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Impact of Surgeon Volume on Patient Safety in Laparoscopic Gynecologic Surgery

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Abstract

OBJECTIVE—To determine the impact of surgeon volume on patient outcomes in gynecologic laparoscopic surgery.

METHODS—We reviewed all patients who underwent a laparoscopic procedure between January 2000 and December 2008. Surgeons were divided into 3 groups based on surgical volume. The mean number of surgeries per year was calculated for each surgeon. Means were categorized into 3 groups. The low-, medium-, and high-volume surgeon groups were compared with respect to level of surgical complexity and intraoperative and postoperative complications.

RESULTS—The study included 829 surgeries. Low-volume surgeons (n=5) performed 5 (31.3%) low-complexity, 10 (62.5%) intermediate-complexity, and 1 (6.3%) high-complexity procedures. Medium-volume surgeons (n=6) performed 26 (11.1%) low-complexity, 203 (86.8%) intermediate-complexity, and 5 (2.1%) high-complexity procedures. High-volume surgeons (n=5) performed 47 (8.1%) low-complexity, 439 (75.8%) intermediate-complexity, and 93 (16.1%) high-complexity procedures. The distribution of surgical complexity was significantly different between the 3 groups of surgeons defined by volume ($P<0.001$). Conversion rates were higher for low-volume surgeons when compared to high-volume surgeons (18.8% vs. 5.2%; $P=0.04$). Similarly, overall complication rates (<30 days) were higher for low-volume surgeons compared to high-volume surgeons (31.3% vs. 17%, $P=0.003$). Mean length of hospital stay was longer for low-volume (2.4 days) than for medium-volume (1.3 days) and high-volume surgeons (1.6 days) ($P=0.003$).

CONCLUSION—High- and medium-volume gynecologic laparoscopists performed a greater proportion of intermediate- and high-complexity procedures than did low-volume surgeons. High-

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Conflict of Interest Statement

The authors report no conflict of interest.

volume surgeons have a lower rate of conversions, overall postoperative complications, and shorter mean length of hospital stay when compared to low volume surgeons.

INTRODUCTION

In 2000, the Institute of Medicine issued a report stating that up to 98,000 Americans die each year from preventable medical mistakes they experience during hospitalization.¹ Since this report, there has been an accelerated drive to improve the quality of healthcare and this drive is reflected in the medical literature. A large body of data has accumulated establishing improved outcomes with high-volume (HV) surgeons compared to lower-volume surgeons in many areas of surgery. This relationship has specifically been established with respect to complicated surgical procedures, including carotid endarterectomy, coronary-artery bypass grafting, aortic valve replacement, elective repair of abdominal aortic aneurysm, resection for lung cancer, esophagectomy, and pancreatic resection.²⁻⁵ Despite the large pool of data in the medical literature about the improved outcomes with HV surgeons, reports on volume-outcome relationships focused on laparoscopy, and on laparoscopy in gynecologic surgery, are sparse.

Laparoscopy has rapidly evolved from a diagnostic tool to a modality for major surgical procedures and represents one of the most important surgical advances in the past 30 years. Currently, almost every surgical technique that can be performed through an open procedure can be performed with the use of laparoscopy.⁶⁻⁹ Operative laparoscopy holds several advantages compared to laparotomy, including smaller surgical scars and faster recovery times because of decreased analgesic requirements and faster return of bowel function.⁶ Complications of operative laparoscopy in gynecologic surgery are infrequent but do occur; the most common such complications include vascular injuries, bowel injuries, genitourinary injuries, and incisional hernias.¹⁰⁻¹⁵

With the increasing prevalence of operative laparoscopy in gynecology and the expansion toward use of operative laparoscopy for more complex surgical procedures, the natural course is that some centers and surgeons will be challenged with a higher volume of patients. The aim of the current study was to determine the impact of surgical volume on patient outcomes among patients undergoing gynecologic laparoscopic surgery.

