

Robotic-Assisted Laparoscopic Treatment of Bowel, Bladder, and Ureteral Endometriosis

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ABSTRACT

Background: Endometriosis commonly affects the pelvic organs but can also affect organs outside the pelvis and is then termed extragenital endometriosis.

Cases: Successful robotically assisted laparoscopic management of extragenital endometriosis, specifically, endometriosis of the bowel, bladder, and ureter in 5 patients.

Conclusion: A substantial body of evidence supports the laparoscopic approach as the preferred method for many procedures; yet, a majority of procedures today still are performed by laparotomy. This preference for open procedures is likely due to the lack of trained endoscopic surgeons, the difficulty in obtaining proper instruments, and the long learning curve of operative laparoscopy. The recent advent of computer-enhanced technology may provide the bridge necessary for more surgeons to incorporate laparoscopic surgery in the treatment of complex cases.

Key Words: Endometriosis, Laparoscopy, Extragenital, Robot.

INTRODUCTION

Endometriosis is a gynecologic disorder defined as the presence of endometrial glands and stroma outside the uterine cavity. It affects as many as 15% of fertile women and up to 50% of infertile women.¹ Endometriosis most commonly affects the pelvic organs. When found outside the pelvis, it is termed extragenital or extrapelvic endometriosis. The most common sites of extragenital endometriosis are the intestine and urinary tract. Less commonly, endometriosis can affect distant sites including the lung and diaphragm.²

Laparoscopic management of extensive extragenital endometriosis has been reported by our group since the mid to late 1980s. (See Nezhat, C. Nezhat, F. Presentation of Evaluation of safety of videolaparoscopic treatment of bowel endometriosis at Scientific Paper and Poster Sessions, 44th Annual Meeting of the American Fertility Society. October 8-13, 1988. Atlanta, Georgia).³⁻¹² Recently, robot-assisted laparoscopy has been used to manage pelvic endometriosis.¹³⁻²¹

Using a computer-enhanced robotic system has multiple advantages. It provides a 3-dimensional view, excellent visualization of the surgical field, and tremor-free movement. The simulation of an open surgical environment facilitates the successful completion of complex procedures that are not otherwise easily accomplished laparoscopically by less experienced surgeons. Thus, the robot can enable laparoscopic surgical management of inherently complex procedures such as treatment of severe extragenital endometriosis.

Here, we report our experience with successful robotic-assisted laparoscopic treatment of endometriosis of the bowel, bladder, and ureter in 5 patients. Although standard laparoscopic management of this pathology has been reported since the late 1980s, it is not widely practiced. The addition of computer-enhanced technology may facilitate the conversion of these procedures from laparotomy to laparoscopy. We will describe our procedures and discuss the potential benefits afforded by robotics in these cases.

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Disclosure: Intuitive, Storz, and Plasma Jet.

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METHODS

In each case, laparoscopy was assisted by the da Vinci Robotic Surgical System (Intuitive Surgical Inc., Sunnyvale, CA). Our surgical techniques have been described previously.^{17,19} In summary, all patients were placed in the dorsal lithotomy position. A Foley catheter was placed followed by insertion of a HUMI uterine manipulator. Four laparoscopic ports were inserted: one 12-mm umbilical, two 8-mm midlateral, and one 5-mm to 12-mm suprapubic or one right upper quadrant port. We began each procedure using standard laparoscopy with subsequent introduction of the robot into the surgical field. During robot-assisted laparoscopy, the primary surgeon controlled the robot remotely from the console, which displayed a high-definition, highly magnified 3D image of the surgical field. The suprapubic port was used by the assistant to provide ancillary laparoscopic instruments as needed by the surgeon. Instruments used during the robotic procedures included a needle holder, a monopolar hook, a suction/irrigator, a grasper, and scissors. Additional equipment used during the laparoscopic portion of the procedures included a vessel-sealing device, a CO₂ laser, a suction/irrigator, a grasper, the Kleppinger bipolar system (Richard Wolf Medical Instruments Corporation, Vernon Hills, IL), and/or the PlasmaJet energy system (Plasma Surgical, Limited, Abingdon, Oxfordshire).

CASE REPORTS

Two patients with endometriosis of the bowel, 2 patients with endometriosis of the ureter, and 1 patient with endometriosis of the bladder are included in this report (**Table 1**). All patients gave their consent to be included in this case study.

CASE ONE

Of the 2 patients with bowel endometriosis, the first underwent robotic-assisted laparoscopic radical hysterectomy, bilateral salpingo-oophorectomy and segmental bowel resection, with reanastomosis.^{5,6,10,20} The patient is a 41-year-old G1P1 with no medical comorbidities and a history of severe endometriosis previously treated laparoscopically in 2000 and 2002. The patient also underwent a cesarean delivery in 2003. She complained preoperatively of diffuse pelvic pain, diarrhea, dyschezia, and dysmenorrhea that had been relieved somewhat by prior surgical treatment but had recurred.

