World J Urol (2006) 24: 188–192
DOI 10.1007/s00345-006-0071-5

TOPIC PAPER

Daniel S. Elliott · George K. Chow · Matthew Gettman

# Current status of robotics in female urology and gynecology

Received: 1 March 2006 / Accepted: 6 March 2006 / Published online: 24 March 2006


**Abstract** Currently, there has been limited reporting and research in the female urology and gynecological literature concerning the use of robotics. To date, robotics have been utilized only for the treatment of three benign gynecologic conditions: benign hysterectomy; repair of vesicovaginal fistula; and sacrocolpopexy which is a treatment for posthysterectomy vaginal vault prolapse. We describe a novel minimally invasive technique of vaginal vault prolapse repair and present our initial experience. The surgical technique involves placement of five laparoscopic ports: three for the daVinci® robot and two for the assistant. A polypropylene mesh is then attached to the sacral promontory and to the vaginal apex using Gortex sutures. Thirty-one patients underwent a robotic-assisted laparoscopic sacrocolpopexy at our institution in the past 24 months for severe symptomatic vaginal vault prolapse. Complications were limited to mild port site infections in two patients, which resolved with oral antibiotic therapy. While our early experience utilizing robotic repairs in female urology and gynecology is encouraging, long-term data are needed to confirm these findings and establish longevity of the repair.

**Keywords** Robotics · Laparoscopy · Sacrocolpopexy · Vaginal vault prolapse

## Introduction

Currently, there has been limited reporting and research in the female urology and gynecological literature concerning the use of robotics. To date, robotics have been utilized only for the treatment of three benign gynecologic conditions: benign hysterectomy [1]; repair of vesicovaginal fistula [2]; and sacrocolpopexy which is a treatment for posthysterectomy vaginal vault prolapse [3, 4]. However, laparoscopy has been utilized extensively in gynecologic surgeries and has demonstrated itself to be invaluable with procedures such as total and supracervical hysterectomies and for the evaluation and treatment of endometriosis [5]. More recently, laparoscopy has been reported for staging purposes of gynecologic malignancies, for the treatment of early stage endometrial cancer, and the treatment of ectopic pregnancies [6–8].

To demonstrate robotics potential benefit to other areas of female urology and gynecology, this manuscript will focus on the emerging benefit discovered for the treatment of vaginal vault prolapse.

It has been estimated that one in nine women will undergo a hysterectomy in their lifetime, and up to 10% of these women will need surgical repair for treatment of a major, symptomatic vaginal prolapse [9]. The search for the type of repair that offers the best combination of the most effective, safest, and most durable for the treatment of vaginal vault prolapse is an ongoing process as evidenced by the multiple surgical approaches to this problem. Clearly, no one surgical approach is ideal for every patient. However, as the known risk factors for prolapse, such as age, obesity and hysterectomy, continue to increase in the United States, so does the need for continuing the search for better means to repair vaginal vault prolapse. [10–12]

Currently, the transabdominal sacrocolpopexy has been shown, on multiple studies, to have one of the highest long-term success rates for durable repair of severe vault prolapse (93–100%) [13–21]. In addition to a high success rate and durable results, other advantages of the sacrocolpopexy approach with the use of synthetic material to repair vault prolapse can be summarized as follows:

Financial disclosure of authors: D.S. Elliott: none; G. Chow: none; M. Gettman: none

D. S. Elliott (✉) · G. K. Chow · M. Gettman
Department of Urology, Sections of Female Urology and Urologic Laparoscopy,
Mayo Clinic, 200 First St. S.W., Rochester MN, 55905, USA
E-mail: elliott.daniel@mayo.edu
Tel.: +1-507-2843983
Fax: +1-507-2844951

1. Support of the vaginal vault to the anterior surface of the sacrum preserves (or restores) the normal axis of the vagina.
2. Maximal vaginal depth can be preserved which is especially important in patients who desire continued sexual activity and in patients with an already foreshortened vagina from previous surgery.
3. Use of synthetic suspensory material can provide a source of strength in patients where the native tissue with prolapse is weak [13].

