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Conversion from robotic surgery to laparotomy: A case-control study evaluating risk factors for conversion

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Abstract

Objectives—To determine risk factors associated with conversion to laparotomy for women undergoing robotic gynecologic surgery.

Methods—The medical records of 459 consecutive robotic surgery cases performed between December 2006 and October 2011 by 8 different surgeons at a single institution were retrospectively reviewed. Cases converted to laparotomy were compared to those completed robotically. Descriptive statistics were used to summarize the demographic and clinical characteristics.

Results—Forty of 459 (8.7%, 95% CI 6.3%-11.7%) patients had conversion to open surgery. Reason for conversion included poor visualization due to adhesions (13), inability to tolerate Trendelenburg (7), enlarged uterus (7), extensive peritoneal disease (5), bowel injury (2), ureteral injury (1), vascular injury (1), bladder injury (1), technical difficulty with the robot (2), and inability to access abdominal cavity (1). 5% of cases were converted prior to docking the robot. On univariate analysis preoperative diagnosis ($p=0.012$), non-White race ($p=0.004$), history of asthma ($p=0.027$), ASA score ($p=0.032$), bowel injury ($p=0.012$), greater BMI ($p<0.001$), need for blood transfusion ($p<0.001$), and expected blood loss ($p<0.001$) were associated with conversion. On multivariate analysis, non-White race (OR 2.88, 95% CI 1.39-5.96, $p=0.004$), bowel injury (OR 35.40, 95% CI 3.00-417.28, $p=0.005$), and increasing BMI (OR 1.06, 95% CI 1.03-1.09,

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p<0.001) were significantly associated with increased risk for conversion. Prior surgery was not associated with conversion to open surgery (p=0.347).

Conclusion—Conversion to laparotomy was required for 8.7% of patients undergoing robotic surgery for a gynecologic indication. Increasing BMI and non-white race were identified as the two preoperative risk factors associated with conversion.

Introduction

Advances in the field of minimally invasive surgery have contributed to the widespread adoption of laparoscopic and robotic-assisted procedures for the treatment of gynecologic malignancies. The benefits of minimally invasive surgery compared with laparotomy for patients undergoing surgical treatment of gynecologic cancer have been well documented. These advantages include lower blood loss, shorter length of hospital stay, smaller incisions with fewer wound complications, earlier ambulation, and faster return to normal activities (1-7). Furthermore, robotic surgery provides many benefits to the surgeon including 3-dimensional visualization, more dexterous movements, and favorable ergonomics compared with traditional laparoscopic surgery(8).

In 2005, the da Vinci surgical system was FDA cleared for use in gynecologic surgery and since that time the uptake of robotic surgery in gynecologic oncology has continued to increase. Despite the widespread adoption and continued rise in robotic cases, there are still patients that require conversion to laparotomy at the time of surgery. In a Swedish study of the first 1,000 robotic cases in a Swedish hospital, conversion to laparotomy occurred in 3.7% of cases. The most common reasons for conversion were extensive adhesions and unexpected cancer. They did not describe any preoperative factors associated with conversion to laparotomy (9). In our practice, patients are selected for robotic surgery based on the indications for surgery and other pre-operative factors.

The purpose of this study was to identify risk factors for conversion to laparotomy by comparing the demographic characteristics and intra-operative factors of patients who were scheduled for a robotic surgery and were converted to laparotomy to those completed with the robotic approach.

Methods

Following approval from the Institutional Review Board in 2007, a prospective database of all planned robotic surgical procedures performed in the Department of Gynecologic Oncology and Reproductive Medicine was maintained. For this study we evaluated all patients who were planned to have robotic surgery between December 2006 and October, 2011 at MD Anderson Cancer Center. The procedures were performed by 8 gynecologic oncologists, all experienced in laparoscopy. Cases were defined as patients whose surgery was completed by an open approach; these included cases converted before and after the robot was docked. Women with successful completion of robotic surgery were used as controls. Preoperative variables analyzed included: age, body mass index (BMI), race, smoking history, pre-operative imaging (CT, MRI, ultrasound, PET/CT), American Association of Anesthesia Classification (ASA), cancer diagnosis, medical co-morbidities, and surgical history. Intraoperative factors that were assessed included reason for conversion to laparotomy, need for blood transfusion, intraoperative complications (vascular injury, cystotomy, ureteral injury, bowel injury), and estimated blood loss. Readmission within 30 days of surgery was also evaluated.

