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Impact of Smoking on Perioperative Pulmonary and Upper Respiratory Complications after Laparoscopic Gynecologic Surgery

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Abstract

OBJECTIVE—To determine the impact of smoking on the rate of pulmonary and upper respiratory complications following laparoscopic gynecologic surgery.

METHODS—We retrospectively identified all patients who underwent laparoscopic gynecologic surgery at one institution between January 2000 and January 2009. Pulmonary and upper respiratory complications were defined as atelectasis, pneumonia, upper respiratory infection, acute respiratory failure, hypoxemia, pneumothorax, or pneumomediastinum occurring within 30 days after surgery

RESULTS—Nine hundred three patients underwent attempt at laparoscopic surgery. Fifty-four were excluded because of conversion to laparotomy and 31 because of insufficient data. Of the 818 patients included, 356 (43%) had cancer. A total of 576 (70%) patients were never smokers, 156 (19%) were past smokers, and 86 (10%) were current smokers (smoked within 6 weeks before surgery). These three groups were similar with regard to median body mass index, operative time, and length of hospital stay. Compared to never and past smokers, current smokers were more likely to undergo high-complexity laparoscopic procedures (10.4%, 15.4%, and 19.8%, respectively; $p=0.015$) and had younger median age 49 years, 51 years, and 46 years, respectively;

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p=0.035. Nineteen (2.3%) patients experienced pulmonary complications - symptomatic atelectasis (n=9), pneumonia (n=5), acute respiratory failure (n=2), hypoxemia (n=1), pneumomediastinum (n=1), and pneumothorax (n=2). The rate of pulmonary complications was 2.1% (12 of 564 patients) in never smokers, 4.5% (7 of 156 patients) in past smokers, and zero in current smokers.

CONCLUSION—In this cohort, smoking history did not appear to impact postoperative pulmonary and upper respiratory complications. In smokers scheduled for operative procedures, laparoscopy should be considered when feasible.

Keywords

Smoking; laparoscopic gynecologic surgery; pulmonary complications

INTRODUCTION

Cigarette smoking is the number one cause of preventable mortality in the United States. It accounts for more than 440,000 deaths annually [1]. Approximately one third of surgical patients are smokers [2], and cigarette smoking has been repeatedly proven to be an important risk factor for postoperative complications [3–6]. Smokers have an increased risk of circulatory, pulmonary, and infectious complications and postoperative admission to the intensive-care unit [5].

Cigarette smoking is a known risk factor for postoperative pulmonary complications. Pulmonary complications following abdominal surgery are frequent and associated with increased morbidity and mortality and length of hospital stay [7–9]. In addition to smoking, factors associated with an increased risk of developing pulmonary complications after surgery include preexisting chronic lung disease, abnormal pulmonary function tests, age > 60 years, upper abdominal or thoracic surgery, obesity, and anesthesia time > 3 hours [10–13]. Studies have shown that current smokers, defined as having smoked within two to six weeks of surgery, are two to six times more likely than current nonsmokers to develop postoperative pulmonary complications [3, 14, 15]. This increased risk may be associated with smoking-induced chronic pulmonary changes such as small airway narrowing, increased closing capacity, impaired tracheobronchial clearance of pulmonary secretions, and chronic obstructive pulmonary disease (COPD) [16].

To date, studies evaluating the effects of preoperative smoking on postoperative pulmonary complications have focused on surgical patients undergoing laparotomy. There is limited information available regarding pulmonary complications in surgical patients undergoing abdominal laparoscopic procedures. The purpose of this study was to evaluate the effects of preoperative smoking on postoperative pulmonary and upper respiratory complications in patients undergoing laparoscopic gynecologic surgery.

MATERIALS AND METHODS

After receipt of Institutional Review Board approval, data were retrospectively collected on patients who underwent laparoscopic gynecologic surgery at The University of Texas MD Anderson Cancer Center between January 2000 and January 2009. Exclusion criteria included conversion to laparotomy and nonelective surgery. Data concerning smoking status and postoperative pulmonary complications were obtained from review of medical records. Current smokers were defined as individuals having smoked at least within 6 weeks before surgery. Past smokers were defined as those having smoked but not within 6 weeks before surgery. Never smokers were defined as those who had never smoked. Six weeks was chosen to separate current from past smokers on the basis of studies suggesting an

improvement in postoperative pulmonary function with smoking cessation at least 6–8 weeks prior to elective surgery [2, 17, 18]. Unfortunately, length of smoking time was documented in fewer than 50% of patients and therefore not available for analysis. In addition, we were unable to capture the amount of smoking in the previous smokers and current smokers group. Pulmonary complications were defined as symptomatic atelectasis (cough, chest pain, breathing difficulty, or evidence of low oxygen saturation and chest x-ray showing incomplete expansion as evidenced by diminished volume), pneumonia, upper respiratory infection, such as bronchitis or sinusitis, acute respiratory failure, hypoxemia with O₂ saturation less than 90%, pneumothorax, or pneumomediastinum occurring within 30 days after surgery.