Potential candidates for the open procedure tend to be younger patients and those who are more active and are more likely to be leading an active lifestyle. Other important indications are concurrent medical conditions such as chronic cough, COPD, and asthma. These conditions place chronic and repeated increased intra-abdominal pressure on the repair. Unfortunately, due to the morbidity of the open transabdominal procedure, many patients are unable to tolerate the surgery. Therefore, many of these patients are treated via a transvaginal approach.

Goals of every surgical repair of vaginal vault prolapse include restoration of proper anatomy, maintenance of sexual function, and durability. Surgical approaches to correct the prolapse include either a vaginal or an abdominal approach or a combination of both. The main advantage to vaginal approach has historically been decreased morbidity, including shorter hospitalization and convalescence [22, 23]. Unfortunately, long-term success rates with transvaginal repairs are consistently lower compared to the abdominal approach such as sacrocolpopexy [24].

In an effort to balance the benefit of the open sacrocolpopexy (durable repair) with the advantage of a vaginal repair (reduced morbidity), many attempts have been made with treating the vault prolapse via laparoscopic sacrocolpopexy [25, 26]. Unfortunately, technical difficulties in actually accomplishing the procedure and the potentially significant increase in operative time have greatly limited its widespread use. To address these specific limitations of laparoscopic repairs, we feel that recent advances in robotic surgery may be an answer.

Telerobotics provides technical features such as three-dimensional vision, increased robotic instrument maneuverability, and physiologic tremor filtering. These factors provide an ergonomic environment for the surgeon that simplifies performance of complex laparoscopic tasks. We describe the technique of robotic-assisted laparoscopic sacrocolpopexy using a polypropylene graft. Our ultimate goal of the robotic-assisted laparoscopic sacrocolpopexy was threefold:

1. Provide the most durable repair for vaginal vault prolapse.
2. Minimize the morbidity associated with transabdominal procedures.
3. Provide a procedure that can be accomplished within a reasonable operative time.

## Surgical technique

The daVinci robot is an integrated computer-based system consisting of two interactive robotic arms, a camera arm, and a remote control with three-dimensional vision capability. The daVinci robot uses instruments with 6 degrees of freedom that provide the same flexibility of the human wrist. The working robotic arms are attached to reusable 8-mm trocars, while the camera is placed through a standard 12-mm laparoscopic port. For optimal robot function and to minimize risk of collisions, the angle created by the camera port and each working robotic port should be obtuse and the distance between the ports at least one hand-breadth. With robotic surgery, the motions of the surgeon at the remote control unit are replicated by the robotic arms placed within the patient. Tactile feedback is not available with daVinci, therefore an increased reliance on visual inputs is required. During robotic surgery, an assistant surgeon is scrubbed at the operating table. The assistant performs a variety of important robot-related tasks including alignment and exchange of instruments on the robotic arms. Furthermore, the assistant performs operative maneuvers with conventional instruments including tissue countertraction, hemostasis, hemoclip application, suction, and assistance during suturing. Most importantly, the scrubbed assistant is available in the event that an emergent conversion would be required.

For the procedure, the patient is placed in the dorsal lithotomy position on the operating table. After general anesthesia is established, a nasogastric tube is placed and both arms are tucked beside the torso. The patient is prepped from the nipples to proximal thigh including the vagina.

After abdominal insufflation using a Varus needle, we place a periumbilical Visiport under direct vision to avoid visceral or vascular injury. Two standard laparoscopic ports are next introduced under direct vision. One 10 mm port right subcostal lateral to the rectus and one 5 mm port one hand-breadth inferior-laterally (Fig. 1). These ports are used for retraction during the procedure. Next, two 8 mm robotic ports are placed lateral to the rectus two fingerbreadths superior to the ileac crest.

