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Robotic Hysterectomy: Surgical Approach and Outcomes Among a Large Institutional Cohort

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ABSTRACT

The purpose of this report is to describe a technique for performing a robotic total laparoscopic hysterectomy (rTLH) with clinical outcomes on safety and efficiency. The rationale for our approach is based on a critical evaluation of the literature. Data from all rTLH procedures performed on our gynecologic oncology service between January 2017 and December 2019 were retrospectively reviewed. Using this database, perioperative data including surgical times, intra- and postoperative complications, and length of hospital stays were evaluated. The steps used to perform the procedure were outlined and illustrated. There were 826 cases of rTLH performed during the study period. A total of 688 of these cases were included for analysis. Malignant diagnoses were found in 218 cases. The median time from skin-to-skin for the entire cohort was 28.43 minutes for benign rTLH +/- BSO (bilateral salpingo oophorectomy) and 30.23 minutes for rTLH/BSO/cancer staging. Surgical complications included vaginal laceration, vaginal bleeding, urinary tract infection, serous fluid leakage from the incision, abdominal wall abscess, pelvic abscess, surgical site infection, serosal tear, enterotomy, rectal injury, acute kidney injury, perforated diverticulitis, and incarcerated bowel through the ventral hernia. The median length of stay was one day. The surgical technique is illustrated step by step. This paper describes a safe and efficient technique to perform rTLH and shows that surgical times, complication rates, and length-of-stays compare favorably to the literature. A description of the technique clarifies many of the details of this procedure which can be made routine to minimize error and surgeon discrepancies. We encourage readers to use this paper as a guide to modify their techniques for robotically assisted laparoscopic hysterectomy.

KEYWORDS
Robotic Hysterectomy, technique and outcome

INTRODUCTION

Hysterectomy is the most common surgical procedure performed by gynecologists, accounting for over 600,000 operations annually in the United States.1 There are a variety of approaches and techniques described to perform a hysterectomy; there are subtotal and total hysterectomies which can be performed vaginally, abdominally, laparoscopically-assisted vaginally, completely laparoscopically, and robotically. This report describes one technique for performing a robotic total laparoscopic hysterectomy that can be completed safely and efficiently. The rationale for this approach is based on an evaluation of the literature.

As medical history explains, the first reported elective hysterectomy was a total hysterectomy performed through the vaginal approach by Conrad Langenbeck in 1813. The first elective abdominal hysterectomy was a subtotal operation performed by Charles Clay of Manchester in 1863.[2] Subtotal abdominal hysterectomies were the operation of choice until 1929 when EH Richardson performed the first total abdominal hysterectomy (TAH). Concerns over the potential for the development of cancer in a conserved cervix, combined with further improvements in operative, antibiotic, and anesthetic techniques, led to the resurgence of the total hysterectomy, which replaced the subtotal hysterectomy almost completely in the 20th century.

Minimally invasive surgical techniques were added to the gynecologist's armamentarium in the

1960s.[3,4] In the 1990s, laparoscopic-assisted vaginal hysterectomies (LAVH) were popularized.[5] While the initial motivation for the use of LAVH may have been to convert TAH to less invasive hysterectomies removed vaginally, the use of LAVHs soon began to replace total vaginal hysterectomies (TVH) even though the American College of Obstetrics and Gynecology recommends the vaginal approach as the safest technique to use.[6] Still, conventional laparoscopy had limitations, and the development of robotic surgical systems presented opportunities for improvement.

The first case series on rTLH was published in 2002, describing a safe technique for use in humans. However, it also reported long operating times, significant blood loss, and a high conversion rate to laparotomy compared to TLH.[7] In 2005, the FDA approved the use of robotic surgery for gynecologic surgeries. As experience with the robotic system increased, the advantages offered by robotic hysterectomy, including improved dexterity, 3D vision, less blood loss, and shorter operating times became more apparent. Shashoua et al. demonstrated decreased length of stay and parenteral narcotic use with rTLH as well as comparable operative times to TLH when controlling for BMI, uterine size, and the need for laparoscopic morcellation.[7] Martino et al. showed that patients undergoing rTLH had significantly lower hospital readmission rates, estimated blood loss, and length of stay compared to patients undergoing hysterectomy for benign indications via laparoscopy, laparotomy, and vaginal routes.[8] rTLH has also been shown to have improved outcomes in patients with malignancy. In their review, Escobar et al. show similar advantages for patients with endometrial cancer.[9] Multiple other studies have also confirmed that compared to TLH, rTLH is associated with a shorter length of stay, fewer post-operative complications, and lower conversion rates to laparotomy.[10]

This report describes a method of performing rTLH. Our technique has been modified from a surgical procedure demonstrated to us during a gynecologic oncology fellowship from 2011 to 2014 and has been utilized in our practice until July 2016. The purpose of this manuscript is twofold: 1) to illustrate and outline the steps of the procedure and 2) to report the clinical outcomes from a series of patients who underwent this procedure in our service.

