

Impact of Chronic Obstructive Pulmonary Disease on Laparoscopic Hysterectomy Outcome

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ABSTRACT

Background and Objectives: Limited research exists on the association between chronic obstructive pulmonary disease (COPD) and morbidity and mortality after laparoscopic hysterectomy. The objective of this study is to examine the following: 1) which demographics and comorbidities are most likely to present concurrently in patients with COPD? 2) Are patients with COPD undergoing laparoscopic hysterectomy at increased risk for development of postoperative complications within 30 days?

Methods: Retrospective cohort study using data collected from 2007 to 2016 from the American College of Surgeons National Surgical Quality Improvement Program database. All patients who underwent laparoscopic hysterectomy were identified by Current Procedural Terminology codes and stratified based on COPD status. Univariate and multivariate analyses were completed to define odds ratios for postoperative complications within 30 days of laparoscopic hysterectomy.

Results: This study included 100,518 laparoscopic hysterectomy patients (COPD = 1,130 [1.12%]); (no COPD = 99,388 [98.8%]). Patients with COPD developed more postoperative complications, including pneumonia, reintubation, renal insufficiency, and sepsis. COPD was identified as an independent risk factor for pneumonia (OR, 4.098; 95% CI, 2.222–7.519) and reintubation (OR, 4.348;

95% CI, 2.387–7.937). Patients with COPD had extended length of hospital stay.

Conclusion: Patients with COPD who undergo laparoscopic hysterectomy have increased risk of experiencing postoperative pneumonia, reintubation, renal insufficiency, and sepsis. Overall, postoperative complication rates remain low, but gynecologists should consider the pulmonary disease status of patients when assessing preoperative risk.

Key Words: Hysterectomy, COPD, Pulmonary disease, Chronic obstructive, Complications.

INTRODUCTION

Hysterectomy is the second most common surgery women undergo.¹ Annually, 600,000 hysterectomies are performed in the United States and account for \$5 billion USD in national health care spending.^{1,2} Few data exist regarding preoperative risk factors and its association with postoperative outcomes.

In a 2002 meta-analysis of over 1.5 million patients who underwent gynecologic laparoscopic operations, the rate of complications ranged from 0.2% to 10.3%.³ A 2007 study by O'Hanlan et al⁴ found a 9.8% complication rate in 830 cases of total laparoscopic hysterectomy (TLH). The complications included fever, hemorrhage, infection, wound dehiscence, voiding dysfunction, urological injuries, intestinal issues, deep venous thrombosis, anesthesia-related events, and conversion to laparotomy.^{3,4} Minimally invasive methods including vaginal hysterectomies and laparoscopic techniques have been associated with decreased blood loss, shorter hospital stay, and decreased infections when compared to abdominal hysterectomies.^{5–7} Despite the evidence in favor of minimally invasive hysterectomy, abdominal hysterectomies account for 45%–50% of hysterectomies.^{8–10} Minimally invasive hysterectomy has been on the rise in recent years with some limitations of implementation being cost, surgeon training, hospital technology, clinical factors, and patient preference.^{2,11}

Chronic obstructive pulmonary disease (COPD) is the third leading cause of disability and mortality, affecting approximately 600 million worldwide.¹² In the United States, prev-

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alence of COPD is around 7.6% in women.¹³ The prevalence and mortality rate of COPD in women have doubled during the past 30 years in industrialized countries, which is in contrast to the plateau in COPD-related mortality for men.¹³ Women may be more susceptible to the negative effects of tobacco smoke.^{14,15}

By the age of 60, an estimated 33% of women will have a hysterectomy and the increasing prevalence of COPD reinforces the need for data on their relationship.^{13,16} This study aims to examine the following questions: 1) what demographics and comorbidities are most likely to present concurrently in patients with COPD? 2) Are patients with COPD undergoing laparoscopic hysterectomy at increased risk for development of postoperative complications within 30 days?

