



The role of the robot in treating urinary tract endometriosis

Camran Nezhat^a, Anna M. Modest^b, and Louise P. King^{b,c}

Purpose of review

To detail the recent advances in the use of computer-enhanced robotic technology to surgically treat urinary tract endometriosis.

Recent findings

Few studies have been published in this field. The studies are severely limited in scope. Further study is warranted.

Summary

Robotic-assisted laparoscopic techniques have proven useful in the treatment of extensive endometriosis and may prove useful in the treatment of urinary tract endometriosis.

Keywords

endometriosis, robotics, urinary tract

INTRODUCTION

Endometriosis is defined as the presence of endometrial glands and stroma outside the uterine cavity. Diagnosis of endometriosis depends on the visualization of endometriotic lesions and histologic confirmation. Endometriotic implants have a multitude of appearances: powder burns, red, blue-black, yellow, white, clear vesicular and peritoneal windows.

Endometriosis most commonly affects the pelvic organs; however, it can be found outside the pelvis and is then termed extragenital endometriosis. The most common sites of extragenital endometriosis are the intestine and urinary tract [1].

Advanced video-assisted laparoscopic management of extensive extragenital endometriosis has been reported by our lead author's group since the mid-to-late 1980s [2–12].

Recently, robot-assisted laparoscopy has been used to manage pelvic endometriosis [13–20]. Using a computer-enhanced robotic system has multiple advantages that are especially useful in the treatment of extensive endometriosis. It provides a three-dimensional view, excellent visualization of the surgical field and thus potentially more accurate visualization of endometriotic lesions, as well as tremor-free movement.

Although laparoscopic management of urinary tract endometriosis has been reported, it is not widely practiced. The addition of computer-enhanced

technology may facilitate the conversion of these procedures from laparotomy to laparoscopy. Here, we will describe the current literature in the area of robotic-assisted laparoscopic treatment of urinary tract endometriosis.

METHODS

All studies published on the role of the robot in treating urinary tract endometriosis were reviewed. An electronic bibliographic search was carried out in December 2012 using the Medline, Embase, Web of Science and BioSYS databases. The following MESH terms were used: 'endometriosis', 'laparoscopy', 'robotics', 'surgery, computer-assisted', in combination with the following key words: 'endometriosis*', 'laparoscop*', 'robot*', 'computer assisted'. Despite initially retrieving 133 records between the four

^aThe Center for Minimally Invasive and Robotic Surgery, Stanford Medical Center, Palo Alto, California, ^bDepartment of Obstetrics and Gynecology, Beth Israel Deaconess Medical Center and ^cThe Department of Obstetrics, Gynecology and Reproductive Biology, Harvard Medical School, Boston, Massachusetts, USA

Correspondence to Camran Nezhat, MD, The Center for Minimally Invasive and Robotic Surgery, Stanford University School of Medicine, 900 Welsh Road, Suite 403, Palo Alto, CA 94304, USA. Tel: +1 650 320 8778; e-mail: drnezhat@gmail.com

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KEY POINTS

- Review of advances in the use of computer-enhanced robotic technology to surgically treat urinary tract endometriosis.
- Few comprehensive studies exist of the computer-enhanced robotic technology used to treat urinary tract endometriosis.
- The studies that do exist are severely limited in scope. Further study is warranted, although initial reports are promising.

databases, upon further review, only 13 studies directly matched our topic. The relevant studies are described briefly in the discussion below.

DISCUSSION

Urinary tract endometriosis can affect the bladder, ureter or kidneys. Estimates of the incidence of urinary tract endometriosis range from 1 to 3%. The disease most commonly affects women between the ages of 25 and 40. The bladder is most commonly affected followed by the ureter and kidneys with a ratio estimated at 40:5:1 [1,21,22^{***}] (see Table 1 [13,14,19,20,23–30] for the list of publications discussed below).

Bladder endometriosis

Bladder endometriosis can be asymptomatic, but usually will present with lower urinary tract symptoms including hematuria, dysuria, frequency and pressure [21]. Endometriosis of the bladder will most frequently be found on the serosal surface and is then treated by simple excision or fulguration as with any superficial endometriotic lesions found at diagnostic laparoscopy. By contrast, bladder endometriomas involving the detrusor muscle have a typical appearance at imaging and can be isolated for extensive resection at the time of surgery.