Preoperative risk factors of interest were identified from the literature on postoperative pulmonary complications and included age, body mass index (BMI), smoking history, preoperative diagnosis, and history of comorbid conditions such as diabetes, chronic heart disease, and COPD [3, 12, 19]. We do not routinely perform pulmonary function tests prior to laparoscopy, so this parameter was not included in our analysis. Patients were grouped into three categories of surgical complexity: low, medium, and high. Low-complexity procedures included diagnostic and second-look laparoscopy. High-complexity procedures included radical hysterectomy, lymphadenectomy, splenectomy, and bowel resection. All remaining procedures were considered intermediate complexity. Additional extracted data included estimated mean blood loss, operative time, and length of hospital stay. Our study included a sample size of 576 non-smokers, 176 former smokers, and 86 current smokers. With this sample size we had >80% power to detect non-inferiority for the former smokers and current smokers as compared to non-smokers. Categorical variables were summarized using frequencies and percentages. Mean, median, and range were used to summarize continuous variables. Chi-square tests or Fisher's exact tests were used when appropriate to assess the association between categorical variables. Wilcoxon rank-sum or Kruskal-Wallis test was used to assess the association between continuous variables, smoking status, and the presence of postoperative pulmonary complications. A p value < 0.05 was considered statistically significant.

RESULTS

We identified 903 consecutive patients who underwent an attempt at laparoscopic gynecologic surgery at MD Anderson during the study period. Fifty-four of these patients were excluded because of conversion to laparotomy, and 31 patients were excluded because of insufficient follow-up data. A total of 818 patients were eligible for evaluation. The median age of the patients was 49 years, (range; 12–88) and the median BMI 26.5 kg/m² (range; 14.2–72.3). A total of 356 (43%) patients had a diagnosis of cancer. Twenty-four (2.9%) patients had chronic heart disease, 2 (0.2%) patients had COPD, and 66 (8%) patients had diabetes. A total of 576 (70%) patients were never smokers, 156 (19%) patients were past smokers, and 86 (10%) patients were current smokers. A majority of patients (78.3%) underwent laparoscopic surgical procedures of intermediate complexity, followed by high (12.5%) and low surgical complexity (9.2%). The median length of hospital stay was 1 day (Table 1).

Nineteen (2.3%) patients experienced pulmonary complications. The most frequent pulmonary complication was symptomatic and radiologically documented atelectasis (n=9, or 1.1%). Additional pulmonary complications included pneumonia (n=5), acute respiratory failure (n=2), hypoxemia (n=1), pneumomediastinum (n=1), and pneumothorax (n=2). Of note, one patient had both hypoxemia and pneumomediastinum. The two patients who developed acute respiratory failure in the postoperative period underwent laparoscopic hysterectomy and bilateral salpingo-oophorectomy for endometrial carcinoma. The first

patient was a never smoker and had no significant medical comorbidities but did have an operative time of 358 minutes due to extensive lysis of adhesions. She had a complete recovery following a brief admission to the intensive care unit. The second patient with acute respiratory failure had several medical comorbidities (hypothyroid, atrial fibrillation, and morbid obesity [BMI = 70.8 kg/m²]) and was a past smoker. She underwent a radical hysterectomy and pelvic lymphadenectomy for cervical cancer. The operative time was 420 minutes. She was then re-admitted 1 week later with acute respiratory failure, acute renal failure, and sepsis due to possible bowel perforation. She subsequently died. The patient who developed both hypoxemia and pneumomediastinum in the postoperative period underwent a radical hysterectomy and pelvic lymphadenectomy for cervical cancer. She had an operative time of 420 minutes and was a past smoker. The pneumomediastinum ultimately resolved within 5 days of surgery.