MATERIALS AND METHODS

After Institutional Review Board approval from the MD Anderson Investigational Review Board, we performed a retrospective review of all patients who underwent a laparoscopic procedure performed by any of the 16 surgeons within the Department of Gynecologic Oncology at The University of Texas MD Anderson Cancer Center between January 2000 and December 2008. Of the 16 surgeons, 4 were surgeons specializing in benign gynecologic conditions and the remaining 12 were designated as gynecologic oncology surgeons. The surgeons were divided into 3 groups based on surgical volume. This was done by calculating the mean number of laparoscopic surgeries per year operating for each surgeon. Only years in which an individual surgeon performed a laparoscopic procedure were used in this calculation. Means were subsequently categorized into 3 groups. The thirty-third percentile of the average number of surgeries per year operating was used to distinguish low-volume (LV) surgeons from medium-volume (MV) surgeons. The sixty-sixth percentile was used to distinguish MV surgeons from HV surgeons. The 3 groups were then compared with respect to intraoperative and postoperative complications. The variables examined included postoperative infectious morbidity within 30 days of surgery, postoperative noninfectious morbidity within 30 days of surgery, overall complications,

postoperative mortality within 30 days of surgery, conversion to laparotomy, hospital readmission, length of hospital stay (LOS) and estimated blood loss (EBL).

To evaluate factors independent of the expertise of the surgeon, the 3 groups were then compared with respect to patient body mass index (BMI), patient history of previous surgery, and patient medical comorbidities. Surgical procedures were divided into 3 groups (low, intermediate, and high) based on degree of complexity. Low-complexity procedures included diagnostic and second-look laparoscopy. Intermediate-complexity procedures included unilateral or bilateral salpingo-oophorectomy, unilateral or bilateral ovarian cystectomy, lysis of adhesions, bilateral tubal ligation, and hysterectomy with or without salpingo-oophorectomy. High-complexity procedures included radical hysterectomy, pelvic and/or para-aortic lymphadenectomy, splenectomy, and small bowel or colonic resection. These criteria are as defined by the MD Anderson Department of Gynecologic Oncology Innovative Surgical Research & Education Group. The 3 groups of surgeons were then compared on the basis of the complexity of surgical procedures.

A logistic regression model with patients clustered within surgeon and a term for surgical complexity was used to test for differences between surgery volume groups with respect to incidence of complications, infections, mortality, conversion, and readmission. A mixed effects regression model with patients clustered within surgeon and a term for surgical complexity was used to test for differences between surgery volume groups with respect to LOS and EBL. A *P* value of less than .05 was considered statistically significant. All data were analyzed using SPSS 15.0 for Windows (SPSS, Inc., Chicago, IL) and SAS 9.1 for Windows (Copyright © 2002-2003 by SAS Institute Inc., Cary, NC).

RESULTS

Sixteen surgeons were included in this study. Of the 16 surgeons, 5 were classified as LV, 6 as MV and 5 as HV. The surgeons performed 829 laparoscopic gynecologic procedures during the study period, 16 (1.9%) performed by LV surgeons, 234 (28.2%) performed by MV surgeons, and 579 (69.8%) performed by HV surgeons.

Patient characteristics by surgeon volume are shown in Table 1. There was no statistically significant difference between patients operated on by LV, MV, and HV surgeons with respect to age at surgery, BMI, or number of prior surgeries. There was also no significant difference between patients operated on by LV, MV, and HV surgeons with respect to incidence of medical comorbidities, including cardiovascular, respiratory, urologic, gastrointestinal, hepatic, metabolic, autoimmune, neurologic, endocrine, and hematologic conditions or prior malignancy (data not shown). Surgeons within the LV group performed a greater percentage of low-complexity procedures than did MV or HV surgeons. MV surgeons performed a greater percentage of intermediate-complexity procedures than did LV or HV surgeons, and HV surgeons performed a greater percentage of high-complexity procedures than did LV or MV surgeons. To determine whether significant differences existed between all 3 groups or simply between 2 groups, pair-wise comparisons were made for each of the analyzed variables. Again, there were no statistically significant differences between groups for age at surgery, BMI, or number of prior surgeries. The differences shown in Table 1 with respect to surgical complexity remained when MV and HV surgeons were compared ($P < 0.001$). The comparison of LV to MV ($P = 0.030$) and LV to HV ($P = 0.004$) were also statistically significant, but these comparisons are made recognizing the small number of procedures performed by LV surgeons.