Descriptive statistics were used to summarize the demographic and clinical characteristics of patients overall and by conversion status. Fisher's exact tests were used to compare the distribution of characteristics between patients with (cases) and without conversion (controls) for categorical variables. For continuous variables the Wilcoxon rank sum test was used to compare medians between cases and controls. Logistic regression methods were used to model the logit of the probability of conversion as a function of potential prognostic factors. Odds ratios (ORs) for continuous variables represent the increased odds for conversion for a 1 unit increase in the variable. ORs for categorical variables represent the increased odds of conversion for the presence of that variable. Multivariate logistic regression was performed with a forward selection method considering those pre-operative factors with p-values < 0.20 on univariate analysis. We included the factor with the smallest p-value in the model first, and then added factors in order of increasing p-value. Only factors with p-values < 0.05 were allowed to remain in the model. We report the p-value for each factor along with the OR and its 95% confidence interval. With 459 patients we were able to estimate the percent of patients with conversion with a 95% confidence interval with precision 4.4% or less. This calculation was performed with nQuery Advisor ® 7.0 (Copyright © 1995-2007, Statistical Solutions, Saugus, MA).

Results

A total of 459 patients were scheduled for robotic gynecologic surgery during the study time period. Figure 1 shows a breakdown of all patients included in the study. A total of 40 (8.7%, 95% CI 6.3%-11.7%) cases were converted to laparotomy. There were 23/459 (5%) who were converted prior to docking the robot. Once the robot was docked an additional 17/459 (3.7%) were converted to laparotomy. Conversion rates were similar between years; 2006-2007 (2/26, 8%), 2008 (11/90, 12%), 2009 (10/143, 7%), 2010 (7/94, 7%), and 2011 (10/106, 9%).

The demographic and preoperative characteristics for the entire cohort are listed in Table 1. There was no difference in median age between cases and controls (51 versus 54.5 years, p=0.192). Median BMI was significantly higher in cases than in controls (36.6 versus 30.4 kg/m^2, p<0.001). Cases were more likely to be non-White (p=0.004). There were no differences in medical comorbidities between the two groups other than history of asthma (12.5% among cases versus 4.3% among controls, p=0.027). The most common medical comorbidity was hypertension (41.4%), followed by diabetes (16.8%), depression (10.0%), asthma (5.0%), history of myocardial infarction (2.0%), and COPD (1.3%). One hundred thirty three (29.0%) patients reported a history of tobacco use. ASA score was associated with conversion to laparotomy (p=0.032). The most common preoperative diagnosis was endometrial cancer/hyperplasia (55.3%), followed by cervical cancer/dysplasia (20.3%), adnexal mass (19.6%), and prophylactic BSO (1.3%). Diagnosis was associated with increased rate of conversion (p=0.040). There was no difference in planned procedure between cases and controls (p=0.782). Most patients underwent preoperative imaging with ultrasound (38.8%), followed by CT scan (34.0%), MRI (12.2%), and PET/CT (2.6%). Preoperative imaging was not associated with conversion to open surgery.

Table 2 compares prior surgical history between the two groups. 322 (70.2%) had prior open abdominal surgery and 138 (30.1%) had prior laparoscopic surgery. The prior abdominal cases included exploratory laparotomy (25.7%), cesarean section (14.8%), cholecystectomy (6.1%), and appendectomy (9.6%). The prior laparoscopic cases included tubal ligation (13.9%), unilateral salpingoophorectomy (2.8%), bilateral salpingoophorectomy (0.4%), hysterectomy (7.0%), appendectomy (1.7%), and cholecystectomy (7.6%). Prior surgery was not associated with conversion to open surgery. There was no difference in surgical history between cases and controls.

Reasons for conversion to laparotomy are listed in Table 3. A total of 40 cases required conversion to laparotomy; 23 before and 17 after the robot was docked. The most common reasons were poor visualization due to adhesions (13, 32%), inability to tolerate Trendelenburg (7, 17.5%), an enlarged uterus (7, 17.5%) and extensive peritoneal disease (5, 12.5%). For a majority of these cases (20/32, 62.5%), the decision to convert to an open procedure was made prior to docking the robot. Additional indications included bowel injury (2), ureteral injury (1), vascular injury (1), and technical difficulty with the robot (2).

