patient had cecal and appendiceal endometriosis. Following laparoscopic mobilization of the bowel, the cecum was resected and reanastomosed through a McBurney incision. An appendectomy was then performed. The other two women had small bowel endometriosis which was causing partial stricture. The mesentery was coagulated and cut, and the bowel exteriorized through a Pfannenstiel incision in one case and through a posterior colpotomy in the other. Resection and reanastomosis were then completed with no intraoperative or postoperative complications, and the women are doing well.

#### The Genitourinary Tract

Variable ureteral and bladder involvement have been reported in 1% to 11% of women diagnosed with endometriosis.<sup>22</sup> As the disease becomes more advanced, the ureter is vulnerable to endometriotic implant involvement. Endometriosis of the urinary tract can be superficial or invasive, and in sporadic cases, may even completely obstruct the ureter. The bladder wall is one of the sites least frequently involved with endometriosis. In fact, fewer than 180 cases have been reported.<sup>23</sup> Management options include hormone suppressive therapy, oophorectomy, hysterectomy, and/or segmental cystectomy.<sup>24,25</sup>

Decreased bladder capacity and bladder instability unresponsive to conventional therapy may be due to endometriosis. Goldstein and Brodmann reported one case of bladder endometriosis that they monitored cystometrically over a 4-year period.<sup>26</sup> They found that decreased bladder capacity and bladder instability, both unresponsive to conventional parasympatholytic agents, were corrected after surgical destruction of superficial bladder endometriosis. When bladder symptoms recurred 2 years later, a course of danazol again reversed bladder instability. It is important that clinicians consider endometriosis in cases of refractory and unexplained urinary complaints.

If endometriosis of the urinary tract is suspected, a complete preoperative evaluation should be performed including an intravenous pyelogram, ultrasound scan of the kidneys, and routine blood and urine workup. In selected cases where patients present recurrent hematuria, cystoscopy may be indicated.

#### Treatment of Genitourinary Tract Implants

Most superficial implants of endometriosis over the ureter and the bladder can be safely treated by operative laparoscopy, utilizing hydrodissection and the CO<sub>2</sub> laser. Before the introduction of hydrodissection to the operative laparoscopic treatment of endometriosis, sensitive areas at risk of injury, such as bowel, ureter, bladder and major blood vessels, were often excluded from surgical intervention.<sup>27,28</sup> This omission was serious because the patient often continued to have symptoms after surgical therapy. Hydrodissection makes treatment with the CO<sub>2</sub> laser in these high-risk areas safer. Because the CO<sub>2</sub> laser beam does not penetrate fluid, treatment can be confined to the endometriotic lesion yet leave adjacent normal tissue unharmed. By creating a bed of fluid

beneath the peritoneum, the risk of laser beam penetration to underlying tissue is reduced.

Superficial implants over the ureter can generally be treated by a variation of hydrodissection. Approximately 20 to 30 ml of lactated Ringer's solution is injected subperitoneally on the lateral pelvic wall, elevating the peritoneum and backing it with a bed of fluid. The CO<sub>2</sub> laser is then used to create a 0.5 cm opening on this elevation. The peritoneum is opened anteriorly and laterally, close to the corresponding round ligament. The hydrodissection probe is then inserted into the opening and approximately 100 ml of lactated Ringer's is injected under 300 mm/Hg pressure into the retroperitoneal space along the course of the ureter. The fluid surrounds the ureter, moves it posteriorly, and allows superficial CO<sub>2</sub> laser dissection or vaporization of the area.

After creating the water bed, a superpulse or ultrapulse mode of the CO<sub>2</sub> laser of between 20 and 80 W is used for vaporization or excision of the lesion, which should be performed with a circumference of 1 to 2 cm. When the lesions are large or excision is preferred, a circular line with a 1 to 2 cm margin is made around the lesion. The peritoneum is then grasped with an atraumatic grasping forceps and peeled away with the help of the CO<sub>2</sub> laser and the tip of the suction-irrigation probe. If the endometrial implant is firmly embedded and has formed scarring down to the subperitoneal connective tissue, hydrodissection should be extended. By injecting around the lesion, fluid "tunnels" created beneath the lesion, which often separates the scar tissue. The lesion can then be safely treated. After vaporization or excision of these lesions, the area must be carefully irrigated to remove all remaining carbonization and verify that all remaining endometriosis has been properly treated.

