2009

Robot-assisted laparoscopic surgery in gynecology: scientific dream or reality?

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Objective: To analyze the feasibility, safety, advantages, and disadvantages of using robotic technology for gynecologic surgeries in a large group of patients.
Design: Retrospective study (Canadian Task Force classification II-3).
Setting: Tertiary endoscopic referral centers.
Patient(s): Eighty-seven patients requiring laparoscopic treatments for benign gynecologic conditions.
Intervention(s): Charts reviewed from robotic-assisted gynecologic operative laparoscopies.
Main Outcome Measure(s): Length of surgery, time for robot assembly and disassembly, rate of conversion to laparotomies, and complications.
Result(s): Between January 2006 and August 2007, 137 robotically assisted gynecologic procedures were performed in 87 patients. The da Vinci Surgical System was used. The average length of the surgeries was 205 minutes (60–420 minutes). Assembly of the robot lasted 16 minutes (10–27 minutes) when disassembly took 2.5 minutes (2–6 minutes). There were no conversions to laparotomy. There were three complications.
Conclusion(s): Robotic-assisted technology, in its present state, is enabling more surgeons to perform endoscopic surgery. Its advantages are 3D Vision and a faster learning curve for suturing and operating while sitting. It's an exciting enabling technology with a great future. (Fertil Steril® 2009;91:2620–2. ©2009 by American Society for Reproductive Medicine.)

Key Words: Robotic-assisted laparoscopy, gynecologic surgery, da Vinci robot

Computerized enhanced robotic surgery using the daVinci Robotic Surgical System has been applied successfully in urology (1, 2), cardiac (3), general (4), and orthopedic (5) surgery, ophthalmology (6), neurosurgery (7), and gynecology (8–11). The use of robotic assistance (RA) in laparoscopy has been proposed to overcome the disadvantages of traditional laparoscopy while still benefiting from the advantages of the minimally invasive technique (12). The RA laparoscopic surgery has the potential to facilitate surgical procedures by allowing the surgeon to seat comfortably while visualizing the abdominopelvic cavity in three dimensions with magnification. The dexterity and precision of the surgeon is increased by using articulated instruments allowing more range of motion and filtration of natural tremor (12–14). Our previously reported experience with RA laparoscopy was limited in numbers to 15 patients (9). The current article reflects our experience with computer-enhanced "robotic" surgery in a large sample of women undergoing various benign gynecologic procedures to provide a better understanding of the role of robotic technology in gynecologic surgeries.

Received September 21, 2007; revised and accepted March 25, 2008; published online July 24, 2008.
C.N. has received honorarium from Intuitive Surgical. O.L. has nothing to disclose. M.L. has nothing to disclose. E.U. has nothing to disclose. C.H.N. has nothing to disclose. F.N. has nothing to disclose.
This study has no source of funding and was not presented at any meeting.
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MATERIALS AND METHODS

Benign RA laparoscopies performed between January 2006 and August 2007 were monitored. The investigation met the internal review board approval. The da Vinci robotic surgical system (Intuitive Surgical Inc., Sunnyvale, CA) was used in all the cases. All patients were positioned in dorsal lithotomy. A HUMI uterine manipulator and a Foley catheter were first placed. Four trocars were inserted: one 12-mm supra- or intraumbilical, two 8-mm lateral, and one 5-, 10-, or 12-mm left paraumbilical or suprapubic trocar. Every procedure started as a standard laparoscopy, followed by the integration of robotic instrumentation and then switching

0015-0282/09/$36.00
doi:10.1016/j.fertnstert.2008.03.070

back to laparoscopy to finalize the last steps. All tissue suturing tasks were performed with the assistance of the robotic arm. Morcellation of uterus and fibroids, cystoscopies, and sigmoidoscopies were done after its disassembly.

Along with the robotic arms standing over the patient, at least three people (the surgeon, a scrub nurse, and a scrub assistant) were involved in each robotic procedure. The surgeon controls the robotic arms remotely from the console while watching a high-definition highly magnified three-dimensional (3D) image. The paraumbilical or suprapubic port was used by the assistant to provide ancillary laparoscopic instruments as needed by the surgeon. A microphone located on the surgeon's consol improves communication between the team members. The instruments used during the laparoscopic portion of the procedure included a LapCap (Aragon Surgical, Palo Alto, CA) for creation of pneumoperitoneum, a Ligasure, Harmonic scalpel, CO2 laser, suction-irrigator, extra grasping forceps, and bipolar. The robotic part required a needle holder, PreCise bipolar forceps, and/or scissors with or without unipolar electrocautery.

RESULTS

During the studied interval, 136 RA gynecologic procedures were performed in 87 women. Mean patients' age was 38 years old (20–65 years). Mean patients' body mass index was 23 [18–33]. Seventeen patients (19.5%) had had a previous laparoscopy and 14 (16%) a previous laparotomy. Table 1 summarizes the type of surgery performed. Most patients (57%) had either a hysterectomy or a myomectomy. An average of 1.6 procedures per patient were done.

In average, the operating length was 205 minutes (60–240 minutes). Table 2 stratifies the duration of the surgery for myomectomy, hysterectomy ± salpingo-oophorectomy and oophorectomy. Mean assembly of the robot was 16 minutes (10–27 minutes) when disassembly took 2.5 minutes (2–6 minutes). The robot was draped before the beginning of the procedure, which takes generally 10 minutes, but may be much longer without well-trained staff.