Perioperative patient variables by smoking status are summarized in Tables 2 and 3. There was no difference in median BMI (26.5 vs. 26.3 vs. 26.6; $p=0.45$), median operative time (174 min vs. 190 min vs. 183 min; $p=0.80$), and median length of hospital stay (1 day for all groups; $p=0.95$) among never smokers, past smokers, and current smokers. Current smokers were significantly younger (46 yrs) than never smokers and past smokers (49 yrs and 51 yrs); respectively ($p = 0.035$) (Table 2). Current smokers were also more likely than never smokers and past smokers to undergo laparoscopic procedures with high surgical complexity (19.8% vs. 15.4% vs. 10.4%; $p=0.015$) (Table 3). The rate of pulmonary complications was 2.1% (12 of 576 patients) among never smokers, 4.5% (7 of 156 patients) among past smokers, and zero among current smokers. Similarly, smoking history did not increase the risk of postoperative pulmonary complications among cancer patients.

We did not find an association between diabetes or chronic heart disease and smoking history or development of pulmonary complications. Both of the patients with COPD had a past history of smoking ($p=0.046$), and one developed a postoperative pulmonary complication. In univariable analysis, the only risk factors associated with the development of postoperative pulmonary complications were older age, longer operative time, and history of COPD. In multivariable logistic regression model with all these 3 factors being included, history of COPD remains a significant predictor of postoperative pulmonary complications ($p=0.028$). Age ($p=0.057$) and operative time ($p=0.0503$) were marginal predictors (Table 4).

Based on an average age of 49 years and operative time of 175 minutes for patients who did not develop postoperative pulmonary complications, we chose cut points to evaluate an age or operative time above which the risk for laparoscopic surgery may be too great. Age over 49 years and operative time over 200 minutes did not significantly increase the risk of a pulmonary complication (Table 3). Patients who developed postoperative pulmonary complications had a significantly longer median length of hospital stay than those who did not (3 vs. 1 days, $p<0.0001$) (Table 4).

DISCUSSION

The key finding of the current study is that in this cohort of patients, smoking history did not impact the rate of postoperative pulmonary complications after laparoscopic surgery. When we controlled for confounding variables, the only risk factors for the development of postoperative pulmonary complications was a history of COPD. The development of a pulmonary complication translated into a significantly longer hospital stay.

In retrospective and prospective studies of patients undergoing abdominal laparotomy, several risk factors for postoperative pulmonary complication have been consistently

identified, including increased duration of surgery, older age, obesity, history of cardiac disease, COPD, and history of smoking [8, 9, 13]. In the current study, a diagnosis of COPD also associated with an increased risk of postoperative pulmonary complications, but the significance of this finding is unclear given there were only 2 patients with this diagnosis, and thus laparoscopic surgery should not be avoided in this patient population. Cardiac history, BMI, and smoking status were not associated with postoperative pulmonary complications in patients undergoing laparoscopic surgery. In the group of patients found to be at increased risk of pulmonary complications following laparoscopic surgery, an emphasis should be placed on lung expansion interventions such as incentive spirometry and deep breathing exercises post surgery [20].

Our findings in patients undergoing laparoscopic surgery differ from findings of other studies that have evaluated postoperative pulmonary complications in patients undergoing laparotomy. Because postoperative pulmonary complication rates have been extensively published in patients undergoing laparotomy, we chose to exclude these patients and focus purely on pulmonary and upper respiratory complication rates in laparoscopy. We found that smoking history did not affect the complication rate, whereas previous studies have shown that in patients undergoing laparotomy, pulmonary complications are at least twice as common in cigarette smokers [3, 13, 21, 22]. Patients in our study who were current or past smokers did not receive any additional testing, medications, or treatments prior to undergoing a surgical procedure. Postoperative pulmonary complication rates of up to 23% have been reported among smokers undergoing laparotomy, compared to rates of 4.9% to 6.3% in never smokers [3, 13, 21, 22]. In addition, Bluman et al. found that among patients undergoing elective general, orthopedic, urologic, or cardiovascular surgery, smokers were six times as likely to develop postoperative pulmonary complications as were never smokers. Another major finding of that same study was that current smokers who reduced their cigarette consumption prior to surgery had nearly seven times the risk of developing a postoperative pulmonary complication compared with smokers who did not reduce cigarette consumption [3]. Another study has demonstrated similar results, with preoperative smoking cessation within 6 weeks of laparotomy leading to an increased risk of postoperative pulmonary complications [18]. This phenomenon is thought to be due to increased tracheobronchial secretions and ineffective sputum removal from altered respiratory epithelium and poor ciliary activity seen in smokers [2, 18].