Nezhat and Nezhat reported over 500 sites of superficial genitourinary implants treated by this method. There have been no major complications involving injury to the bladder or ureters. Two patients were unable to void immediately following surgery; this problem was resolved with an indwelling catheter which was removed the day after surgery. Four patients with endometriosis of the bladder had postoperative hematuria which cleared within several hours. Following

hydrodissection of the broad ligaments and the pelvic side wall, about 5% of the patients had swelling of the external genitalia. This is most likely because of the penetration of water through the inguinal canal to the labia. This swelling resolved in most cases within one to two hours, and did not leave any permanent sequelae.

### Obstructed Ureter

In severe cases of endometriosis, the implants may invade the tissue of ureter and cause obstruction. The incidence of ureteral obstruction due to endometriosis is low. Most gynecologists will never encounter this entity. However, as this complication has severe effects on the patient's quality of life, any surgeon treating endometriosis must be thoroughly acquainted with the modes of treatment available. Conventional therapy consists of laparotomy and resection of the obstructed segment of the ureter.

We first performed a ureteroureterostomy by laparoscopy in 1989 in a 36 year old woman with long-term ureteral obstruction caused by endometriosis.<sup>29</sup> The condition had been previously diagnosed at laparoscopy, but the patient refused to undergo treatment by laparotomy. When the patient came to us, she had had a nephrostomy tube in place for 4 years. Laparoscopic findings included a 3 to 4 cm fibrotic nodule over the left ureter, approximately 4 cm above the bladder, distorting the course of the ureter. This corresponded to the level of the obstruction previously diagnosed by radio-imaging techniques. Under direct visualization by laparoscopy, we attempted to place a retrograde catheter, but were unsuccessful. We decided to excise the nodule using videolaseroscopy and hydrodissection.

The left retroperitoneal space was entered at the pelvic brim and after treating all associated lesions, such as endometriosis, fibrosis, or adhesions, the ureter was dissected with the CO<sub>2</sub> laser. During dissection, when we discovered that the nodule involved the entire thickness of the ureter, we elected to do a partial resection.

Under cystoscopic guidance, a 7F ureteral catheter was passed through the ureterovesical junction, and the CO<sub>2</sub> laser was used to enter the ureter at this level. Indigo carmine was injected into the patient's IV to test the ureter's patency. The distal ureter was

transected over the stent, and the obstructed portion of the ureter was removed. When this was completed, the ureteral stent was introduced into the proximal ureter and advanced into the renal pelvis. Finally, the edges of the ureter were reapproximated using four 4-0 PDS sutures placed in an interrupted fashion at the 6, 12, 9, and 3 o'clock positions to approximate the proximal and distal ureteral edges. An external ureteral stent was left in the ureter for a minimum of 4 weeks, at which time it is exchanged cystoscopically for an internal stent. This stent remained in place for approximately 2 months postoperatively. The patient's follow-up, IVP, and ultrasound, showed functional kidneys with normal patient ureter long term follow up.

This patient went home the day after surgery. Her postoperative course was uncomplicated. An intravenous pyelogram confirmed ureteral patency and renal function. Estimated blood loss was less than 100 ml and the duration of the procedure was just under 2 hours. The length of the removed/vaporized segment was 3 to 4 cm. The pathology report confirmed severe endometriosis and fibrosis of the resected ureter.

Since then, we have treated 12 more cases of severe endometriosis of the ureter in which the endometriosis and fibrosis caused partial or complete ureteral obstruction. All patients had known history of endometriosis and underwent different surgical and medical treatments.

In four women, the ureteral endometriosis was completely removed without entering the ureteral lumen. In three women, the obstructed ureter, required a complete segmental resection. One right and one left ureteroureterostomy and one reanastomosis of the left ureter to the bladder (ureteroneocystostomy) were performed using four through and through interrupted 4-0 polydioxanone (PDS) sutures to reapproximate the edges over the ureteral catheter. In five women, the ureter was partially involved. The severe retroperitoneal and ureteral endometriosis was cautiously excised or vaporized using CO<sub>2</sub> laser until ureterotomy occurred.

