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Total Laparoscopic Hysterectomy Utilizing a Robotic Surgical System

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ABSTRACT

Objectives: To describe the use of a robotic surgical system for total laparoscopic hysterectomy.

Methods: We report a series of laparoscopic hysterectomies performed using the da Vinci Robotic Surgical System. Participants were women eligible for hysterectomy by standard laparoscopy. Operative times and complications are reported.

Results: We completed 10 total laparoscopic hysterectomies between November 2001 and December 2002 with the use of the da Vinci Robotic Surgical System. Operative results were similar to those of standard laparoscopic hysterectomy. Operative time varied from 2 hours 28 minutes to 4 hours 37 minutes. Blood loss varied from 25 mL to 350 mL. Uterine weights varied from 49 g to 227 g. A cystotomy occurred in a patient with a history of a prior cystotomy unrelated to the robotic system.

Conclusion: Total laparoscopic hysterectomy is a complex surgical procedure requiring advanced laparoscopic skills. Tasks like lysis of adhesions, suturing, and knot tying were enhanced with the robotic surgical system, thus providing unique advantages over existing standard laparoscopy. Total laparoscopic hysterectomy can be performed using robotic surgical systems.

Key Words: Laparoscopy, Hysterectomy, Robotics.

INTRODUCTION

The da Vinci Robotic Surgical System (Intuitive Surgical, Mountain View, CA, USA) is used worldwide to perform cardiac, urologic, and general surgical procedures. These procedures include mitral valve repair, pelvic lymph node dissection, cholecystectomy, adrenalectomy, and Nissen fundoplication. Surgeons at the East Carolina University Brody School of Medicine in Greenville, North Carolina, use the system extensively for cardiac and general surgery applications.[1,2] Robotically assisted gynecologic procedures in humans described in the current literature include bilateral tubal reanastomosis and more recently hysterectomy.[3–6]

The da Vinci Robotic Surgical System overcomes many of the limitations of standard laparoscopic technique: 2-dimensional images, hand tremors, and dexterity limitations. The da Vinci uses 2 magnifying wide-angle cameras within a single 12-mm laparoscope combined with sophisticated image synchronizers, to generate a 3-dimensional image. Articulated EndoWrist instruments at the ends of each surgical arm greatly improve mobility. Seven degrees of freedom of motion are provided by the combination of the abdominal wall trocar-positioned arms (insertion, pitch, yaw) and the instrument wrists (yaw, pitch, roll, and grip). The surgeon operates from a remote master console using a combination of foot pedals and hand controls. One foot pedal controls camera movement, orientation, and focus. A second pedal provides a clutching mechanism for repositioning and centering the hand controls in a similar manner to lifting and repositioning a computer mouse on a mouse pad. The hand controls operate the instruments, which are capable of manipulation, dissection, coagulation, and suturing. The da Vinci's computer also provides motion scaling, tremor elimination, and graduated instrument grip. Limitations of the da Vinci system include setup time, cost, and limited tactile feedback. The system has been approved by the Food and Drug Administration for use in human surgical procedures.

Implementation of robotic surgery requires special training for surgeons and operating room personnel prior to performing procedures. Before progressing to total laparoscopic hysterectomies using the robotic system, training was obtained by all surgeons involved with the robotic

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system in an intensive 2-day training session with inanimate and animate labs. Credentialing to perform robotically assisted laparoscopic surgery was obtained according to our institutional policies. To gain proficiency with the robotic system, the surgeons first performed bilateral tubal ligations with robotic assistance under the supervision of surgeons credentialed in robotic surgery. Each surgeon was able to decrease operative time with each case. After becoming proficient with relatively uncomplicated cases, we proceeded with total laparoscopic hysterectomies.

METHODS

We reviewed the files of 11 patients from the gynecology clinics at the East Carolina University Brody School of Medicine who underwent robotically assisted total laparoscopic hysterectomy between November 2001 and December 2002. All patients were candidates for total laparoscopic hysterectomy. The patients were counseled on the use of the da Vinci robotic system at the preoperative visit. Patient demographics were collected and summarized. Operative times were obtained from the medical record.

At least 2 surgeons were present to perform all of the procedures. One surgeon was stationed at the robotic console remote from the patient but within the same operating room. The assisting surgeon stood at the patient's side. Standard surgical preparation and draping were performed. We placed a KOH cervical cup (CooperSurgical, Shelton, CT, USA) and RUMI uterine manipulator (Cooper Surgical, Shelton, CT, USA). The plastic KOH cup was used as a landmark high in the vagina around the cervix so as not to shorten the vagina and as a backstop for safer usage of monopolar cautery while making the vaginal incision. Because the robot lacks tactile feedback, the cup provides a good visual target. The cup also displaces the ureters laterally, offering protection from thermal spread during control of the uterine vessels.