TABLE 1

Robotic-assisted surgeries.

Procedure	N
Hysterectomy + oophorectomy	17
Hysterectomy	10
Myomectomy	23
Oophorectomy	6
Ovarian cystectomy	14
Ovarian drilling	2
Salpingectomy	3
Adhesiolysis	27
Peritoneal biopsies	14
Appendectomy	16
Mosckovitz	4
Ureteroneocystostomy	1
Total	137

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TABLE 2

Duration of RA laparoscopic procedures.

	N	Length (minutes)
Myomectomy	23	137 (60–404)
Hysterectomy	10	192 (60–420)
Hysterectomy + oophorectomy	17	236 (122–355)
Oophorectomy	6	117 (58–225)

Note: Results are presented as mean (min–max). RA = robot assistance.

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None of those laparoscopies was converted to laparotomy. One patient postoperatively had a hernia of the bowel at the site of the left 8-mm port. This was diagnosed the day after surgery and was reduced successfully, laparoscopically. One patient with severe endometriosis and partial ureteral obstruction had laparoscopic hysterectomy and ureteroneocystostomy. She had severe headaches and neck pain postoperatively, which resolved spontaneously. The third patient had a small bowel obstruction following myomectomy, which was managed successfully laparoscopically. None of these patients had long-term sequelae.

Otherwise, no major complication requiring blood transfusion, readmission to the hospital, or use of antibiotics was recorded in this series of patients.

DISCUSSION

"Wherever in the body a cavity exists or a cavity can be created, laparoscopy is indicated and probably preferable. The limiting factor is the availability of proper instruments, skill and experience of the surgeon" (15). The new millennium has brought with it a worldwide interest in RA surgery. It promises improved instrumentation to allow more complex procedures to be done endoscopically and even remotely (16). Essentially, the robotic technology is aiming to offer the opportunity to bridge the gap between laparotomy and laparoscopy.

During this study, we noticed that the 7 degrees of freedom offered by intraabdominal articulated instruments and the virtual 3D imaging provided by the robot improve the precision of surgical tasks (17–19). The learning curve for suturing was not as long as standard laparoscopy. The majority of gynecologic surgeries performed via laparotomy can be accomplished with a RA laparoscopy approach. In addition, the time for mastering endoscopic surgery and suturing might be shorter, and the technology may overcome some of the skill limitation when using a "robot," which could allow

a less-skilled laparoscopist to perform suturing. It's exciting enabling technology with a great future.

However, the exchange of instruments through the trocars was more laborious during the RA portion of the surgery. Because of the bulkiness of the material, additional space is necessary and the use of the uterine manipulator or the suprapubic port is not ergonomic for assistants limiting the range of motion obtained. Larger incisions are required such as 12 mm for the camera and 8 mm instead of 5 mm for lateral ports. Larger incisions may increase the risk of herniation. In addition, the heavy robotic arms could further expand the diameter of the incisions and theoretically increase the risk of post operative bowel herniation. This happened in one of our patients despite fascia closure of the 8-mm port. Some commonly used tools, including suction-irrigator, Babcock clamps, stapler, etc., are not available in the systems and need to be used through an accessory port by a skilled assistant.

Other disadvantages of the RA surgery are lack of tactile feedback to the surgeon, inability to move the surgical table once the arms of the robots are fixed, and expenses related to the robot and its semidisposable instruments. A major drawback initially noted in our series is the overall increase in the time needed to complete the gynecologic procedures. This was attributed to the learning curve of the technology, the assembly and disassembly time of the robotic equipment, and the need to convert to conventional endoscopy in cases where morcellation or additional procedures like cystoscopy, hysteroscopy, or sigmoidoscopy were performed. The time required to drape and calibrate the system also must be considered, and all together, those delays may be sufficient to modify the schedule of the operating room. The assembly time of the robot could be significantly decreased to single digit minutes with the new generation of da Vinci and a dedicated team.

During this series, we found advantages to RA endoscopic surgery mainly when treating pathologies requiring fine manipulations in a limited field of vision such as tubal surgery, ureteral dissection, cystectomies, and suturing as opposed to procedures necessitating panoramic vision and wide angled movements like morcellation or dissection of large masses.

In conclusion, our series demonstrates that, in the field of gynecology, computer-enhanced technology ("robot") is enabling more surgeons to do laparoscopic procedures. Surgeons benefit from using the "robot" by sitting and from the 3D view; in addition, the robot makes suturing much faster to learn. It does not appear that it makes a significant difference in the outcome of the patient (20). Selection of patients is essential. We do believe that the currently available robotic system is a step forward in the field of minimally invasive surgery. The future aim must be the use of miniature robots and to deliver advanced surgical expertise worldwide through remote telesurgery, which would be the exciting part of "Robotic Surgery." Another exciting development would be that "robots" will be programmed to do the whole procedure. The master surgeons will do the "perfect surgery"; it is taped, programmed, and distributed so that the "robots" can do the "perfect surgery" for every patient all over the world!

Acknowledgments: Data were collected by Brittany Liedstrand.

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