Upon entry with the laparoscope, we noted extensive adhesions of the rectum and rectosigmoid colon to the

uterus and adnexa, resulting in complete posterior cul-de-sac obliteration. In addition, there was a stricture of the rectosigmoid colon approximately 30cm from the dentate line. We performed a cystoscopy and inserted ureteral catheters bilaterally before proceeding with the radical hysterectomy and bilateral salpingo-oophorectomy. Our surgical techniques have been described previously.¹⁸ We then mobilized the rectosigmoid colon down to the rectovaginal fascia. The rectosigmoid segment and the distal sigmoid colon were severely foreshortened by the large volume of surrounding fibrosis and endometriosis. Careful dissection was carried laterally to mobilize the descending colon as well as a fibrotic sigmoid endometrioma. The left ureter was identified, dissected, and left free in the retroperitoneal space. The endometrioma and rectosigmoid segment were shifted and retracted laterally. Dissection was continued to free the cuff of the upper rectum, which was then divided with an Endo-GIA that had been placed through the ancillary port. The mesocolon was also divided at the level of the sigmoid colon in anticipation of reanastomosis. In sum, a 10-cm segment of the rectosigmoid colon more than 30cm from the dentate line was removed. The suprapubic incision was enlarged to 4cm, and the Alexis wound protector was inserted. The excised rectosigmoid segment was removed through the enlarged suprapubic incision. An EEA stapler was inserted into the rectum after sufficient dilatation, and the rectal stump was reanastomosed to the sigmoid colon. We ensured that there was no tension at the level of the anastomosis. The proximal sigmoid colon was then obliterated by compression, and the anastomosis was submerged under saline solution. The rectum was insufflated with air under pressure to assure there was no leak. The patient did well after surgery and was discharged on the third postoperative day. Pathology revealed severe bowel endometriosis. This patient is doing well and is pain free 10 months later.

CASE TWO

The second patient with bowel endometriosis underwent robotic-assisted laparoscopic disc excision of the rectal wall.^{3,11,12,22} The patient is a 30-year-old G0 with a history of congenital absence of the left kidney and left adnexa as well as unicornuate uterus. She presented with constipation and dyschezia. Prior to our involvement in her case, she had been evaluated for these symptoms and was found to have a palpable mass on rectal examination. A colonoscopy revealed a 4-cm submucosal mass approximately 10cm from the anal verge. An exploratory laparoscopy was performed and confirmed the presence of se-

Table 1.
Basic Characteristics of Patients Included in Case Series

Case	Age	Pre-operative Symptoms	Previous Surgery	Procedure	Operation Time	Blood Loss (mL)	Hospital Stay (days)	Pathologic Confirmation of Endometriosis	Follow-up (months)	Post-operative Symptoms
1	42	Diffuse pelvic pain, diarrhea, painful BM, dysmenorrhea	Laparoscopic treatment of endometriosis (2000 and 2002); Cesarean section (2003)	Robot assisted laparoscopic radical hysterectomy, bilateral salpingoophorectomy, segmental bowel resection and reanastomosis	5h49m	350	3	Rectosigmoid colon, right and left ovaries, left fallopian tube	14	None
2	30	Constipation, pain with bowel movement	Exploratory laparoscopy (2009)	Robot assisted laparoscopic disc excision of anterior rectal wall	4h17m	100	1	Rectovaginal septum, anterior rectal wall, bladder serosa,	16	Mild constipation, much improved
3	49	Diffuse pelvic pain, dyspareunia, dysmenorrhea, menorrhagia, urgency, frequency, incomplete void	Hernia repair (1987); Cystostomy with J stent placement (2006)	Robot assisted laparoscopic hysterectomy, right ureteroneocystostomy and psoas hitch	5h15m	125	3	Uterosacral and cardinal ligaments, ureter	55	Mild RUQ pain related to gallbladder polyps, subsequently underwent laparoscopic cholecystectomy
4	36	Diffuse pelvic pain, constipation, dyspareunia, left sided lower extremity edema	Exploratory laparotomy, left salpingoophorectomy (1/2009); left ureteral stent (3/2009)	Robot assisted laparoscopic treatment of extensive pelvic and extragenital endometriosis including endometriosis of pelvic sidewalls, extensive right uterolysis, left nephrectomy	7h55m	300	3	Serosa right ureter, rectal bulb biopsy, left perirectal biopsy left and right pelvic sidewall, left ovarian remnant, left ureteral biopsy, left iliac vessel biopsy, left common iliac artery biopsy	12	Mild diarrhea, resolved, no pain
5	31	Frequency, painful urination during menses	None	Robot assisted laparoscopic segmental bladder resection and repair	4h 5m	100	2	Bladder excision, uterine biopsy	16	Mild cramping after sex, yeast infections

vere endometriosis after which the patient was referred to our center.