In three women, the ureterotomy was very small and was detected by intravenous injection of indigo carmine. A ureteral stent was left in place and no suture was required. In two patients, the ureterotomy was repaired using 4-0

PDS to overlap the resected portion. The pathologic specimen revealed fibrosis, endometriosis, or both in women. A rare case of endometriosis with focal severely atypical hyperplasia was found in the specimen of a 46 year old woman. She had undergone a total abdominal hysterectomy and bilateral salpingo-oophorectomy followed by hormonal replacement therapy at another institution. All patients had uneventful intra- and postoperative courses and reported symptomatic relief of their symptoms. Imaging techniques demonstrated patent ureters with functioning kidneys in all patients except for one. She was a 24 year old woman who had been diagnosed several months earlier with pelvic endometriosis which was partially treated at initial laparoscopy followed by GnRH analog therapy postoperatively. During a second laparoscopy, she was found to have severe left uterosacral, left pelvic sidewall endometriosis and left ureteral endometriosis which had caused complete obstruction of the ureter. Segmental resection and ureteroureterostomy was performed. Intraoperative intravenous injection of indigo carmine did not reveal any leakage from the ureter and raised the question of a non-functioning kidney. Postoperative follow up and imaging revealed a 5%-10% functioning kidney. However, the ureter was patent.

### Bladder endometriosis

If the lesions of the bladder serosa are superficial, hydrodissection and vaporization will adequately remove them. However, different management is necessary when the involvement is deep within the muscularis or mucosa. The efficacy of conservative therapy varies. Some regard it as palliative or temporary. When conservative medical and surgical therapy fails, segmental cystectomy is necessary to remove the lesions.

We have successfully performed laparoscopic segmental cystectomy on six patients. Operative laparoscopy was performed using a laparoscope, video camera, and three suprapubic portals. We thoroughly evaluated the abdominal and pelvic cavities to assess the extent of the endometriosis. Simultaneous cystoscopy was performed. Bilateral ureteral catheters were inserted to better identify the ureters.

The bladder dome was held near the midline with the grasping forceps

the endometriotic nodule was excised 5 mm beyond the lesion. The incision was made with the CO<sub>2</sub> laser using the suction irrigation probe as a backstop. The specimen removed from the abdominal cavity with the assistance of a long grasping forceps through the operative channel of the laparoscope. The excised tissue by a previously placed grasping forceps. The lesion was then re-grasped and removed with the laparoscope as one unit. The CO<sub>2</sub> gas distended the bladder cavity and provided excellent visualization of the bladder interior. After again identifying the ureters, and careful examination of the bladder mucosa, the bladder was closed. This was performed with several interrupted polydioxanone or vicryl through-and-through sutures using extracorporeal or intracorporeal knotting. A cystoscopy was then performed to check for possible leaks. Laparoscopic segmental cystectomy takes approximately 35-45 minutes. Each woman was discharged from the hospital the following day and instructed to take trimethoprim and sulfamethoxazole for 2 weeks. The Foley catheter was removed 10-14 days later, at which time the cystograms were normal. The average estimated blood loss was less than 150 ml. The pathology report confirmed severe endometriosis and fibrosis of the resected bladder wall in all cases. No intraoperative or postoperative complications were noted. Ten to 23 months postoperatively, the patients are doing well, with no hematuria at menstruation.

### SUMMARY

In experienced hands, the laparoscopic approach provides an adequate route for diagnosis and treatment of endometriosis of the intestine and genitourinary tract. Endoscopic magnification of the bowel and bladder wall planes, coupled with hemostasis facilitated by pneumoperitoneum and the CO<sub>2</sub> laser, allows excellent identification of anatomic structures with this

laparoscopic technique; bipolar electrocoagulation and laser replace conventional dissection techniques and sharp instruments. Our short-term and long-term follow-up have been promising. Adequate laparoscopic treatment of endometriosis requires surgical skill, and of paramount importance, the operator's knowledge of this disease and its natural history. **□**

