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Successful incorporation of robotic surgery into gynecologic oncology fellowship training

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Abstract

Background—The increasing role of robotic surgery in gynecologic oncology may impact fellowship training. The purpose of this study was to review the proportion of robotic procedures performed by fellows at the console, and compare operative times and lymph node yields to faculty surgeons.

Methods—A prospective database of women undergoing robotic gynecologic surgery has been maintained since 2008. Intra-operative datasheets completed include surgical times and primary surgeon at the console. Operative times were compared between faculty and fellows for simple hysterectomy (SH), bilateral salpingo-oophorectomy (BSO), pelvic (PLND) and paraaortic lymph node dissection (PALND) and vaginal cuff closure (VCC). Lymph nodes counts were also compared.

Results—Times were recorded for 239 SH, 43 BSOs, 105 right PLNDs, 104 left PLNDs, 34 PALND and 269 VCC. Comparing 2008 to 2011, procedures performed by the fellow significantly increased; SH 16% to 83% (p<0.001), BSO 7% to 75% (p=0.005), right PLND 4% to 44% (p<0.001), left PLND 0% to 56% (p<0.001), and VCC 59% to 82% (p=0.024). Console times (min) were similar for SH (60vs. 63, p= 0.73), BSO (48 vs. 43, p=0.55), and VCC (20 vs. 22, p=0.26). Faculty times (min) were shorter for PLND (right 26 vs. 30, p=0.04, left 23 vs. 27, p=0.02). Nodal counts were not significantly different (right 7 vs. 8, p=0.17 or left 7 vs. 7, p=0.87).

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Conflict of Interest Statement
The authors declare that there are no conflicts of interest.

Conclusions—Robotic surgery can be successfully incorporated into gynecologic oncology fellowship training. With increased exposure to robotic surgery, fellows had similar operative times and lymph node yields as faculty surgeons.

Keywords

robotic surgery; gynecologic cancers; minimally invasive surgery; fellowship training; learning curve

Introduction

The da Vinci® surgical system (Intuitive Surgical, Sunnyvale, CA) was initially cleared by the Food and Drug Administration in 2005 for use in gynecologic surgery. Since that time there have been a number of publications evaluating the utility of robotic surgery in gynecologic oncology for endometrial cancer (1, 2), cervical cancer (3, 4), and the evaluation of an adnexal mass (5). Introduction of the robotic surgical system has addressed many of the obstacles of conventional laparoscopy including lack of depth perception, limited range of motion, camera instability, and a steep learning curve (6). While the number of cases performed with the robot in gynecologic oncology has continued to increase, there are limited published data regarding the impact of the robot on fellowship training.

Lee *et al.* described their systematic approach to training fellows on the robot in 2009 which included (1) didactic and hands-on training with the robotic system, (2) instructional videos, (3) assistance at the operating room table, and (4) performance of segments of the procedure in tandem with the attending physician (7). In this early evaluation of the feasibility of training fellows on the robotic system, there was no difference in surgical times between faculty and fellows. Similar to the approach by their group, the fellows at our institution are required to complete the online training, an animate lab, and additional simulation prior to participating in the operating room. In addition, a hands-on course including both a robotic dry lab as well as a cadaver lab is provided for all surgical fellows on an annual basis. The purpose of this study was to assess the incorporation of fellows into our robotic surgery program by determining the proportion of cases with the fellow seated at the console as the primary surgeon. In addition, we compared surgical times and pathologic parameters between faculty and fellow cases.

Materials and Methods

After approval from our Institutional Review Board in 2008, a prospective study of all women undergoing a robotic surgical procedure by a surgeon in the Department of Gynecologic Oncology at MD Anderson Cancer Center has been maintained. Data for cases performed between January 1, 2008 and August 31, 2011 were included in this analysis. A total of eight faculty members performed robotic procedures during the study time period, each with a different level of experience. All women scheduled for a robotic procedure were approached by a member of the research staff at their pre-operative visit and informed consent was obtained.

An intra-operative data sheet was completed during the procedure that includes surgical start and end time, docking start and end time, console start and end time. Docking time was defined as time to advance the column to the operating table, fastening the robotic arms to the inserted trocars, and introducing the camera and instruments. In addition, the intra-operative data sheet provides a standard breakdown of each surgical procedure including simple hysterectomy +/− salpingoophorectomy (SH), unilateral or bilateral salpingoophorectomy (USO/BSO), right pelvic lymph nodes (RPLND), left pelvic lymph

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nodes (LPLND), para-aortic lymph nodes (PALND), vaginal cuff closure (VCC), and other. The start and end times for each portion of the procedure, as well as the primary surgeon performing each portion of the procedure was recorded at the time of the surgery. The primary surgeon was defined as the surgeon who was at the console for more than 50% of that portion of the procedure. For each surgical case, the primary surgeon could vary for each part of the procedure. For example, the fellow may have performed one side of the lymph node dissection (RPLND) and the faculty the other (LPLND). Additional data collected included demographic characteristics, operative times, and pathologic results.