At this point, using standard laparoscopy, a retracting suture is placed through the sigmoid tenia to eventually help in exposing the sacral promontory. The next step is dissection of the bladder from the anterior vaginal wall using forceps and scissors with cautery. A customized handheld vaginal retractor manufactured at the Mayo Clinic (Fig. 2) is used to facilitate the dissection, which should be a relatively bloodless plane. Posteriorly,

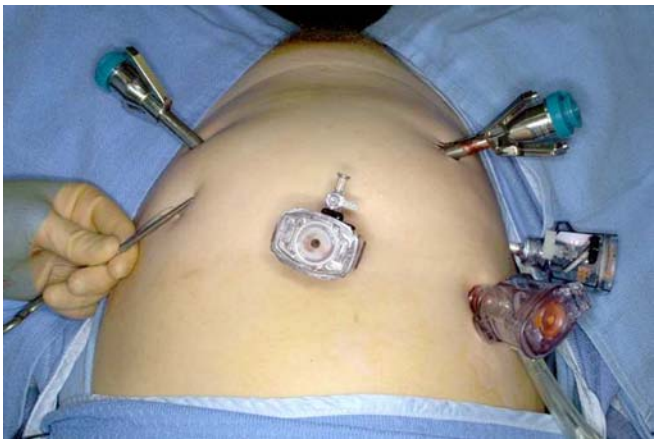

**Fig. 1** Port placement

**Fig. 2** Mayo vaginal hand-held retractor

the peritoneal reflection is then incised to mobilize the vagina. Both of these dissections should be carried out as distal (toward the introitus) as possible to maximize the support given by the Y-graft. After adequate vaginal mobilization the sacral dissection with careful attention to avoid sacral venous complexes is accomplished. Once the shiny periosteum is exposed, the polypropylene Y-graft (IntePro™ American Medical Systems, Minnetonka, MN, USA) (Fig. 3) is brought into the field through the 10 mm port. To date, in our experience, the aforementioned steps can be accomplished within 30–40 min.

The robot is now docked with the base positioned at the foot of the bed. The main reason to utilize the robot at this point in time is to facilitate and greatly reduce the operative time needed for suturing of the graft to the vagina and the sacrum. The Y-shaped graft is inserted via a port. The graft is then robotically sutured using 1.0 Gore-Tex. The 30° lens and vaginal retractor maximize exposure for placement of the sutures. We have found that placing the posterior sutures first, as they are more difficult, followed by suturing the anterior portion of the Y-graft reduces the difficulty of the process. The tail end of the graft is then sutured to the sacral promontory using three to four interrupted sutures with careful attention to avoid any undo tension on the vagina. We also perform a standard Halban's culdoplasty with plication of the uterosacral ligaments to further aid in the prevention of recurrent vaginal prolapse. The posterior peritoneum is then closed to completely retroperitonealize the graft.

## Results

At our institution, we have performed robotic-assisted laparoscopic sacrocolpopexy on 31 patients for the treatment of high grade, symptomatic vaginal vault prolapse over that past 24 months. Mean age is 66 (47–82) years. Ten patients of the 25 patients (40%) underwent a concurrent anti-incontinence procedure at the time of the prolapse repair to treat concurrent stress urinary incontinence. Mean total operative time was 3.2 (2.25–4.75) h. Initially, the "skin-to-skin" time was 4.75 h. However, with experience and utilizing multiple

**Fig. 3** IntePro® polypropylene Y-Graft. (American Medical Systems)

various time-saving steps, we are now routinely completing the case within 2.5 h.

One patient had to be converted to an open procedure secondary to unfavorable anatomy. All but three patients were discharged from the hospital after an overnight stay; three patients were dismissed on postoperative day #2. All patients were dismissed on oral pain medication. Fifteen of the patients have reported that they only required non-steroidal anti-inflammatory medication for control of their pain.

## Complications

Complications were limited to mild port site infections in two patients, which resolved with oral antibiotic therapy. One patient developed recurrent grade 3 rectocele, but had no evidence of cystocele or enterocele. One patient developed a small erosion of the synthetic cuff into the vagina 6 months following the procedure. This was easily managed with an outpatient, transvaginal excision. Significant incontinence ($>1$ pad/day) was present in two patients. All 31 patients reported being satisfied with the outcome of their surgery and 30/31 would recommend it to a friend. The one patient who did not recommend the procedure was the solitary patient who was converted to an open procedure.