METHODS

The American College of Surgeons National Surgery Quality Improvement Program is a national database comprised of data from 600 hospitals with the goal of optimizing quality of surgical care. This paper used American Medical Association Current Procedural Terminology (CPT) codes to identify patients in the database who underwent TLH (58570, 58571, 58572, 58573), laparoscopically assisted vaginal hysterectomy (58550, 58552, 58553, 58554), and laparoscopic supracervical hysterectomy (58541, 58542, 58543, 58544). Once patients were identified through CPT codes, information regarding their demographics (including patient race and age), medical comorbidities, preoperative factors, and postoperative complications within 30 days of hysterectomy were collected.

Comorbidity data collected included current use of antihypertensive medication, renal failure, need for dialysis, steroid use, recent unexplained weight loss, bleeding disorders, preoperative transfusion, malignancy as indication for hysterectomy, and uterine size > 250 g. Preoperative factors associated with increased risk of postoperative complications, including smoking status, diabetes mellitus status, body mass index, dyspnea status, American Society of Anesthesiologists (ASA) class, type of anesthesia used, and preoperative functional status, were also recorded.

The 30-day postoperative complications included in this analysis were surgical-site wound infection, deep wound infection, organ or space infections, wound dehiscence, pneumonia, reintubation, pulmonary embolism, failure to wean off ventilator within 48 hours of hysterectomy, renal failure, renal insufficiency, urinary tract infection, stroke,

cardiac arrest, myocardial infarction, deep vein thrombosis, sepsis, septic shock, and all-cause death. Thirty-day postoperative outcomes, including extended length of stay (hospital stay > 2 d) and unplanned return to operating room (OR), were also analyzed.

Univariate analysis was performed using χ^2 test, Fisher's exact test, and one-way analysis of variance (ANOVA). Age and body mass index were analyzed by χ^2 test, Fisher's exact test, and one-way ANOVA; however, for multivariate analysis, if both the categorical analysis and one-way ANOVA tests resulted in statistical significance, the continuous variable was used instead of the categorical variable. To determine independent risk factors for returning to the OR and extended length of stay (>2 d), risk factors with $P < .2$ in univariate analysis were included in multivariate analysis. In addition to including the risk factors identified through univariate analysis, COPD was considered a risk factor in multivariate analysis. Multivariate regression analysis was performed using binary logistic regression for return to the OR, extended length of stay (> 2 days) (LOS) using a forward stepwise approach; Poisson log-linear regression analysis was performed on 30-day postoperative complications using a forward stepwise approach. Results of multivariate analyses were reported as odds ratios with 95% confidence intervals. Those with a $P < .05$ were considered statistically significant. Statistical analysis was conducted using Statistical Package for the Social Sciences (SPSS Version 22, Armonk, NY, USA).

RESULTS

Demographics

A total of 100,518 patients underwent laparoscopic hysterectomy and met inclusion criteria for this study. A total of 1,130 patients had COPD (1.1%) and 99,388 did not have a diagnosis of COPD. Patients with COPD were on average more likely to be older ($P \leq .001$), have a higher body mass index ($P \leq .001$), have diabetes ($P \leq .001$), have a higher ASA class ($P \leq .001$), be a smoker, have moderate exertional dyspnea ($P \leq .001$), and be less functionally independent ($P \leq .001$) than those without a COPD diagnosis (**Tables 1 and 2**).

Comorbidities

Patients with COPD had more preoperative comorbidities than patients without COPD. Comorbidities included cardiac comorbidity ($P < .001$), steroid use ($P < .001$),

Table 1.
Demographics and Clinical Characteristics of 100,518 Patients who Underwent Laparoscopic Hysterectomy

Demographics	No COPD (N = 99,388)		Yes COPD (N = 1,130)		P-Value
	N	%	N	%	
Race					<.001
White	71,813	72.3	898	79.5	
Black or African American	12,963	13.0	129	11.4	
Hispanic	9,842	9.9	87	7.7	
American Indian or Alaska Native	145	0.1	3	0.3	
Asian	3,557	3.6	2	0.2	
Native Hawaiian or Pacific Islander	641	0.6	8	0.7	
Anesthesia					.359
General	99,255	99.9	1,128	99.8	
Regional	106	0.1	1	0.1	
MAC/IV sedation	27	0.0	1	0.1	
Diabetes					<.001
No diabetes	90,565	91.1	878	77.7	
Noninsulin-dependent DM	6,483	6.5	152	13.5	
Insulin-dependent DM	2,489	2.5	100	8.8	
ASA class					<.001
1 or 2	75,360	75.8	310	27.4	
3 or 4	24,301	24.5	820	72.6	
Smoke	16,546	16.6	521	46.1	<.001
Dyspnea					<.001
No dyspnea	96,727	97.3	799	70.7	
Moderate exertion	2,585	2.6	310	27.4	
At rest	76	0.1	21	1.9	
Functional status pre-op					<.001
Independent	99,076	99.7	1,108	98.1	
Partially dependent	274	0.3	18	1.6	
Totally dependent	38	0.0	4	0.4	