Intraoperative complications were uncommon and included ureteral injury (0.7%), bowel injury (0.7%), vascular injury (0.4%), and cystotomy (0.4%). On univariate analysis, bowel injury (p=0.012) was the only intraoperative complications associated with conversion to an open procedure. The median estimated blood loss for robotic surgery was 50 mL (range 0-900) compared with 299 mL (range 50-1600) for those requiring conversion (p<0.001). A total of 25 patients (5.4%) received a blood transfusion. The transfusion rate was significantly higher (p<0.001) among patients that required conversion (n=9, 22.5%) than those that did not (n=16, 3.8%). Twenty-nine (6.3%) patients were readmitted to the hospital within 30 days of surgery.

On multivariate analysis of pre-operative factors we found increasing BMI (OR 1.07, 95% CI 1.03-1.10, p<0.001) and non-White race (OR 2.43, 95% CI 1.24-4.76, p<0.001) to be the only factors significantly associated with increased risk for conversion.

Discussion

Conversion to exploratory laparotomy was uncommon in women undergoing robotic surgery for a gynecologic indication. In our single institution study 8.7% of cases required conversion to laparotomy to complete the procedure, more than half of which occurred prior to docking the robot. This rate is slightly higher than other retrospective robotic studies, which document conversion rates from 0.5-3.7% (9-11). It is possible that our conversion rate is slightly higher due to patient factors like obesity and other comorbidities as we are a large tertiary referral center. To date the only completed randomized controlled trial of minimally invasive surgery in gynecologic oncology patients is the GOG LAP2 trial, which reported a 25.8% conversion rate from conventional laparoscopy to laparotomy in the treatment of early stage endometrial cancer (7). While the conversion rates were noted to be very high, this study was done early in the learning curve for most surgeons performing minimally invasive gynecologic surgery. More recent data for both robotic surgery as well as conventional laparoscopy suggest the conversion rates for experienced surgeons are significantly lower (9-11) and more in line with our reported rate of 8.7%. Additional prospective data comparing robotic surgery to laparotomy in treating gynecologic cancer may be difficult to collect as many gynecologic oncologists are already offering robotic surgery in their practice.

With an aging American population and rates of obesity greater than 30%, it is important that we are able to offer minimally invasive treatment options. It is well known that larger abdominal incisions, specifically in elderly and obese patients, are associated with greater morbidity in terms of wound healing, infection, pulmonary problems, and increased use of narcotics, immobility and deep venous thromboembolism. Additionally, studies have documented obesity and age above 70 years old are independent risk factors for post-operative complications and increased hospital mortality suggesting additional benefit of minimally invasive surgery for these at-risk patients (12).

We found that increasing BMI and non-White race were the only preoperative risk factors independently associated with risk of conversion to laparotomy. While increasing BMI was associated with conversion to laparotomy, there were a number of patients that had successful robotic surgery despite being obese with BMI's as high as 70.8 kg/m^2. Therefore, obesity should not be considered a contraindication to minimally invasive surgery. It is unclear why non-White race was associated with risk of conversion. We hypothesize that this could be related to different weight distribution or a higher incidence of fibroids in the African-American population. Similar factors including increasing BMI, age and metastatic disease were also identified in the GOG LAP2 study as important preoperative factors increasing risk for conversion (7). Although we evaluated a number of other pre-operative factors that we felt may contribute to risk for conversion including medical comorbidities, cancer diagnosis and prior abdominal surgery, none were associated with increased rate of conversion on multivariate analysis.

The most common reasons for conversion included poor visualization due to adhesions, inability to tolerate Trendelenburg, an enlarged uterus and extensive peritoneal disease. Among patients converted to laparotomy prior to docking the robot, a large uterus, extensive peritoneal disease and inability to tolerate Trendelenburg were the most common. These factors are limitations of minimally invasive surgery in general and do not reflect limitations specific to the robot. In patients converted after the robot was docked a majority were due to adhesions/poor visualization. Complications, although very uncommon, also resulted in conversion to laparotomy after the robot was docked. Bowel injury was the only complication associated with a higher risk of conversion. From a clinical standpoint, this information makes sense as the conversion was likely performed to repair the injury. In addition, patients who had a conversion were more likely to have higher blood loss and blood transfusions. While these factors met significance, the data must be interpreted with caution due to very few patients experiencing these complications. While intraoperative injuries are rare, it is important to counsel patients preoperatively that if a complication occurs, the risk of conversion to laparotomy to address the complication will be higher.