### Limitations of robotic-assisted sacrocolpopexy

One of the obvious limitations with this procedure is the learning curve associated with laparoscopy itself. Clearly, the technical aspect of laparoscopy requires advanced training; however, with the addition of robotics, the technical difficulty of the procedure is actually reduced. Individuals with basic laparoscopy skills usually are able to master the procedure when it is combined with robotics. However, the advantage of the robot does come with a price tag attached. Currently, the da Vinci Robotic system can be purchased for roughly US $1 million. It is true the device cuts down on operative time but for many facilities, the price tag may prohibit its purchase. In larger institutions, the device is used in many other surgical specialties, thereby, saving considerable operative time, and thereby, making the purchase price more palatable.

### Conclusion

We feel, and the data support, that transabdominal sacrocolpopexy is the most durable and effective treatment for posthysterectomy vaginal vault prolapse. However, not every patient is a candidate for this procedure due to age, concurrent medical conditions or concerns regarding postoperative recovery time. We also feel that the advantage of a robotic-assisted laparoscopic sacrocolpopexy accomplishes the identical repair as that of the open transabdominal technique. The morbidity associated with that of the open procedure is greatly reduced and the hospital stay has been reduced from 2 to 5 days with the open procedure, down to 1 day with the laparoscopic repair. [27, 28] Also, based upon early, short-term results, it appears that the durability of the repair will be the same as with the open procedure. Potentially, many more women will be able to be offered the strongest repair for prolapse while still keeping the morbidity to a minimum. As long-term results become available we will better be able to determine the durability of this repair.

Relative contraindications would be the same for most laparoscopic procedures including patients with prior abdominal surgeries and those with morbid obesity. Clearly, longer follow-up is needed; however, the robotic-assisted laparoscopic sacrocolpopexy described in this report may be an ideal approach to the surgery repair of vaginal vault prolapse.

## The future of robotics in gynecology

Though the robotics experience is early, the potential for robotics in this surgical specialty is significant. Clearly, there are limitations to robotics; however, since many gynecologic surgeons feel comfortable with the use of laparoscopy, the potential to transfer those skills to robotics is clearly present and the benefit to patients potentially dramatic.

## References


1. Beste TM, Nelson KH, Daucher JA (2005) Total laparoscopic hysterectomy utilizing a robotic surgical system. J Soc Laparoendosc Surg 9(1):13–15
2. Sundaram BM, Kalidasan G, Hemal AK (2006) Robotic repair of vesicovaginal fistula: a case-series of 5 patients. Urology (in press)
3. DiMarco DS, Chow GK, Gettman MT, Elliott DS (2004) Robotic-assisted laparoscopic sacrocolpopexy for treatment of vaginal vault prolapse. Urology 63(2):373–376
4. Elliott DS, Frank I, DiMarco DS, Chow GK (2004) Gynecological use of robotically assisted laparoscopy: sacrocolpopexy for the treatment of high-grade vaginal vault prolapse. Am J Surg 188(Suppl):52S–56S
5. Jenkins TR (2004) Laparoscopic supracervical hysterectomy. Am J Obstet Gynecol 191(6):1875–1884
6. Yu CK, Cutner A, Mould T, Olaitan A (2005) Total laparoscopic hysterectomy as a primary surgical treatment for endometrial cancer in morbidly obese women. Br J Obstet Gynecol 112(1):115–117
7. Barakat RR (2005) Laparoscopically assisted surgical staging for endometrial cancer. Int J Gynecol Cancer 15(2):407
8. Subair O, Omojole F, Mistry N, Morgan H (2004) Trainees and the management of ectopic pregnancy. J Obstet Gynaecol 24(7):811–812
9. Marchionni M, Bracco GL, Checcucci V, Carabaneanu A, Coccia EM, Mecacci F et al. (1999) True incidence of vaginal vault prolapse. Thirteen years of experience. J Reprod Med 44(8):679–684