Upon entry with the laparoscope, we noted evidence of complete posterior cul-de-sac obliteration as well as a 4-cm saddle lesion on the anterior rectosigmoid colon approximately 18cm from the dentate line and attached to the posterior aspect of the vagina and unicornuate uterus. We proceeded with careful dissection and mobilization of the rectosigmoid colon. Right and left pararectal areas were entered laterally. Superiorly, we entered the presacral space at the level of the sacral promontory, and inferiorly we entered the rectovaginal space. This process was complicated by the severe nodularity and fibrosis created by extensive endometriosis in this area. After mobilization, we excised the lesion approximately 20cm from the dentate line using the da Vinci Robot grasper and scissors. The excised portion of bowel measured 4.3cm in total. We repaired the defect with multiple interrupted 2-0 Vicryl sutures using the da Vinci Robot needle holders. Sigmoidoscopy was performed to confirm adequate repair. Pathology revealed extensive endometriosis of the rectum, rectovaginal septum, and bowel. Postoperatively, the patient is doing well and is pain free 12 months later.

CASE THREE

Of the 2 patients with ureteral endometriosis, the first underwent robotic-assisted laparoscopic hysterectomy and right ureteroneocystostomy with a psoas hitch.^{4,8,19,23} The patient is a 49-year-old G2P2 with no medical comorbidities who presented with diffuse pelvic pain, dysmenorrhea, and significant genitourinary symptoms including urgency and frequency.

Upon entry with the laparoscope, we noted severe endometriosis of the posterior cul-de-sac and lower portion of the broad ligament as well as evidence of partial right hydroureter. We proceeded first with hysterectomy. Our surgical technique has been described previously.¹⁹ We then directed our attention to the extensive endometriosis creating a stricture of the right ureter. We first mobilized the ureter beginning approximately 7cm from the insertion of the ureter to the bladder. Given the extensive disease burden in this area, we transected the affected portion of the ureter and made a fish mouth incision using robotic scissors. Retroperitoneal mobilization of the ureter was then carried up above the pelvic brim. A bladder flap was developed, and the space of Retzius was entered to complete mobilization. Three 1-0 interrupted delayed absorbable sutures were placed through the bladder dome to the psoas tendon and were secured. A cystotomy was

then made in the dome of the bladder and a 0.38 Benson guidewire was passed through this cystotomy into the intraperitoneal space and then retrograde up the right ureter into the renal pelvis. The ureter was then anastomosed to the bladder by using 4 interrupted, full-thickness 4-0 polydioxanone sutures placed at 3, 6, 9, and 12 o'clock. These sutures incorporated the serosa, muscularis, and mucosa of the bladder and ureter. The ureteral stent was retained for 4 weeks. Pathology revealed severe endometriosis of the uterosacral cardinal ligament complex and endometriosis of the right ureter. Postoperatively, the patient is doing well and has been pain free for over 4 years.

CASE FOUR

The second patient with endometriosis of the ureter also had severe endometriosis of the left pelvic sidewall affecting the left external iliac artery and vein, the left common iliac artery and vein, and the superior and inferior hypogastric plexi. The patient is a 36-year-old G1 with chronic hypertension. She presented with diffuse pelvic pain, constipation, dyspareunia, severe left lower quadrant pain, and left lower extremity pain, swelling, and paresthesia. Given this history, her physician had recommended life long anti coagulation therapy. The patient presented to us after a previous attempt at curative open surgery had been unsuccessful. Her surgeons had indicated that further attempts at surgical treatment might result in loss of her leg or death. Prior to surgery, imaging revealed an infiltrative soft tissue process within the left pelvis, which exerted a mass effect upon the left ureter causing severe hydronephrosis and hydroureter. A renal scan revealed severe cortical thinning and only 15% remaining kidney function.