METHODS

The study was approved by the Marshall Institutional Review Board (IRB). A retrospective electronic chart review was performed to collect data, and 826 women were identified who underwent robotic-assisted total laparoscopic hysterectomy between January 2017 and December 2019. Of the 826 women, 138 were excluded from analysis due to missing data (e.g., total time on the surgeon console), leaving a final sample of 688. All cases were performed at Cabell Huntington Hospital (CHH) in Huntington, West Virginia by the same gynecologic oncologist and assisted by obstetrics and gynecology residents from the Joan C. Edwards School of Medicine at Marshall University. The robotic-assisted total laparoscopic hysterectomies were performed utilizing an 8-mm camera port and two 8-mm operative ports, as well as the da Vinci Xi Robotic Surgical System (Intuitive, Inc., Sunnyvale, CA). We identified steps completed during the procedure, including bilateral salpingo-oophorectomy, bilateral salpingectomy, omentectomy, ureterolysis, lysis of adhesions, lymph node dissection, ovarian cystectomy, and debulking for each patient.

After de-identifying the cases, the following demographic information, preoperative variables, intraoperative variables, and postoperative variables were collected: body mass index (BMI), steps completed during the procedure, total console time, length of hospital stay, and postoperative complications. Blood loss data from 30 patients' charts was randomly sampled from each group (benign and malignant) and averaged to create an estimate of mean group blood loss. A step-by-step outline of the technique used to perform rTLH in our service is explained and illustrated. Descriptive statistics are provided for continuous data (Table 1), and frequency data are provided for categorical variables (Table 2).

Independent t-tests were used to compare each continuous variable (BMI, total console time, and length of hospital stay) for benign and malignant groups using a 2-tailed significant threshold of α= 0.05. Any outlying cases exceeding 2 +/- 2SD from the total console time group mean were excluded from the total console time analysis (n=29).

RESULTS

Overall, women with malignant diagnoses (M=37.68, SE0.689) had significantly higher BMIs than those with benign diagnoses (M=35.64, SE=0.484; p =0.0159). There was no significant difference between benign and malignant groups for total console time (p=0.446) or length of hospital stay (p=0.084).

An independent t-test was performed to compare estimated blood loss from the 30 participants randomly sampled from each group. There was no significant difference in estimated blood loss between the benign (M=47.1 mL, SD=15.21) and malignant groups (M=52.10 mL, SD=34.37; p=0.46).

rTLH OUTCOMES

From January 2017 to December 2019, 826 consecutive procedures that included rTLH were performed on our gynecologic oncology service. A total of 688 make up the cohort described in this report. Each procedure was performed by the same attending physician (NBZ) along with a PGY-2 or PGY-4 resident.

Malignant indications for surgery accounted for 218 of the 688 cases (31.6%). Of the malignant cases, none were converted to an exploratory laparotomy. Postoperatively, we encountered one pelvic abscess (0.45%) requiring hospitalization and treatment

Variable	Diagnosis	Range	Mean +/- Standard Deviation
BMI (kg/m2)	Benign (N=470)	15.4 - 74.74	35.64 +/- 10.3
	Malignant (N=218)	18.95 - 68.27	37.68 +/- 9.82
Total Console Time (minutes)	Benign (N=454)	9.0 - 96.00	28.43 +/- 14.54
	Malignant (N=205)	14.0 - 83	30.22 +/- 10.95
Length of Stay (day)	Benign (N=470)	0.28 - 4.69	1.13 +/- 0.39
	Malignant (N=218)	0.20 - 4.89	1.10 +/- 0.365

TABLE 1: Descriptive Statistics of Variables in the Benign and Malignant Groups

Procedure	Benign	Malignant
Bilateral Salpingo-oophorectomy	413 (87.8%)	207 (95%)
Bilateral Salpingectomy	80 (17 %)	10 (4.6%)
Omentectomy	63 (13.4%)	39 (17.9%)
Uterolysis	31 (6.6%)	4 (1.8%)
Lysis of Adesions/ Enterolysis	120 (25.5%)	72 (33%)
Lymph Node Dissection	21 (4.5%)	170 (78%)
Ovarian Cystectomy	12 (2.5%)	1 (0.46%)
Debulking	16 (3.4%)	17 (7.8%)

TABLE 2: Frequency of Step Completed During Procedure

with antibiotics. Three surgical site infections (0.64%) required hospitalization and treatment with antibiotics. Two patients (0.91%) were treated for acute kidney injuries due to volume depletion. Of the benign cases, one (0.21%) was converted to an exploratory laparotomy due to a cecal mass requiring hemicolectomy with reanastomosis. We encountered four intraoperative complications (0.85%), including two enterotomy injuries (one during trocar placement and the other during lysis of extensive adhesions) and two serosal injuries which were repaired intraoperatively using 3.0 silk sutures.

A TECHNIQUE FOR rTLH

When performing a rTLH without BSO, we use the same steps except we do not transect the infundibulopelvic (IP) ligaments. Instead, the fenestrated bipolar and monopolar scissors devices are used to coagulate and divide the utero-ovarian ligaments as they approach the uterine cornua.