Rates of surgical morbidity by surgeon volume are shown in Table 2. Patients operated on by LV surgeons had an increased rate of intraoperative complications when compared to

MV surgeons (6.3% vs. 0.9%, $P=0.017$); however, there was no difference when compared to HV (6.3% vs. 4.5%, $P=0.61$). Patients operated on by LV surgeons had higher postoperative infection within 30 days than those operated by MV and HV surgeons ($P<0.001$). The rate of conversion to laparotomy was also higher for LV surgeons than for HV surgeons ($P=0.041$). The mean hospital length of stay was longer for LV surgeons than for MV or HV surgeons ($P=0.016$). Both postoperative noninfectious complications ($P<0.001$) and hospital readmission ($P<0.001$) were more common in the MV and HV groups. There was no statistically significant difference between the three groups with respect to the mean estimated blood loss ($P=0.136$).

No cases of intraoperative mortality were documented in any of the groups. However, a single death within 30 days of surgery was reported in a patient who underwent an intermediate-complexity procedure performed by a high-volume surgeon. The patient was a 54-year-old morbidly obese woman who underwent a total laparoscopic hysterectomy and bilateral salpingo-oophorectomy for grade 1 endometrial carcinoma. She was discharged home on postoperative day 2 but presented to an outside hospital on postoperative day 6 with abdominal pain. She was found to be in multisystem organ failure. A computed tomography scan could not be obtained because of the patient's body habitus. An exploratory laparotomy for a suspected bowel perforation was planned, but the patient's condition rapidly deteriorated, and she died prior to the operation. No further details were available regarding this patient.

For intraoperative complications, HV surgeons had a higher complication rate than MV surgeons ($P=0.004$). For postoperative infection within 30 days, significant differences remained when LV and MV surgeons were compared ($P<0.001$) and when LV and HV surgeons were compared ($P<0.001$). For conversion to laparotomy, the difference was greater between LV and HV surgeons ($P=0.041$) than between LV and MV surgeons ($P=0.153$). Length of hospital stay remained significantly different between all surgeon-volume groups ($P=0.027$). For estimated blood loss, there were suggestive differences between the MV and HV groups ($P=0.078$), but the HV group had more of the high complexity procedures.

DISCUSSION

In our review, patients operated on by LV surgeons experienced greater rates of conversions, overall postoperative complications (<30 days), and longer median length of hospital stay when compared to those operated on by HV surgeons. The percentage of laparoscopic procedures converted to laparotomy was markedly increased among LV surgeons when compared to MV and HV surgeons (18.8%, 6.0% and 5.2%, respectively). In addition, the mean length of hospital stay was almost a day shorter for MV and HV surgeons. While experiencing lower rates of postoperative complications, HV and MV surgeons still performed a greater proportion of intermediate- and high-complexity procedures, when compared to LV surgeons.

Numerous other studies have demonstrated a favorable relationship between surgeon volume and patient outcome. Eppsteiner et al. evaluated 134 HV and 1,450 LV surgeons who performed 3,581 pancreatic resections over an 8-year period and noted a significantly lower mortality rate associated with the HV group of surgeons (2.4% vs. 6.4%).¹⁶ Cowan et al. observed similar findings in patients undergoing carotid endarterectomy. Compared to procedures conducted by LV and MV surgeons, procedures conducted by HV surgeons were associated with a lower rate of mortality (1.1% vs. 0.63% vs. 0.44%) and postoperative stroke (2.03% vs. 1.63% vs. 1.14%).¹⁷ In addition, Csiksz et al. reported on laparoscopic cholecystectomy and revealed lower rates of conversion to open procedure (11.8% vs.