Robot-assisted treatment of deeply infiltrating intrinsic bladder endometriosis has been described in seven studies to date. All reports found during our literature search have been case studies and the authors have described a typical excisional procedure with a multilayer closure of the bladder. The literature in this area is limited by small numbers and a lack of reported follow-up.

No uniform approach to presurgical imaging exists. All authors at minimum describe pelvic ultrasonography which will demonstrate a bladder mass. Some authors describe the addition of magnetic resonance imaging to further delineate the lesion(s) [21]. Cystoscopy and biopsy can also be undertaken

to confirm the diagnosis and exclude malignancy before proceeding with definitive surgical management [28].

Postprocedure cystogram is routinely undertaken to ensure adequate repair at a 1-week interval before removing the foley catheter. One author described cystoscopy at 1 month and 3 months postoperatively [27]. However, imaging to rule out fistula formation or recurrence likely can be undertaken at the surgeon's discretion or in response to concerning symptoms.

In 2006, Chew *et al.* was the first to describe a case of combined transurethral and robotic-assisted laparoscopic partial cystectomy for the treatment of bladder endometrioma. The patient presented with a 7-year history of progressive abdominal discomfort and lower urinary tract symptoms. She was diagnosed with a deeply infiltrating 4-cm bladder endometrioma. After failing conservative medical therapy, she was treated with simultaneous transurethral and laparoscopic partial cystectomy and robot-assisted bladder reconstruction [14,23].

Chammas *et al.* [20] presented a single case of robotic-assisted laparoscopic partial bladder resection as well as excision of a rectal nodule and treatment of other extensive endometriosis. Full resection was accomplished and there were no operative complications. The authors note that 2 years postoperatively the patient had had no documented recurrence and became pregnant by in-vitro fertilization. Also in 2008, Liu *et al.* [19] described a single case of robotic-assisted laparoscopic partial bladder resection for the treatment of endometriosis.

In 2010 and 2011, Nezhad *et al.* [24,25] described robotic-assisted laparoscopic treatment of endometriosis of the bladder with segmental bladder resection and repair. There were no intraoperative or postoperative complications. This patient was followed for 12 months postoperatively with no recurrence of pain or lesion. This was the longest follow-up period reported.

Three other case reports were published in 2011. Bot-Robin *et al.* [26] presented a case report of four partial bladder resections for bladder endometriosis in addition to other procedures. All four patients at initial presentation had reported chronic pelvic pain associated with urinary tract symptoms. The authors described 'lesion mapping' by magnetic resonance imaging prior to surgery to assist with surgical planning. Complete resection was accomplished and no operative complications were encountered. Gallo *et al.* [27] reported a single case of robotic-assisted laparoscopic partial cystectomy. The patient presented with characteristic macrohematuria during menses. Complete resection of a large endometrioma at the bladder dome was

Table 1.

Citations	Study type	Sample size	Detail
Bladder endometriosis			
Chew <i>et al.</i> and Sener <i>et al.</i> [14,23]	Case report	1 Patient	Partial bladder resection, endometrioma
Chammas <i>et al.</i> [20]	Case report	1 Patient	Partial bladder resection with resection of rectal lesion
Liu <i>et al.</i> [19]	Case report	1 Patient	Partial bladder resection
Nezhat <i>et al.</i> [24,25]	Case series	5 Patients	1 Segmental bladder resection
Bot-Robin <i>et al.</i> [26]	Case series	6 Patients	4 Partial bladder resections for endometriosis
Gallo <i>et al.</i> [27]	Case report	1 Patient	Partial bladder resection
Saceanu <i>et al.</i> [28]	Case series	2 Women	2 Partial bladder resections
Ureteral endometriosis			
Williams and Leveillee [13]	Retrospective cohort	7 Patients	8 Ureteroneocystostomies
Nezhat <i>et al.</i> [29]	Case series	5 Patients	1 Ureteroneocystostomy, 1 ureterolysis
Frick <i>et al.</i> [30]	Case series	2 Patients	2 Ureteroneocystostomies

achieved. The patient was followed up to 6 months after surgery at which time she was pregnant and then went on to deliver at term. Saceanu *et al.* [28] described two cases of robotic-assisted laparoscopic resection of large bladder endometriomas.