For the statistical analysis, parametric continuous variables were compared using the t-test for independent samples and one-way analysis of variance. Chi-square tests were used to compare differences in categorical variables. The Kruskal-Wallis test was used to evaluate differences in non-parametric continuous variables. Two-tailed tests were used with p-values less than 0.05 considered statistically significant. All statistical analyses were performed using SAS 9.1 for Windows (Copyright © 2002–2003 by SAS Institute Inc., Cary, NC).

Results

Between January, 2008 and August, 2011, 405 women underwent a robotic surgical procedure within the Department of Gynecologic Oncology at MD Anderson Cancer Center. The demographic characteristics for the entire cohort are list in table 1. The median age was 54.6 years. Median body mass index (BMI) was 30.8 kg/m^2. The majority of women were White (66%). The most common preoperative diagnosis was endometrial cancer/hyperplasia (54%) followed by adnexal mass (20%) and cervical cancer/dysplasia (18%). Seven percent of the procedures required conversion to laparotomy for completion of the case.

Table 2 includes the number of procedures per year broken down by the primary surgeon. The proportion of SH performed by the fellow as the primary surgeon increased significantly each year with 16% in 2008, 34% in 2009, 59% in 2010, and 83% in 2011 ($p<0.001$). Although fewer USO/BSO procedures were performed using the robot over time, we saw a similar increase in the percentage of these procedures performed with the fellow as the primary surgeon with 7% in 2008, 29% in 2009, 50% in 2010, and 75% in 2011 ($p=0.005$). While the total percentage of pelvic lymph node dissections performed by the fellows were not as high as the other procedures, the increase by year was statistically significant from 4% to 44% for the RPLN ($p<0.001$) and 0% to 56% for LPLN ($p<0.001$). During the study time period all 34 of the PALND performed robotically were done by the faculty surgeon. Vaginal cuff closure, often considered the most basic portion of the procedures performed, increased from 59% in 2008 to 82% in 2011 ($p=0.024$).

Comparisons were then made between patients that underwent surgery with the faculty as the primary surgeon versus the fellow. There was no difference in median age between the patients that underwent surgery by the faculty versus the fellow for SH (57.3 vs. 58.3 years, $p=0.52$), USO/BSO (50.2 vs. 45.6 years, $p=0.39$), RPLND (55.8 vs. 58.7 years, $p=0.86$), LPLND (57.5 vs. 48.1 years, $p=0.42$), or VCC (53.5 vs. 57.1 years, $p=0.09$). Similarly, there was no difference in median BMI for those who underwent SH (31.6 vs. 32.9 kg/m^2, $p=0.77$), USO/BSO (28.7 vs. 26.1 kg/m^2, $p=0.25$), LPLND (29.4 vs. 28.9 kg/m^2, $p=0.51$), or VCC (30.9 vs. 31.2 kg/m^2, $p=0.33$). For those who underwent RPLND the BMI was significantly lower in the faculty group (29.4 kg/m^2) vs. the fellow group (32.2 kg/m^2, $p=0.04$).

Median operative times for each procedure were then compared and are listed in Table 3. There was no statistically significant difference in operative time between faculty and fellow for SH (60 vs. 63 min, $p=0.73$), USO/BSO (48 vs. 43 min, $p=0.55$), or VCC (20 vs. 22 min, p=0.26). For RPLND, the operative times were significantly shorter for faculty (26 min) compared to fellows (30 min, p=0.04). This was also seen for LPLND (23 vs. 27 min, p=0.02). The median time to perform the PALND was 63 min (range 38 – 78). While the RPLND and LPLND operative times were longer for the fellows, there was no difference in the number of lymph nodes retrieved on the right (7 vs. 8, p=0.17) or left (7 vs. 7, p=0.87) based on primary surgeon at the console.

While it was not possible to directly compare the complication rates between faculty and fellow cases as each case may have had more than one primary surgeon, the summary of these data are listed in Table 4. The most common complication was fever, defined as a temperature greater than 38.3 degrees Celsius. Urinary tract and wound infection were the next most common complications noted. All patients were treated with antibiotic therapy and did not have any long term sequella. Bowel complications were noted in 6 patients; two had an intraoperative bowel injury that was repaired via laparotomy and four patients had postoperative ileus. There were 2 ureteral injuries repaired via laparotomy, one of which required a reoperation for a leak.