The strength of our study is the prospectively maintained data on a large number of consecutive robotic surgical cases performed by 8 different surgeons. In addition, our study is one of the first to look specifically at preoperative and intraoperative factors that may put patients at higher risk for conversion to laparotomy at the time of their robotic surgical procedure. The main limitation of this study is that the primary surgeon determines which patients are considered a candidate for robotic surgery. This introduces selection bias and may not accurately represent all patients that could have been offered minimally invasive surgery. In addition, there were a group of patients who were converted prior to docking the robot. While these patients were included in the analysis, they likely represent limitations of minimally invasive surgery in general and do not reflect limitations specific to the robotic platform.

Advances in the field of minimally invasive surgery have contributed to the widespread adoption of laparoscopic and robotic-assisted procedures for the treatment of gynecologic malignancies. The benefits of minimally invasive surgical approaches compared with laparotomy have been well documented. Despite offering minimally invasive surgery to a wide variety of patients undergoing robotic gynecologic surgery, a small percentage of patients will require a laparotomy to complete their procedure. Based on our study, preoperative factors including increasing BMI and non-White race were associated with an increased risk of conversion. This information could be used to counsel patients in the preoperative setting to give them a better understanding of their surgical risks, including conversion to an open procedure.

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Research Highlights

- Conversion to laparotomy was uncommon in women undergoing robotic gynecologic surgery.
- Increasing body mass index and non-white race were associated with conversion.