Ureteral endometriosis

Ureteral endometriosis is frequently asymptomatic, or at best presents with vague nonspecific symptoms associated with pelvic endometriosis and pelvic pain. The clinical presentation may be obstruction and can include silent kidney loss. As with bladder endometriosis, ureteral endometriosis can be intrinsic or extrinsic with a reported 1:4 ratio [21].

Intrinsic disease can infiltrate the muscularis, lamina propria or ureteral lumen. Such infiltrative disease usually requires resection. To re-establish a functional ureter, the surgeon must assess the location and amount of ureter resected. Short distances may be treated with ureteroneocystostomy with or without a psoas hitch, whereas larger distances may require a Boari flap, ileal interposition or autotransplantation. By contrast, with extrinsic disease, endometrial tissue invades only the adventitia or surrounding connective tissue and can be treated with ureterolysis [21,31].

Robot-assisted treatment of extensive pelvic endometriosis frequently involves ureterolysis and thus treatment of extrinsic ureteral endometriosis. Various authors have described this use of the robot, most notably Nezhat *et al.* [22²³,25,30,32–34].

Laparoscopic treatment of deeply infiltrative intrinsic disease by resection is technically difficult. Ureteral implantation requires precise movements and the use of fine caliber suture. The advantages of robotic assistance, specifically better visualization

and wristed instrumentation, may be well suited to this type of surgical intervention [30]. To date, four case reports have been published to describe this procedure in the setting of endometriosis.

In 2009, Williams and Leveillee [13] reported on their experience of robotic-assisted laparoscopic ureteroneocystostomies in seven patients with ureteral obstruction including one resulting from endometriosis.

In 2011, Nezhat *et al.* [29] described two cases of ureteral endometriosis treated with robotic-assisted laparoscopy. The first patient underwent right ureteroneocystostomy with a psoas hitch along with hysterectomy for pelvic pain. This patient was followed for 4 years postoperatively with no recurrence. The second patient had bilateral ureteral disease. A soft-tissue mass within the left pelvis exerted a mass effect on the left ureter, resulting in severe hydronephrosis and hydroureter with only 15% remaining kidney function on the left. This patient underwent robotic-assisted laparoscopic left nephrectomy, right ureterolysis for extrinsic disease, resection of endometriosis of the rectovaginal septum and removal of endometriosis of the major vessels of the left pelvic sidewall. The second patient was followed for over a year and a half with no recurrence and eventually had a successful pregnancy that she carried to term.

Two other studies in 2011 described robotic-assisted laparoscopic treatment of ureteral endometriosis. Frick *et al.* [30] reported two cases of ureteral obstruction secondary to endometriosis managed with robotic-assisted laparoscopic partial ureterectomy and ureteroneocystostomy. Khanna *et al.* [35] described the techniques involved in robotic-assisted ureteral reconstruction because of multiple causes including endometriosis.

CONCLUSION

Despite early criticism, advanced video-assisted laparoscopic surgery (VALS) is slowly replacing laparotomy as the gold standard of operative management for a large proportion of procedures. Minimally invasive surgery has progressed to include advanced procedures previously thought possible only by open incision. There is now a substantial body of evidence to support the laparoscopic approach as the preferred method for many procedures.

Nevertheless, a majority of procedures today still are performed by laparotomy. This preference for open procedures is likely because of 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 the surgeons to incorporate laparoscopic surgery into their practice. The da Vinci robot is one example of how technology can assist in this regard. The advantages of the robot are especially useful to the inexperienced laparoscopic surgeon during complex procedures such as those described here.

The literature reviewed here represents some of the first examples of robot-assisted laparoscopic treatment of urinary tract endometriosis. The patients in these cases series have overall had favorable outcomes after treatment. This would suggest that robotic assistance in the treatment of urinary tract endometriosis is feasible and well tolerated. However, further randomized trials are needed to fully assess the benefits afforded by robotic assistance in this patient population.

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Conflicts of interest

Disclosures: *The authors do not have any disclosures.*

REFERENCES AND RECOMMENDED READING

Papers of particular interest, published within the annual period of review, have been highlighted as:

- of special interest
- of outstanding interest

Additional references related to this topic can also be found in the Current World Literature section in this issue (pp. 343–344).

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