ASA, American Society of Anesthesiologists class; COPD, Chronic obstructive pulmonary disease; DM, diabetes mellitus; MAC/IV, monitored anesthesia care/intravenous.

Bolding indicates significance $P < .05$.

weight loss ($P = .003$), bleeding disorder ($P < .001$), gynecologic malignancy ($P < .001$), uterine weight >250 g ($P < .001$), or disseminated cancer ($P = .002$). Renal failure, dialysis requirement, transfusion, chemotherapy, and pregnancy were not found to be significantly different between groups (**Table 3**).

Complications

The patients who underwent hysterectomy with diagnosed COPD had higher rates of postoperative complications ($P < .001$). Patients with COPD had a higher frequency of at least one complication, 121 (14.7%),

Table 2.

Demographics of 100,518 Patients who Underwent Laparoscopic Hysterectomy

Demographics	No COPD (N = 99,388)		Yes COPD (N = 1,130)		P-Value	No COPD, Mean	Yes COPD, Mean	ANOVA (P-Value)
	N	%	N	%				
Age, years					<.001	48.170 ± 11.15	57.830 ± 12.73	<.001
18–30	3,308	3.3	7	0.6				
31–40	20,933	21.1	91	8.1				
41–50	40,330	40.6	289	25.6				
51–60	19,127	19.2	295	26.1				
61+	15,690	15.8	448	39.6				
BMI Class, kg/m ²					<.001	30.743 ± 8.10	34.254 ± 10.47	<.001
Underweight (<18.5)	795	0.8	17	1.5				
Normal (18.5–24.9)	22,766	22.9	201	17.8				
Non-obese (25–30)	27,438	27.6	238	21.1				
Obese I (30–35)	21,264	21.4	217	19.2				
Obese II (35–40)	27,125	27.3	457	40.4				
Obese 3 (>=40)		0.0		0.0				

BMI, body mass index; COPD, chronic obstructive pulmonary disease.

Bolding indicates significance $P < .05$.

compared with patients without COPD (5,487 [5.5%]) (Table 4). The patients with COPD had higher rates of superficial surgical site infection ($P = .004$), pneumonia ($P < .001$), reintubation ($P < .001$), renal insufficiency ($P < .020$), renal failure ($P = .004$), sepsis ($P = .018$), and all-cause death ($P = .015$). The multivariate analysis showed that COPD is an independent risk factor for two postoperative complications (Table 5). Patients with COPD were 4.1 times more likely to develop pneumonia (95% CI, 2.222–7.519; $P < .001$), and 4.3 times more likely to need unplanned reintubation (95% CI, 2.387–9.737; $P < .001$).

Length of Stay/Return to the OR

Univariate analysis found 109 (13.3%) patients with COPD and 3,292 (3.3%) patients without COPD required an extended LOS (>2 days) (Table 4). In addition, multivariate analysis indicates COPD is an independent risk factor for extended LOS (OR, 1.739; 95% CI, 1.414–2.137; $P < .001$) (Table 5). There was no significant difference in return to the OR based upon COPD status (Table 4).

DISCUSSION

There is limited research on the impact of COPD on gynecologic surgery outcomes. Often, COPD is studied in relationship to pulmonary complications, but this study explores the implications of the disease on a wide range of outcomes following TLH. To our knowledge, this is the first study to establish a clear relationship between COPD and various postoperative complications following TLH. Pulmonary complications are among the most common postoperative complications associated with morbidity and mortality for all surgical procedures.¹⁷ Currently, there is a 1% occurrence of pulmonary complications for all patients in TLH.¹⁸ Our data analysis found COPD was an independent risk factor for pneumonia and unplanned reintubation. Patients with COPD were 4.6 times more likely to develop pneumonia ($P < .001$) and 4.5 times more likely to need reintubation ($P < .001$).