We start our procedure by performing an exam under anesthesia to assess the pelvic anatomy and appreciate any abnormality. Subsequently, we place a Foley catheter in the bladder and then a V-care uterine manipulator in the uterus after choosing the right size of the cup depending on the patient's anatomy. Once finished, we start with the abdominal approach and choose to create pneumoperitoneum using a veress needle entry technique at the supraumbilical area if no or few prior surgeries were performed on the abdomen. In a case where we expect severe adhesions, we choose the left upper quadrant as our first entry point for the veress needle. A total of three robotic 8 mm ports are introduced. The first one is introduced at the same site as the veress needle entry and will be mainly used for our camera. The remaining two trocars are used for the robotic instruments and are placed laterally to the supraumbilical trocar around 8 cm away from the midline. The wide positioning of the trocars allows for maximum access and exposure to the pelvis. No assistant trocar is used in most cases.

We start the case by asking the bedside assistant to lift the uterus anteriorly using the V-care and provide a small degree of clockwise rotation of the uterus. This allows us to suspend the right round ligament, which is then ligated and cut using the fenestrated bipolar device and the monopolar scissors. Subsequently, the right pelvic peritoneum is tented up and dissected, and the retroperitoneal space is developed. If a salpingo-oophorectomy is planned, the dissection is carried proximally to the level of the pelvic brim to isolate the IP ligament; however, if ovarian preservation is planned, then the tube is dissected out of the right adnexa using the monopolar scissors and occasionally the fenestrated bipolar grasper. Following this procedure, the anterior leaf of the broad ligament is dissected off of the uterus. At this level, we ask the assistant to exaggerate the clockwise rotation of the uterus and push the specimen towards the patient's left shoulder. This allows for better exposure of the right cardinal ligament and uterine artery and vein. Once skeletonized, the uterine vessels are ligated, cut, and dissected along with the cardinal ligament off of the lower uterine segment and cervix. The procedure is repeated in the same fashion on the left side, with the only difference being the uterine positions. We ask the bedside assistant to put the uterus in a neutral position first and then to rotate the uterus in a counterclockwise direction at approximately 10 degrees. This allows for exposure of the left round ligament and the left pelvic side wall. When the left uterine vessels are approached, the uterus is then turned in an exaggerated counterclockwise motion and pushed towards the patient's right shoulder.

Finally, the uterus is detached from the vaginal canal by circumscribing the cervico-vaginal attachment around the V-care cup using monopolar scissors. Once detached, the specimen is extracted vaginally and the cuff is closed with barbed delayed absorbable sutures in a vertical, double-layer running fashion.

DISCUSSION

Women who are offered a hysterectomy for benign or malignant indications have multiple options to consider. A TVH is generally considered the procedure of choice and is recommended by the American College of Obstetrics and Gynecology (ACOG) for most benign conditions.[6] When the vaginal approach is not adequate, minimally invasive techniques including laparoscopy and robotic surgery are considered. Over the past decade, experience with robotic surgery has significantly increased, and many studies have compared robotic hysterectomy with traditional laparoscopic hysterectomy.

Robotic-assisted hysterectomy has increased in popularity since its first use in the early 2000s. Between 2007 and 2010, robotic hysterectomy rates increased from .5% to 9.5%.[11] This paper demonstrates a safe and efficient model for rTLH for both benign and malignant diseases. Common complications associated with laparoscopic hysterectomy include conversion to laparotomy (3.9%),[12] urinary tract injury (1.2-2.6%),[13] vaginal cuff dehiscence (.64%),14 and bowel injury (.34-.45%).[15] Our data compares favorably with the rates established in the literature. We had a conversion to laparotomy rate of .002% in benign cases and 0% in malignant cases. Two enterotomy injuries and two serosal injuries to the bowel were encountered in the study group, giving a complication rate of .006% for bowel injury. We had no cases of hemorrhage, urinary tract injury, or vaginal cuff dehiscence.

Our paper also demonstrated an efficient approach to robotic hysterectomy with operative console times ranging from 9-96 minutes with no significant difference in mean console time between benign (28.43 mins) and malignant groups (30.22 mins).

Our results show that the average BMI for benign cases was 35.64 versus 37.68 for malignant patients. This represented a statistically significant difference. Interestingly, using a robotic approach can provide benefits over TLH in patients with a high BMI. One trial conducted by the Gynecologic Oncology Group demonstrated that the odds of converting to an open laparotomy during laparoscopic staging were significantly increased with an increase in BMI.[16] Cusimano et al. also found that although conversion rates between laparoscopic and robotic hysterectomy for endometrial cancer were similar for patients with BMI >30, robotic surgery was associated with fewer conversion to laparotomy for patients with BMI >40.[17] In our study, none of the malignant cases were converted from rTLH to laparotomy.

The prospectively collected data presented in this report describes a safe and efficient technique utilized to perform TLH in a relatively complex patient population. This technique has been preferentially used in our service based on a critical review of the medical literature that outlines rationales for the uses of various types of hysterectomies. Our overall laparotomy conversion rate of 0.002% compares favorably to that found in the literature. A step-by-step description of the technique clarifies many of the details of performing this procedure. We encourage readers to use this paper as a guide to modify their techniques for robotic-assisted laparoscopic hysterectomies.

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