Four incisions were made for the trocars: one 12-mm infraumbilical incision, two 8-mm lateral incisions, and one 5-mm suprapubic incision. After confirming the feasibility of the intended procedure, the robotic system was docked with the trocars. The robot was positioned just medial to the patient's right lower extremity, which allowed full range of motion of the robotic instruments as well as allowing the patient-side surgeon access to the vaginal manipulator and suprapubic port for manipulation of nonrobotic instruments. The robotic camera was placed through the 12-mm infraumbilical incision, and the robotic arms with their instruments were placed through the two 8-mm lateral incisions. The 5-mm suprapubic port was used for accessory instruments including suction/irrigators and manipulators. Ultrasonic energy was used to desiccate and divide the round, utero-ovarian ligament and the fallopian tube. The bladder flap was created using the monopolar cautery hook. The ultrasonic energy source was used to divide the broad ligament down to the cardinal ligament, and then to skeletonize the uterine artery, which was desiccated at the level of the uterocervical junction. If adequate hemostasis could not be achieved with ultrasonic energy, bipolar cautery was used to assure hemostasis before dividing the entire cardinal ligament. Since lateral spread is greater with the bipolar cautery than with ultrasonic energy, the uterine artery was divided high on the uterocervical junction and inside the KOH cup to avoid the ureter.

The incision into the vagina was performed circumferentially with the monopolar hook cautery onto the KOH cup. The uterus was then pulled down into the vagina to maintain the pneumoperitoneum. Because the incision into the vagina was made close to the cervix, the uterosacral ligaments remained intact, which provides good support for the vaginal cuff. Additionally, the uterosacral ligaments were incorporated into the cuff closure. The vaginal cuff was closed with figure-of-eight, 2–0 braided sutures. The robotic needle driver and grasper were used to tie sutures intracorporeally with a surgeon's knot followed by 3 more throws. After ensuring hemostasis, the infraumbilical incision was closed with a fascial closure, and the skin incisions were closed with a subcuticular stitch.

RESULTS

Total laparoscopic hysterectomy using the da Vinci robotic system was attempted in 11 women from November 2001 to December 2002. The average age was 38 years, average height 1.56 meters, average weight 67.5 kg, and the average body mass index (BMI) was 26. Surgical indications included menorrhagia, dysmenorrhea, chronic pelvic pain, and symptomatic fibroids. Operative time varied from 2 hours 28 minutes to 4 hours 37 minutes with an average operating time of 3 hours 12 minutes. Uterine weight ranged from 49 g to 227 g. Estimated blood loss ranged from 25 mL to 350 mL. As is standard at our institution for a total laparoscopic hysterectomy, patients were discharged home on the first postoperative day.

One case was converted to an open procuedure. The 42-year-old patient weighed 80 kg and had a history of cholecystectomy, bilateral tubal ligation, and Cesarean delivery. During this case, the ultrasonic energy source

was being used to desiccate and divide the broad ligament down to the level of the uterine arteries, at which point bleeding was encountered. After unsuccessful attempts to control bleeding laparoscopically, the decision was made to convert the case to an open procedure. Total abdominal hysterectomy and bilateral salpingo-oophorectomy were performed. The uterine weight was 204 g. She did not require a blood transfusion. The patient did well postoperatively and was discharged home on the second postoperative day.

In a patient with a prior history of a cystotomy, a 5-mm port was placed suprapubically before introduction of the robot. No blood was found in the urine, and no leakage of urine occurred during the procedure. A cystotomy was identified after skin closure, when gas was noted in the Foley bag. A urology consult was obtained. Because the robotic system was removed and all skin incisions were closed, 300 mL of radio-opaque dye was instilled into the bladder. The defect was not leaking contrast into the peritoneal cavity. The patient went home the next day with a Foley catheter in place for 1 week. Follow-up by the urologist confirmed satisfactory closure of the defect. This incidental cystotomy was totally independent of and unrelated to the use of the robotic surgical system.

DISCUSSION

Robotic systems are being used in cardiac, urologic, and general surgery. In gynecology, the use of robotic systems is developing. We believe there are advantages to performing total laparoscopic hysterectomies robotically that otherwise would have required total abdominal hysterectomy. A significant advantage of the robotic system is the 3-dimensional view that improves visualization. Three-dimensional views allow greater precision and accuracy and decrease operative time for the surgeon.[7] Another advantage of the robotic system is the wrist-like motion made available by the robotic instruments. The additional degrees of movement provide finer, more delicate manipulation of tissue and facilitate procedures that are typically more difficult, such as suturing and knot tying. However, the instrumentation has been designed for cardiac surgery. We found that the existing robotic instruments, while acceptable, could be improved for use in gynecologic surgery. We did not have access to bipolar cautery or ultrasonic energy instruments specifically made for the da Vinci system for these cases. Equipment better suited to gynecologic robotic surgery will have to be developed. Based on our experience with total laparoscopic hysterectomies, the robotic system offers some improvements over traditional laparoscopy but the additional cost, setup time, and current equipment are limitations.

In our experience, properly trained physicians and operating room staff familiar with the system can perform total laparoscopic hysterectomy safely and effectively using a robotic surgical system. With each case, we were able to improve our setup time, improve trocar and robot placement, and gain familiarity with the surgical instrumentation. With future modifications adapted to gynecologic surgery, we believe operating room times can be further reduced. Performing bilateral tubal ligations as a precursor facilitated a smoother transition to hysterectomies. Our operative times compared favorably with those already published.[6] In certain situations, it may have advantages over total abdominal or total laparoscopic hysterectomy. Other gynecologic cases of high complexity have been performed. It has been shown by Degueldre[3] that bilateral tubal reanastomosis can be performed successfully using the robotic system. Also, our urologic colleagues have shown that pelvic lymph node dissection can be performed using the robotic system laparoscopically.[8] In complex laparoscopy, the robotic surgical system will serve as a useful tool in a surgeon's minimally invasive armamentarium.

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