8.0%), lower rates of prolonged hospitalization (12.8% vs. 11.1%), lower rates of bile duct injury (0.22% vs. 0.15%), and lower rates of in-hospital mortality (0.80% vs. 0.67%) for HV than for LV surgeons.¹⁸

The concept of a volume-outcome relationship is not entirely novel in gynecologic surgery. Vernooij et al. evaluated the influence of hospital and gynecologist level of specialization (general, semi-specialized, or specialized) and volume on surgical results and on survival among patients with ovarian cancer. Among patients with stage III disease, the proportion of patients with optimal debulking was 37% among patients operated on by LV gynecologists, compared to 45% among patients operated on by intermediate-volume gynecologists and 57% among patients operated on by HV gynecologists. This effect was also reflected in survival when HV and LV surgeons were compared: surgery by a HV surgeon reduced the mortality risk by 29%.¹⁹ Recently, Wright et al. utilized a national database to evaluate the influence of surgeon volume on morbidity and mortality among women undergoing abdominal radical hysterectomy. When compared to LV surgeons, patients treated by HV surgeons had fewer postoperative hemorrhages (0.2% vs. 1.6%), gastrointestinal complications (7.0% vs. 12.5%), lower transfusion requirements (6.8% vs. 13.7%), shorter lengths of stay (median 3.0 vs. 4.0 days) and lower rates of intensive care unit usage (1.8% vs. 4.1%).²⁰

While the two previously mentioned studies evaluated “open” gynecologic procedures, studies do exist evaluating operative gynecologic laparoscopy. Boyd et al. conducted a cross-sectional study utilizing the New York State Department of Health database to estimate whether a surgeon's case volume was related to route of hysterectomy, as well as short-term morbidity. Twenty-six percent of hysterectomies were found to have been performed by physicians who, on average, performed fewer than 10 hysterectomies per year. When hysterectomy was performed by surgeons who performed 10 or more hysterectomies per year, the surgery was more likely to be achieved through a minimally invasive approach. Patients operated on by these higher-volume surgeons also experienced lower rates of morbidity and mortality.²¹ In contrast, Tunitsky et al. conducted a retrospective analysis of 1016 laparoscopic hysterectomies separated between two groups of surgeons (LV vs. HV), based on a cut-off of 30 operative cases. When the two groups were evaluated, the mean operating time was longer in the LV group (188 minutes vs. 163 minutes). More importantly, no statistically significant differences were noted between the LV and HV groups with respect to: conversion rates to laparotomy, intraoperative injuries or postoperative complications.²²

Our study has several limitations and results should be interpreted with caution. Inherent to the retrospective nature of the current study, there exists the potential for underreporting of events, complications, and diagnoses. In addition, the LV group of surgeons includes a relatively small number of patients, resulting in a decreased chance to observe events. When events do occur within this group, they may also be estimated at a greater frequency. With this in mind, a separate analysis of the current data was conducted in which the sample was divided into two groups (LV+MV and HV), rather than three groups. When these two groups were considered, HV surgeons still performed a greater percentage of high complexity procedures. Despite a greater complexity level, the only factor that was different between the two groups was the rate of intraoperative complications (data not shown). Also worthy of consideration is the fact that this study was conducted using data from a large cancer research center. Patient demographics and surgeon practices may not be representative of local demographics and surgeon practices, which may vary by state and community.