Discussion

Since the initiation of the robotic surgery program at our institution, the number of surgical procedures performed with the fellows as the primary surgeon has significantly increased each year. Currently, a majority of cases are performed by the fellow under direct supervision of the faculty, a pattern similar to that of both open and laparoscopic procedures. To the best of our knowledge, these data are some of the first to demonstrate the evolution of robotic surgery training at a large fellowship program. In addition to the increasing number of procedures performed with the fellow at the console, we found that the surgical times and the lymph node retrievals were similar between the faculty and the fellows. This suggests that in a short period of time, fellows can be trained to perform robotic surgery.

As with other advances in technology used in the operating room, the general guidelines set forth by the American College of Surgeon's apply to the robotic system. These guidelines include assessing a surgeon's eligibility to use the new technology based on previous training and experience, education required for adequate understanding of the technology, and the environment recommended for appropriate use of the new technology (8). This systematic approach is believed to result in improved patient safety when new technology is implemented. While patient outcomes and safety are the primary concern for surgeons in general, we also have a responsibility to train our future colleagues to adequately manage their patients after completion of their training. With the increasing number of gynecologic oncology cases being performed with the robot, evaluation of the impact on training programs is important.

In 2009, Hoekstra *et al.* described the change in surgical approach after introduction of their robotic surgery program and the impact on the surgical experience of their gynecologic oncology fellows (9). In just a 12 month period, the number of patients undergoing minimally invasive surgery significantly increased from 3.3% to 43.5% clearly affecting the training experience of the fellows. This transition was seen for endometrial cancer cases which went from 94% done by an open approach to 11% by laparoscopy, 49% by robot and 40% by an open approach. Similarly, the number of cervical cancer cases performed open went from 100% to just 50% during the same time period with the other 50% of radical hysterectomies being done with the robotic approach. This change in approach reflects the numerous studies addressing the benefits of minimally invasive surgery over laparotomy including shorter length of hospital stay, less blood loss, and shorter recovery times for our patients (10, 11).

A survey of gynecologic oncology fellows and fellowship program directors in 2010 found that 95% of the responders had at least one robotic system available at their training institution (12). Seventy percent of fellowship directors felt that introduction of the robot had a positive impact on fellowship training with 65% of trainees stating that they planned to use the robot once in practice. These statistics emphasize the importance of adequately educating fellows in the use of this new technology.

Similar to reports from other institutions, the fellows in our program are required to go through a series of training steps prior to participating in robotic surgical cases (7, 13). First, they must complete the online training module provided by Intuitive Surgery. In addition, they each participate in a one day, hands-on animate lab to become more familiar with the robotic instruments, camera movements, and the surgeon console. The role of the fellow in the operating room varies based on the complexity of the surgical case and the experience of the attending surgeon. Typically, the fellow starts as the bedside assistant and their participation as the primary surgeon at the console gradually increases over time. Closure of the vaginal cuff is often the first procedure performed, allowing them to use basic suturing skills. Once they have shown aptitude with this portion of the procedure, their role as primary surgeon gradually increases based on their skill set and level of complexity of the procedure. While experience with conventional laparoscopy seems to result in a faster learning curve for robotic surgery, there is no set laparoscopy requirement for the fellows prior to sitting at the robot console. This study does not formally address our training curriculum; however, it is one of the first to look objectively at the role of the fellow during robotic surgical procedures.

Over the 4 year time period, the fellows' experience as the primary surgeon increased significantly across all procedures. We feel this reflects our success in training fellows in this new technology. In order to evaluate any differences in cases performed by the faculty versus the fellow, we felt that comparing surgical times for each portion of the procedure was the most feasible way to measure the learning curve. For the procedures done most commonly by the fellows, including SH, USO/BSO, VCC we found no difference in surgical times between faculty and fellows. While the fellow experience with pelvic lymph node dissection has continued to increase, in 2011 approximately 50% of the pelvic node dissections were performed with the fellow as the primary surgeon. While the surgical times were significantly shorter for faculty performing this portion of the procedure based on our statistical evaluation, one could argue that a 4 minute difference in surgical time is not clinically relevant. More importantly, the number of lymph nodes retrieved, which is often used as a surrogate for surgical adequacy, was the same between both groups. During the study time period, all of the robotic para-aortic nodes were performed by the faculty. The relatively low number of robotic PALND done during this time period reflected our practice pattern. Initially many surgeons attempted to do the PALND with the robot, however, a majority or surgeons changed to either an extraperitoneal or transperitoneal approach to the PALND as these methods were felt to be more reliable in obtaining the infrarenal para-aortic nodes. We are currently comparing different approaches to the PALND in a separate study.