Our findings that the rate of postoperative pulmonary complications among smokers undergoing laparoscopic gynecologic surgery was lower than previously published complication rates in smokers undergoing laparotomy has significant clinical implications. A reduction in the complication rate can lead to decreased patient morbidity and mortality. In addition, pulmonary complications contribute to prolonged hospital stay and additional health care costs. Our findings suggest that in smokers scheduled for surgery, laparoscopy should be considered the method of choice when feasible.

The current study is a retrospective review, and as such, suffers from the limitations of retrospective studies. We examined postoperative pulmonary complications among surgical patients at a major tertiary referral center, reporting only on patients with available follow-up data. We did not have information on the intensity and duration of smoking for past and current smokers. In addition, a heterogeneous population of patients undergoing abdominal surgery was studied. Complications were measured within 30 days, but we were unable to account for the possibility of patients either starting or stopping smoking after surgery. Also of note, patients who were considered to be at a higher risk of perioperative complications might not have undergone laparoscopy or even laparotomy. Therefore, our population is a population deemed to be adequate candidates for laparoscopic surgery based on preoperative risk assessment.

In summary, our study demonstrates a low overall incidence of postoperative pulmonary and upper respiratory complications among patients undergoing laparoscopic gynecologic surgery, with smoking history having no effect on the pulmonary complication rate. To the best of our knowledge, this is the first study to evaluate the effects of preoperative smoking on postoperative pulmonary complications in patients following laparoscopic abdominal surgery.

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Highlights

- Smoking history does not appear to impact postoperative pulmonary complications in this cohort of patients undergoing laparoscopic gynecologic surgery.
- Pulmonary complications after laparoscopy are lower than those reported after laparotomy.
- The development of a pulmonary complication translated into a significantly longer hospital stay.

Table 1

Perioperative Patient Characteristics

Variable	Levels	No. of patients	% of patients
-	-	818	-
Chronic heart disease	No	794	97.1
	Yes	24	2.9
Chronic obstructive pulmonary disease	No	816	99.8
	Yes	2	0.2
Diabetes	No	752	92
	Yes	66	8
Smoking status	Current smoker	86	10.5
	Never smoker	576	70.2
	Former smoker	156	19
Disease	Carcinoma	356	43
	Benign	462	57
Atelectasis	No	809	98.9
	Yes	9	1.1
Pneumonia	No	813	99.4
	Yes	5	0.6
Acute respiratory failure	No	816	99.8
	Yes	2	0.2
Hypoxemia	No	817	99.9
	Yes	1	0.1
Pneumomediastinum	No	817	99.9
	Yes	1	0.1
Pneumothorax	No	816	99.8
	Yes	2	0.2
Any pulmonary complication	No	799	97.7
	Yes	19	2.3
Hospital length of stay, days	0	200	25
	1	335	40.9
	2	194	23.8
	3	55	6.7
	4	34	3.6
Surgical complexity	-	-	-
Low	Diagnostic laparoscopy	33	9.2
	Second-look laparoscopy	42	
Intermediate	Unilateral or bilateral salpingoophorectomy	202	78.3
	Unilateral or bilateral ovarian cystectomy	10	
	Ovarian transposition	4	
	Bilateral tubal ligation	9	
	Hysterectomy and unilateral or bilateral	415	

Variable	Levels	No. of patients	% of patients
High	salpingo-oophorectomy		
	Radical hysterectomy	34	
	Pelvic and/or paraaortic	64	12.5
	Lymphadenectomy	3	
	Splenectomy	2	
	Small bowel or colon resection		
Median age at diagnosis (range), years	-	818	49 (12, 88)
Median BMI (range), kg/m ²	-	812	26.5 (14.2, 72.3)
Median operative time (range), min	-	756	177(26, 734)
Median blood loss (range), mL	-	818	50 (10, 1000)
Median length of hospital stay (range), days	-	818	1 (0, 13)

Table 2

Continuous Variables by Smoking Status

Variable	Smoking status	No. of patients	Median (range)	Kruskal-Wallis p
Age at diagnosis, years	Never smoker	576	49 (12, 88)	0.035
	Past smoker	156	51 (24, 81)	.
	Current smoker	86	46 (25, 80)	.
BMI, kg/m ²	Never smoker	570	26.5 (14.2, 59.4)	0.447
	Past smoker	155	26.3 (16.8, 72.3)	.
	Current smoker	84	26.6 (19.2, 54.3)	.
Operative time, minutes	Never smoker	530	174 (26, 684)	0.804
	Past smoker	146	189.5 (36, 526)	.
	Current smoker	80	182.5 (50, 734)	.
Blood loss, mL	Never smoker	575	75 (0, 1000)	0.054
	Past smoker	15	50 (0, 800)	.
	Current smoker	86	50 (5, 800)	.
Length of hospital stay, days	Never smoker	576	1 (0, 13)	0.954
	Past smoker	156	1 (0, 6)	.
	Current smoker	86	1 (0, 13)	.