COPD has been shown to increase the overall complication rate in other surgical settings including general, cardiac, and thoracic.¹⁹ Patients who underwent laparoscopic hysterectomy with diagnosed COPD had higher rates of postoperative complications ($P < .001$). Univariate analysis showed patients with COPD were nearly 3 times more likely to suffer

Table 3.
Preoperative Comorbidities of 100,518 Patients who Underwent Laparoscopic Hysterectomy

Comorbidities	No COPD (N = 99,388)		COPD (N = 1,130)		P-Value
	N	%	N	%	
Cardiac comorbidity*	28,457	28.6	646	57.2	<.001
Renal failure	12	0.0	0	0.0	.712
Dialysis	129	0.1	4	0.4	.039
Steroid use	1,448	1.5	69	6.1	<.001
Weight loss	162	0.2	6	0.5	.003
Bleeding disorder	932	0.9	45	4.0	<0001
Transfusion	366	0.4	4	0.4	.937
Chemotherapy	34	0.0	0	0.0	.518
Pregnancy	9,610	9.7	109	9.6	.379
Uterine weight >250 g	12,821	12.9	93	3.5	<.001
Malignancy	16,256	16.3	332	29.3	<.001
Disseminated cancer	551	0.6	14	1.2	.002

COPD, chronic obstructive pulmonary disease.

Bolding indicates significance $P < .05$.

*Cardiac comorbidity was recorded as whether the patient was on hypertensive medications or not.

from an all-cause complication than those without COPD. A 2012 study by Jennings et al²⁰ found COPD to be a significant risk factor for readmission within 30 days of laparoscopic hysterectomy. The group with COPD had a readmission rate of 8.5% versus a readmission rate of 3.1% in the group without COPD ($P = .02$).²⁰ In our study, COPD was demonstrated to be an independent risk factor for extended LOS ($P < .001$). One retrospective study of pulmonary complications following gynecologic procedures found a significantly longer length of stay (1.75 days) associated with pulmonary complications.²¹

The indications for hysterectomy in 80% of cases are for benign pathology but impact of disease on patients can range from minor discomfort to debilitating pain.¹ Assessing the risk and benefits for COPD patients is complicated due to variability in indication for hysterectomy and the elevated risk of postoperative complication, highlighting the importance of shared decision making between patient and gynecologist. The less invasive TLH approach to hysterectomy has been associated with decreased length of stay, morbidity, and infection over the open approach.⁵⁻⁷ Patients with COPD when possible should undergo minimally invasive hysterectomy to decrease the combined risk associated with

COPD and open surgery, which includes increased length of stay, morbidity, and infection. In the setting of elective operation, measures to medically optimize patients should be implemented. These measures include identifications of COPD by thorough history taking, and referral to pulmonologist for patient with extensive risk factors or suspicious signs and symptoms. Pulmonary specialists use the 2017 The Global Initiative for Chronic Obstructive Lung Disease (GOLD) criteria to stratify disease severity and make treatment decisions. Measures to reduce exacerbations and worsening of disease including nonpharmacologic and pharmacologic approaches.^{22,23} Nonpharmacologic measures include patient education on smoking cessation, pulmonary rehabilitation, exercise, and immunizations, including annual influenza and pneumococcal vaccines. Pharmacologic approaches include long- and short-acting bronchodilators, long-acting muscarinic antagonists, and inhaled corticosteroids.^{22,23}

Beyond the preoperative setting to the OR, the American Society of Anesthesiologists uses a physical status classification of 1 to 6 to classify patients' operative risk based on general health. A diagnosis of COPD is categorized by this system as a class 3 or 4, indicating severe systemic illness. Depending on disease control, COPD is classified as 3 for nonlife-threatening or 4 for constant threat to life.²⁴ Further risk-modifying measures include considering the mode of anesthesia delivery. Studies suggest the use of regional anesthesia instead of general anesthesia in COPD patients has been associated with a decrease in the incidence of pulmonary complications.^{25,26} Regional anesthesia is not generally applied for laparoscopic surgery but is feasible for vaginal hysterectomy.²⁷ The optimal surgical approach for the pathology should be carefully considered and must be weighed against the optimal anesthesia for that approach. Future studies comparing surgical approach for hysterectomy as well as type of anesthesia for patients with COPD with would be beneficial.