The strength of this study is the prospective collection of surgical data in over 400 consecutive robotic surgery cases over a four year time period. During the 4 years, faculty were at different stages of the learning curve, yet the fellows were still able to transition to the primary surgeon in a relatively short period of time. As with many surgical procedures, regardless of approach, more than one surgeon participates in completing the procedure. With the robot, there is one designated person (at the console) that is the primary surgeon. Breaking down each surgical case into primary surgeon for different parts of the procedure and prospectively collecting this data, allowed a comprehensive evaluation of the role of each surgeon. While our study was done in a unique clinical setting with 8 gynecologic oncology faculty, 12 clinical fellows performing the robotic procedures over the 4 year time period, and no dedicated residency training program to consider, we think our data is relevant to other surgical training programs as well as trained gynecologic oncologists learning a new technology. The main limitation of this study was our inability to determine a learning curve for each individual user over time. Unfortunately, the data was not collected in a way that the number of cases performed by Fellow A overtime could be evaluated on an individual bases. In addition we were unable to compare complication rates between faculty and fellow. This was not possible as many cases had more than one the primary surgeon for each portion of the procedure.

The role of robotic surgery has clearly changed since it was first cleared by the F.D.A. in 2005. While a number of studies have addressed the feasibility and safety of robotic surgery for the treatment of gynecologic cancer, there are limited data on the impact of this new technology on fellowship training. Our study reflects the successful incorporation of robotic surgery into a large gynecologic oncology fellowship training program. With increased exposure to robotic surgery, fellows can achieve similar operative times and pelvic lymph node yields as in cases completed by faculty surgeons. In addition, teaching tools such as robotic simulators and the dual console may have a significant impact on fellow training.

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Highlights

- The number of robotic surgeries performed with the fellow at the console has significantly increased over time.
- For common procedures like hysterectomy and vaginal cuff closure, there is no difference in surgical time between fellows and faculty

Table 1

Demographic Characteristics

	N = 405	%
Median Age (years)	54.6	
Range	18 – 85	
Median BMI (kg/m^2)	30.8	
Range	13.9 – 70.8	
Race		
White	270	66%
Hispanic	78	19%
African-American	25	6%
Asian	18	4%
Other/Unknown	14	4%
Preoperative Diagnosis		
Endometrial Cancer/Hyperplasia	219	54%
Adnexal Mass	79	20%
Cervical Cancer/Dysplasia	72	18%
Other	33	8%
Conversion to Laparotomy	29	7%

Table 2

Proportion of Procedures Performed by Faculty versus Fellow

Procedure	Year	Faculty N	%	Fellow N	%	Total N	p-value
Simple Hysterectomy	2008	31	84	6	16	37	P<0.001
	2009	57	66	30	34	87	
	2010	26	41	37	59	63	
	2011	9	17	43	83	52	
	Total	123	52	116	48	239	
USO/BSO*	2008	14	93	1	7	15	P=0.005
	2009	10	71	4	29	14	
	2010	3	50	3	50	6	
	2011	2	25	6	75	8	
	Total	29	67	14	33	43	
Right Pelvic	2008	22	96	1	4	23	P<0.001
Lymphadenectomy	2009	38	90	4	10	42	
	2010	13	54	11	46	24	
	2011	9	56	7	44	16	
	Total	82	78	23	22	105	
Left Pelvic	2008	22	100	0	0	22	P<0.001
Lymphadenectomy	2009	40	95	2	5	42	
	2010	16	67	8	33	24	
	2011	7	44	9	56	16	
	Total	85	82	19	19	104	
Vaginal Cuff Closure	2008	18	41	26	59	44	P=0.024
	2009	40	38	65	62	105	
	2010	17	26	48	74	65	
	2011	10	18	45	82	55	
	Total	85	46	184	54	269	

* unilateral/bilateral salpingoophorectomy

Table 3

Procedures and Operative Times (minutes)

Procedure	Surgeon	N	Median Time (range)	p-value
Simple Hysterectomy	Faculty	121	60 (20 – 153)	0.73
	Fellow	115	63 (29 – 165)	
USO/BSO*	Faculty	29	48 (10 – 142)	0.55
	Fellow	14	43 (8 – 116)	
Right Pelvic Lymph Nodes	Faculty	81	26 (3 – 70)	**0.04**
	Fellow	23	30 (15 – 80)	
Left Pelvic Lymph Nodes	Faculty	84	23 (9 – 53)	**0.02**
	Fellow	19	27 (14 – 52)	
Paraaortic Lymph Nodes	Faculty	34	63 (31 – 78)	N/A
Vaginal Cuff Closure	Faculty	85	20 (7– 105)	0.26
	Fellow	183	22 (8 – 65)	

*unilateral/bilateral salpingoophorectomy

Table 4

Complications

	Number
Fever	34
Pneumonia	2
Urinary tract infection	36
Cuff infection	2
Abscess	8
Wound infection	13
DVT/PE*	2
Myocardial infarction	0
Bowel complication	6
Urinary complication (injury)	2

*Deep vein thrombosis/Pulmonary embolis