In conclusion, our findings suggest that the volume-outcome relationship, previously demonstrated in other areas of surgery, may also exist in gynecologic laparoscopic surgery. The present study revealed that while MV and HV surgeons performed a higher proportion of complex surgical procedures, they did not have increased complication rates. Rather, the rates of postoperative complications and conversion to laparotomy were the greatest among LV surgeons. In addition, the postoperative length of hospitalization was almost a day longer for LV surgeons. Our current findings are consistent with the previous reports by Vernooij, Wright and Boyd.¹⁹⁻²¹ However, all of these studies are in contrast to the results observed by Tunitsky et al. One possible explanation may be in how a HV and LV surgeon is defined. Interestingly, the study by Tunitsky et al. is unique in that LV and HV surgeon groups were separated based on achieving a threshold number of surgical procedures rather than a mean number of cases per year.²² This may suggest that the benefits associated with case volume are more importantly influenced by a consistent number of cases per year rather than achieving a certain number of cases. Insights with respect to this and other factors contributing to differences in patient outcomes between different providers may improve the delivery of patient care by pointing to evidence-based practices that can be implemented by providers of all surgical volumes or by centralization of complex surgical procedures to higher-volume surgeons. We recognize that several questions remain unanswered as it pertains to strategies to increase surgeon volume and shorten learning curve to improve outcomes. It is imperative that the leadership of our specialty implement policies to create guidelines for competency requirements.

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Highlights

- Low volume surgeons experience increased perioperative laparoscopic complications
- Outcomes are improved in patients treated by medium and high-volume surgeons

Précis

Compared to surgeons of greater volume, low volume surgeons experienced increased rates of conversions and overall postoperative complications.

Table 1

Patient Characteristics and Procedure Complexity by Surgeon Volume (n=829 procedures)

	Surgeon Volume			<i>P</i>
	Low (n=16 procedures)	Medium (n=234 procedures)	High (n=579 procedures)	
Mean age at surgery, years (median)	47.0 (48.4)	51.0 (50.7)	50.3 (49.3)	0.46
Range in age, years	21.9-71.7	17.1-80.3	11.8-88.0	
Mean BMI [kg/m ²] (median)	27.0 (25.0)	27.3 (26.2)	28.7 (26.8)	0.13
Range in BMI [kg/m ²]	20.1-53.8	16.8-59.4	14.2-72.3	
Patients with 1 prior surgery	5 (31.3%)	88 (37.6%)	206 (35.6%)	0.84
Patients with >1 prior surgery	9 (56.3%)	142 (60.7%)	361 (62.3%)	0.82
Surgical complexity				
Low	5 (31.3%)	26 (11.1%)	47 (8.1%)	<0.001
Intermediate	10 (62.5%)	203 (86.8%)	439 (75.8%)	
High	1 (6.3%)	5 (2.1%)	93 (16.1%)	

BMI, body mass index.

Table 2

Surgical Morbidity by Surgeon Volume (n=829 procedures)*

	Surgeon Volume			P-values		
	Low (n=16 procedures)	Medium (n=234 procedures)	High (n=579 procedures)	L vs H	M vs H	L vs M
Intraoperative complication	1 (6.3%)	2 (0.9%)	26 (4.5%)	0.613	0.004	0.017
Postoperative infection < 30 days	5 (31.3%)	22 (9.7%)	63 (11.3%)	< 0.001	0.552	<0.001
Postoperative noninfectious complication	0 (0%)	16 (7.0%)	46 (8.2%)	< 0.001	0.723	<0.001
Overall postoperative complications < 30 days	5 (31.3%)	34 (14.9%)	95 (17.0%)	0.003	0.559	< 0.001
Postoperative mortality < 30 days	0 (0%)	0 (0%)	1 (0.2%)	N/A	N/A	N/A
Conversion to laparotomy	3 (18.8%)	14 (6.0%)	30 (5.2%)	0.041	0.740	0.153
Readmission	0 (0%)	9 (4.0%)	26 (4.6%)	< 0.001	0.847	<0.001
Mean LOS (days)	2.4	1.3	1.6	0.016	0.027	0.002
Median (range)	1.0 (0-8)	1.0 (0-13)	1.0 (0-18)			
Mean EBL (mL)	87.537.5 (20-500)	125.9	148.9	0.267	0.078	0.579
Median (range)		50.0 (0-900)	75.0 (0-2000)			

* Values are number of patients (percentage) unless otherwise indicated., LOS, length of stay, EBL, estimated blood loss