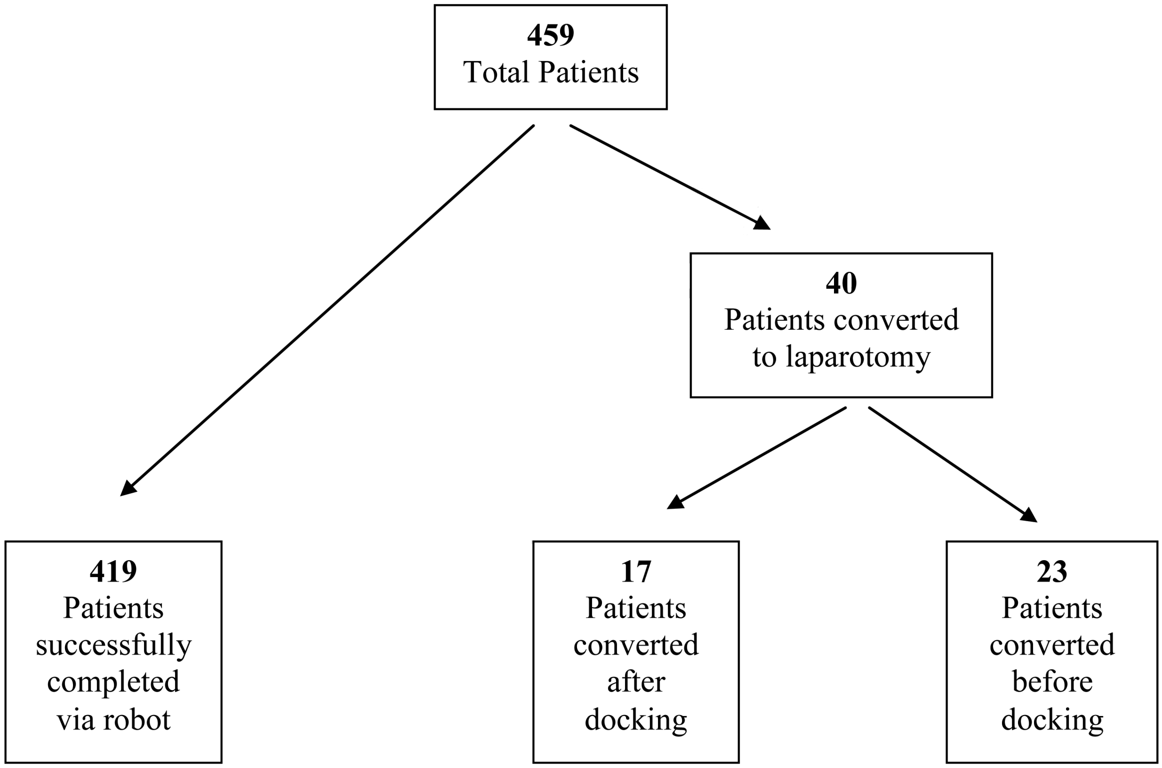

Figure 1.
Study population

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Table 1

Demographic characteristics and preoperative risk factors

	Cases n=40 (%)	Controls n=419	Total n=459	P-value
Age (yr)				0.192
Median (range)	51.0 (28-76)	54.5 (18-85)	54 (18-85)	
BMI (kg/m^2)				**<0.001**
Median (range)	36.6 (20.7-64.0)	30.4 (16.6-70.8)	30.8 (16.6-70.8)	
Race (%)				**0.002**
Asian	2 (5.0)	18 (4.3)	20 (4.4)	
Black	5 (12.5)	22 (5.3)	27 (5.9)	
Hispanic	14 (35.0)	79 (18.9)	93 (20.3)	
White	19 (47.5)	297 (70.9)	316 (68.8)	
Unknown	0	3 (0.7)	3 (0.7)	
Medical history (%)				
Diabetes	9 (22.5)	68 (16.2)	77 (16.8)	0.277
Hypertension	21 (52.5)	169 (40.3)	190 (41.4)	0.105
Myocardial infarction	0 (0.0)	9 (2.1)	9 (2.0)	0.999
Depression	6 (15.0)	40 (9.5)	46 (10.0)	0.251
Asthma	5 (12.5)	18 (4.3)	23 (5.0)	**0.027**
COPD	0 (0.0)	6 (1.4)	6 (1.3)	0.999
Smoking History	9 (22.5)	124 (29.6)	133 (29.0)	0.384
ASA (%)				**0.032**
1	5 (12.5)	12 (2.9)	17 (3.7)	
2	14 (35.0)	183 (43.7)	197 (42.9)	
3	19 (47.5)	209 (49.9)	228 (49.7)	
4	1 (2.5)	8 (1.9)	9 (2.0)	
Missing	1 (2.5)	7 (1.7)	8 (1.7)	
Diagnosis				**0.040**
Cervical cancer/dysplasia	3 (7.5)	90 (21.5)	93 (20.3)	
Adnexal mass	10 (25.0)	80 (19.1)	90 (19.6)	
Endometrial Ca/hyperplasia	24 (60.0)	230 (54.9)	254 (55.3)	
Endometrial Sarcoma	1 (2.5)	0 (0.0)	1 (0.2)	
BRCA 1/2	0 (0.0)	6 (1.4)	6 (1.3)	
Other	2 (5.0)	13 (3.1)	14 (3.1)	

Table 2

Prior surgery for cases and controls

	Cases n=40	Controls n=419	Total n=459	P-value
Prior Open Surgery	30 (75.0)	292 (69.7)	322 (70.2)	0.347
Ex Lap	12 (30.0)	106 (25.3)	118 (25.7)	0.439
Cesarean section	8 (20.0)	60 (14.3)	68 (14.8)	0.301
Cholecystectomy	3 (7.5)	25 (6.0)	28 (6.1)	0.671
Appendectomy	6 (15.0)	38 (9.1)	44 (9.6)	0.191
Laparoscopic (any)	14 (35.0)	124 (29.6)	138 (30.1)	0.412
Tubal	6 (15.0)	58 (13.8)	64 (13.9)	0.791
USO	1 (2.5)	12 (2.9)	13 (2.8)	0.912
BSO	0 (0.0)	2 (0.5)	2 (0.4)	0.999
Hysterectomy	4 (10.0)	28 (6.7)	32 (7.0)	0.406
Appendectomy	0 (0.0)	8 (1.9)	8 (1.7)	0.999
Cholecystectomy	3 (7.5)	32 (7.6)	35 (7.6)	0.997

Table 3

Reasons for Conversion

	Total (n=40)	Before Robot Docked (n=23)	After Robot Docked (n=17)
Adhesions/Poor Visualization (%)	13 (32.5)	4 (17.4)	9 (52.9)
Injury (%)			
Bowel	2 (5.0)	0 (0)	2 (11.7)
Ureteral	1 (2.5)	0 (0)	1 (5.9)
Vascular	1 (2.5)	0 (0)	1 (5.9)
Bladder	1 (2.5)	1 (4.3)	0 (0)
Large Uterus (%)	7 (17.5)	5 (21.7)	2 (11.7)
Inability to tolerate Trendelenburg (%)	7 (17.5)	6 (26.0)	1 (5.9)
Extensive peritoneal disease (%)	5 (12.5)	5 (21.7)	0 (0)
Technical Difficulty with Robot (%)	2 (5.0)	1 (4.3)	1 (5.9)
Unable to access abdominal cavity (%)	1 (2.5)	1 (4.3)	0 (0)