The patient underwent robotic-assisted laparoscopic left nephrectomy, right ureterolysis, resection of endometriosis of the rectovaginal septum, and removal of endometriosis of the major vessels of the left pelvic wall. Upon entry with the laparoscope, we noted extensive adhesions of the rectum and rectosigmoid colon to the fundus of the uterus obliterating the posterior cul-de-sac and then extending superiorly. We first proceeded with enterolysis and ureterolysis. The left ureter was occluded 10cm from the ureterovesical junction. Superior to this point, severe hydronephrosis was noted consistent with previous imaging. The inferior obliterated portion of the left ureter was resected and a left simple nephrectomy was performed. Multiple pathology specimens from the right and left sidewalls, right ureteral serosa, the left ureter, the rectal bulb, the left external iliac artery and vein, the left common iliac artery and vein, and the bowel were positive for endome-

triosis. The excised left kidney had evidence of chronic obstructive pyelonephritis. Postoperatively, after 8 months of follow-up, the patient has done well. Her left lower extremity swelling and numbness have resolved. She is pain-free and spontaneously achieved pregnancy 5 months after surgery. She delivered a healthy child in August 2011.

CASE FIVE

The final patient with endometriosis of the bladder underwent robotic-assisted laparoscopic segmental bladder resection and repair. The patient is a 31-year-old G0 with no medical comorbidities who presented with frequency and dysuria mostly during menses. The patient had no past surgical history. Preoperatively, a cystoscopy was performed and confirmed the presence of a 2-cm by 3-cm mass in the midline 3cm behind the intraureteric ridge.

Upon laparoscopic entry, we noted an endometriotic lesion near the dome of the bladder that corresponded to the lesion observed during cystoscopy. We then proceeded with resection of this bladder mass. We first entered the vesicovaginal space and mobilized the bladder posteriorly. We then entered the right and left paravesical spaces as well as the space of Retzius to mobilize the bladder anteriorly. The endometriotic nodule and a surrounding segment of bladder, measuring 3.2cm in total, were removed. We then repaired the bladder with a running stitch and then with multiple interrupted stitches of Vicryl using da Vinci Robotic instruments. A cystoscopy was performed to confirm adequate repair. Pathology revealed endometriosis of the bladder wall. Postoperatively, the patient is doing well and is pain free after 12 months.

CONCLUSION

Despite early criticism, advanced operative laparoscopy is slowly replacing laparotomy as the gold standard of operative management for a large proportion of procedures.²⁴⁻²⁷ Minimally invasive surgery has progressed to include advanced procedures previously thought possible only by open incision. As early as 1988, our group successfully managed bowel endometriosis with laparoscopic surgery.^{3,5} More recently, in 2010, a randomized comparison of laparoscopically assisted versus open colectomy for colon cancer published in the *New England Journal of Medicine* demonstrated beneficial results in favor of minimally invasive procedures.²⁴ There is now a substantial body of evidence to support the laparoscopic

approach as the preferred method for many procedures, including surgery for malignancies.²⁶

Despite the clear advantages of minimally invasive surgery, a majority of procedures today still are performed by laparotomy. This preference for open procedures is likely due to the lack of trained endoscopic surgeons, the difficulty in obtaining proper instruments, and the long learning curve of operative laparoscopy.

The recent advent of computer-enhanced technology, more sophisticated instruments and better energy sources may provide the bridge necessary for surgeons to incorporate laparoscopic surgery into their practice. The da Vinci Robot is one example of how technology can assist in this regard. Since Nezhat's collaborative work with robotic pioneers Ajit Shah and Phil Green of the Stanford Research Institute who developed the Da Vinci robot in the 1990s, this technology has been successfully applied to multiple fields. The robot enables visualization of the surgical field in 3 dimensions, eliminates tremors, has more wrist motions, and decreases the learning curve for suturing,²⁸ all while allowing the surgeon to sit. The advantages of the robot are especially useful to the inexperienced laparoscopic surgeon during complex procedures such as those described here. The addition of robotic assistance may lead more surgeons to adopt minimally invasive techniques for complex cases when otherwise they might have resorted to laparotomy. This is especially true in a training program such as ours. The procedures described here require advanced laparoscopic suturing skills and thus may not be feasible for fellows in training with more limited laparoscopic experience. Robotic-assisted laparoscopic surgery may shorten the learning curve for these surgeons. Nevertheless, research to date has not shown superior patient outcomes using computer enhanced technology (robotic assistance) when compared to standard laparoscopy.

The additional cost of the robot when compared to standard laparoscopy is not negligible. This additional cost includes, not only the cost of the system itself but also maintenance, the need for specially trained staff, and additional operating room time. However, this cost might be outweighed by the benefit to the public in general should robotic technology result in a greater proportion of cases being performed by minimally invasive techniques with the potential result of shorter hospital stays, decreased postoperative morbidity, and fewer recovery days away from work. The cases reported here are some of the first examples of robot-assisted laparoscopic treatment of multiorgan endometriosis involving the bowel, bladder, and ureter. The patients in this series overall had favorable

outcomes after treatment. This would suggest that robotic assistance in the treatment of extragenital endometriosis is feasible and safe. However, further randomized trials are needed to fully assess the benefits afforded by robotic assistance in this patient population.

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