### REFERENCES

1. Sampson JA. Intestinal adenomas of endometrial type. *Arch Surg* 1922;5:217-80.
2. Prystowsky JB, Stryker SJ, Ujiki GT, et al. Gastrointestinal endometriosis. *Arch Surg* 1988;123:855-8.
3. Samper ER, Slagle GW, Hand AM. Colonic endometriosis: Its clinical spectrum. *South Med J* 1984;77:912-4.
4. Castell RB. Endometriosis of the colon and rectum with intestinal obstruction. *N Engl J Med* 1987;217:9-16.
5. Forsgren H, Lindhagen J, Melander S, et al. Colorectal endometriosis. *Acta Chir Scand* 1983;149:431-5.
6. Meyers WC, Kelvin FM, Jones RS. Diagnosis and surgical treatment of colonic endometriosis. *Arch Surg* 1979;114:169-75.
7. Williams TJ, Pratt JH. Endometriosis in 1,000 consecutive celiotomies: Incidence and management. *Am J Obstet Gynecol* 1977;129:245-50.
8. Coronado C, Franklin RR, Lotze EC, et al. Surgical treatment of symptomatic colorectal endometriosis. *Fertil Steril* 1990;53:411-16.
9. Nezhat C, Nezhat F, Nezhat CH. Operative laparoscopy (minimally invasive surgery): state of the art. *J Gynecol Surg* 1992;8:111-41.
10. Nezhat C. Videolaseroscopy for the treatment of endometriosis. *Progress in Obstetrics and Gynecology*, John Studd, ed., 1989;293-303.
11. Nezhat C, Nezhat F, Winer W. Salpingectomy via laparoscopy: a new surgical approach. *J Laparosc Surg* 1991;1:91-5.
12. Nezhat C, Nezhat F. Incidental appendectomy during videolaseroscopy. *Am J Obstet Gynecol* 1991;165:559-66.
13. Semm K, Friedrick E. Operative manual for endoscopic abdominal surgery. Chicago; Year Book Medical 1987.
14. Nezhat C, Nezhat F, Silfen SL. Laparoscopic hysterectomy and bilateral salpingo-oophorectomy using multifire GIA surgical stapler. *J Gynecol Surg* 1990, 6:287-8.
15. Nezhat C, Nezhat F, Pennington E. Laparoscopic treatment of infiltrative rectosigmoid colon and rectovaginal septum endometriosis by the technique of videolaparoscopy and the CO<sub>2</sub> laser. *Br J Obstet Gynecol* 1992;99:664-7.
16. Nezhat C, Nezhat F. Safe laser endoscopic excision or vaporization of peritoneal endometriosis. *Fertil Steril* 1989;52:149-51.
17. Nezhat C, Pennington E, Nezhat F. Laparoscopically assisted anterior rectal wall resection and reanastomosis for deeply infiltrating endometriosis. *Surg Laparosc Endosc* 1991;1:106-8.
18. Nezhat C, Nezhat F, Pennington E. Laparoscopic proctectomy for infiltrating endometriosis of the rectum. *Fertil Steril* 1992;57:1129-32.
19. Nezhat F, Nezhat C, Pennington E, et al. Laparoscopic segmental resection for infiltrating endometriosis of the rectosigmoid colon: a preliminary report. *Surg Laparosc & Endosc* 1992;2:212-6.
20. Nezhat C, Nezhat F, Pennington E, et al. Laparoscopic partial colon resection and reanastomosis for deeply infiltrative endometriosis, in press 1993. *Surg Endosc*.
21. Nezhat C, Nezhat F, Ambroze W, et al. Laparoscopic repair of small bowel, colon, and rectal endometriosis: a report of twenty-six cases. *Surg Endosc* 1993;7:88-9.
22. Stanley KE, Utz DC, Dockerty MB. Clinically significant endometriosis of the urinary tract. *Surg Gynecol Obstet*. 1965;120:491.
23. Fianu S, et al: Surgical treatment of post abortum endometriosis of the bladder and postoperative bladder function. *Scand J Urol Nephrol* 1980;14:151-5.
24. Anderson WC, Larsen GD. Endometriosis: treatment with hormonal pseudopregnancy and/or operation. *Am J Obstet Gynecol* 1975;118:643-51.
25. Neto WA, Lopes RN, Cury M, et al. Vesical endometriosis. *Urology* 1984;24:271-4.
26. Goldstein MS, Brodmann ML. Cystometric evaluation of vesical endometriosis before and after hormonal or surgical treatment. *Mt Sinai J Med* 1990, 57:109-111.
27. Davis GD, Brooks RA. Excision of pelvic endometriosis with the carbon dioxide laser laparoscope. *Obstet Gynecol* 72:816, 1988.
28. Martin DC, Vander Zwag R. Excisional techniques for endometriosis with the laser laparoscope. *J Reprod Med* 1987;32:754.
29. Nezhat C, Nezhat F, Green B. Laparoscopic treatment of obstructed ureter due to endometriosis by resection and ureteroureterostomy. A case report. *J Urol* 1992;148:865-8.
30. Nezhat F, Nezhat C. Laparoscopic segmental bladder resection for endometriosis: A report of two cases. *Obstet Gynecol* 1993;81.