10. Dwyer PL, Lee ETC, Hay DM (1988) Obesity and urinary incontinence in women. Br J Obstet Gynaecol 95:91–96
11. Virtanen HS, Makinen JI (1993) Retrospective analysis of 711 patients operated on for pelvic relaxation in 1983–1989. Int J Gynecol Obstet 42:109–115
12. Olsen A, Smith V, Bergstrom J, Colling J, Clark A (1997) Epidemiology of surgically managed pelvic organ prolapse and urinary incontinence. Obstet Gynecol 89(4):501–506
13. Addison WA, Timmons MC (1993) Abdominal approach to vaginal eversion. Clin Obstet Gynecol 36(4):995–1004
14. Timmons MC, Addison WA, Addison SB, Cavenar MG (1992) Abdominal sacral colpopexy in 163 women with posthysterectomy vaginal vault prolapse and enterocele. J Repro Med 37(4):323–327
15. Cundiff GW, Harris RL, Coates K, Low VHS, Bump RC, Addison WA (1997) Abdominal sacral colpoperineopexy: a new approach for correction of posterior compartment defects and perineal descent associated with vaginal vault prolapse. Am J Obstet Gynecol 177(6):1345–1353
16. Snyder TE, Krantz KE (1991) Abdominal-retroperitoneal sacral colpopexy for the correction of vaginal prolapse. Obstet Gynecol 77(6):944–949
17. Menefee SA, Miller KF, Wall LL (1999) Results of abdominal sacral colpopexy using polyester mesh in the treatment of posthysterectomy vaginal vault prolapse and enterocele. Obstet Gynecol 54(9):563–565
18. Reddy K, Malik TG (2002) Short-term and long-term follow-up of abdominal sacrocolpopexy for vaginal vault prolapse: initial experience in a district general hospital. J Obstet Gynaecol 22(5):532–536
19. Addison WA, Timmons MC, Wall LL, Livengood CH (1989) Failed abdominal sacral colpopexy: observations and recommendations. Obstet Gynecol 74(3 pt 2):480–483
20. Addison WA, Timmons MC (1997) Abdominal sacral colpopexy for the treatment of vaginal vault prolapse with enterocele. In: Rock JA, Thompson JD (eds) Te Linde's operative gynecology, 8th edn. Lippincott-Raven Publishers, Philadelphia
21. Webb MJ, Aronson MP, Ferguson LK, Lee RA (1998) Posthysterectomy vaginal vault prolapse: primary repair in 693 patients. Obstet Gynecol 92(2):281–285
22. Podratz LK, Ferguson VR, Lee RA, Symmonds RE (1995) Abdominal sacral colpopexy for posthysterectomy vaginal vault descensus. Obstet Gynecol 50(10):719–720
23. Karram M, Goldwasser S, Kleeman S, Steele A, Vassallo B, Walsh P (2001) High uterosacral vaginal vault suspension with fascial reconstruction for vaginal repair of enterocele and vaginal vault prolapse. Am J Obstet Gynecol 185(6):1339–42; discussion 42–43
24. Benson JT, Lucente V, McClellan E (1996) Vaginal versus abdominal reconstructive surgery for the treatment of pelvic support defects: a prospective randomized study with long-term outcome evaluation. Am J Obstet Gynecol 175(6):1418–21; discussion 21–22
25. Ostrzenski A (1996) Laparoscopic colposuspension for total vaginal prolapse. Int J Gynaecol Obstet 55(2):147–152
26. Cosson M, Rajabally R, Bogaert E, Querleu D, Crepin G (2002) Laparoscopic sacrocolpopexy, hysterectomy, and burch colposuspension: feasibility and short-term complications of 77 procedures. J Soc Laparoendosc Surg 6(2):115–119
27. Cosson M, Bogaert E, Narducci F, Querleu D, Crepin G (2000) Laparoscopic sacral colpopexy: short-term results and complications in 83 patients. J Gynecol Obstet Biol Reprod Paris 29(8):746–750
28. Montironi PL, Petruzzelli P, Di Noto C, Gibbone C, De Sanctis C, Fedele M (2000) Combined vaginal and laparoscopic surgical treatment of genito-urinary prolapse. Minerva Ginecol 52(7–8):283–288