Table 3

Categorical Variables by Smoking Status

Covariate	Levels	Never smokers, no. of patients (%)	Past smokers, no. of patients (%)	Current smokers, no. of patients (%)	Chi-square p	Fisher's exact test p
Chronic heart disease	No	564 (97.9)	149 (96.5)	81 (94.2)	--	0.482
	Yes	12 (2.1)	7 (4.5)	5 (5.8)	.	.
Chronic obstructive pulmonary disease	No	576 (100)	154 (98.7)	86 (100)	--	0.047
	Yes		2 (1.3)		.	.
Diabetes	No	525 (91.1)	148 (94.9)	79 (91.9)	0.317	--
	Yes	51 (8.9)	8 (5.1)	7 (8.1)	.	.
Atelectasis	No	569 (98.8)	154 (98.7)	86 (100)	--	0.756
	Yes	7 (1.2)	2 (1.3)		.	.
Pneumonia	No	573 (99.5)	154 (98.7)	86 (100)		0.322
	Yes	3 (0.5)	2 (1.3)		.	.
Acute respiratory failure	No	575 (99.8)	155 (99.4)	86 (100)	--	0.504
	Yes	1 (0.2)	1 (0.6)		.	.
Hypoxemia	No	576 (100)	155 (99.4)	86 (100)	--	0.296
	Yes		1 (0.6)		.	.
Pneumomediastinum	No	576 (100)	155 (99.4)	86 (100)	--	0.296
	Yes		1 (0.6)		.	.
Pneumothorax	No	575 (99.8)	155 (99.4)	86 (100)	--	0.504
	Yes	1 (0.2)	1 (0.6)		.	.
Any pulmonary complication	No	564 (97.9)	149 (95.5)	86 (100)	--	0.082
	Yes	12 (2.1)	7 (4.5)			
Length of hospital stay, days	0	148 (25.7)	36 (23.1)	16 (18.6)		0.521
	1	227 (39.4)	65 (41.7)	43 (50)	.	
	2	133 (23.1)	42 (26.9)	19 (22.1)	.	
	3	44 (7.6)	7 (4.5)	4 (4.7)	.	
	4	24 (4.2)	6 (3.8)	4 (4.7)	.	
Surgical complexity	Low	47 (8.2)	21 (13.5)	7 (8.1)	0.015	
	Intermediate	469 (81.4)	111 (71.2)	62 (72.1)		

Covariate	Levels	Never smokers, no. of patients (%)	Past smokers, no. of patients (%)	Current smokers, no. of patients (%)	Chi-square p	Fisher's exact test p
Age	High	60 (10.4)	24 (15.4)	17 (19.8)		
	<49	286 (49.7)	65 (41.9)	49 (57)	0.06	
Operative time, min	49	290 (50.3)	90 (58.1)	37 (43)		
	<200	317 (59.8)	79 (54.1)	47 (58.8)	0.464	
	200	213 (40.2)	67 (45.9)	33 (41.3)		

Table 4

Perioperative Pulmonary Complications

Variable	Levels	No Pulmonary Complication	Any Pulmonary Complication	p *
Median age (range), years	-	49 (12, 88) N=799	55 (30,83) N=19	0.023
Median BMI (range), kg/m ²	-	26.5 (14.2, 72.3) N=793	27.4 (18.2, 70.8) N=19	0.666
Median operating time (range), min	-	175 (26, 734) N=737	217 (36, 420) N=19	0.042
Median blood loss (range), mL	-	50 (0, 1000) N=799	50 (10, 700) N=19	0.85
Median length of hospital stay (range), days	-	1 (0, 13) N=799	3 (1, 8) N=19	< 0.0001
Chronic heart disease, no. of patients (%)	No	776 (97)	18 (94.7)	0.435
	Yes	23(3)	1 (5.3)	
Chronic obstructive pulmonary disease, no. of patients (%)	No	799 (99.9)	18 (94.7)	0.046
	Yes	1 (0.1)	1 (5.3)	
Diabetes, no. of patients (%)	No	735 (92)	17 (89.5)	0.66
	Yes	64 (8)	2 (10.5)	

* Based on Wilcoxon rank-sum test for continuous variables and Fisher's exact test for categorical variables.