Among the limitations of this study is the retrospective design and inherent selection bias. In our study patients with COPD were more likely to have comorbidities and surgical risk factors than the group without COPD. In addition, complications rates are only measured up to 30 days following operation. Furthermore, our study did not stratify the severity or stage of COPD in patients. Lastly, the Centers for Disease Control (CDC) projects that COPD may be underdiagnosed and, therefore, undertreated.²⁸ Based on the findings of this study, the identification and treatment of COPD may alter the discrepant outcomes of patients with COPD. Despite these limitations, the current study identifies significant associations and has a large sample size with isolation of COPD as

Table 4.
Postoperative Complications and Outcomes of 100, 518 Patients who Underwent Laparoscopic Hysterectomy

Complications	No COPD (N = 99,388)		COPD (N = 1,130)		P-Value
	N	%	N	%	
Any complication	5,487	5.5	121	14.7	<.001
Superficial surgical site wound	804	0.8	18	2.2	.004
Deep wound infection	171	0.2	3	0.4	.146
Organ/space infection	904	0.9	13	1.6	.428
Wound dehiscence	213	0.2	5	0.6	.101
Pneumonia	120	0.1	13	1.6	<.001
Re-intubate	89	0.1	14	1.7	<.001
Pulmonary embolism	214	0.2	3	0.4	.718
Fail to wean >48 hours	46	0.0	2	0.2	.102
Renal insufficiency	48	0.0	3	0.4	.020
Renal failure	18	0.0	1	0.1	.087
Urinary tract infection	2,200	2.2	28	3.4	.548
Stroke	25	0.0	1	0.1	.255
Peripheral nerve injury	11	0.0	0	0.0	1.000
Cardiac arrest	21	0.0	0	0.0	1.000
Myocardial infarction	27	0.0	1	0.1	.271
Deep vein thrombosis	136	0.1	1	0.1	.744
Sepsis	338	0.3	9	1.1	.018
Septic shock	59	0.1	3	0.4	0.033
Death	43	0.0	3	0.4	0.015
Other outcomes					
Extended LOS (>2 days)	3,292	3.3	109	13.3	<0.001
Return to OR	1,331	1.3	19	2.3	0.361

Bolding indicates significance $P < 0.05$.

COPD, chronic obstructive pulmonary disease; LOS, length of stay; OR, operating room.

a risk factor for increased postoperative complications. These results have implications for patient outcomes and care. Future studies stratifying severity of COPD undergoing TLH can confirm whether optimizing management will attenuate the difference in outcomes between patients with COPD and those without. The identification of known risk factors of COPD will allow providers to predict and optimize treatment in the preoperative setting to mitigate potential postoperative complications.

CONCLUSION

We used the National Surgery Quality Improvement Program database, including data from 100,518 patients, to

understand the relationship of patients with COPD who underwent laparoscopic hysterectomies compared to patients without COPD. Patients with COPD had a greater risk of developing postoperative complications including pneumonia, unplanned reintubation, renal insufficiency, and sepsis. COPD was identified as an independent risk factor for the development of pneumonia, need for reintubation, and extended length of hospital stay. Gynecologists should take into consideration the COPD status of patients when assessing preoperative risk and refer to pulmonary specialist if needed for medical optimization. When possible, patients with COPD should be offered a minimally invasive hysterectomy to reduce risk of postop-

Table 5.

Multivariate Analysis to Determine if COPD is an Independent Risk Factor for Post-operative Complications in 100, 518 Patients

Postop Complication	P-Value	Odds Ratio	95% CI	
			Low	High
Superficial infection	.025	1.684	1.067	2.652
Pneumonia	<.001	4.098	2.222	7.519
Re-intubate	<.001	4.348	2.387	7.937
Renal insufficiency	.09	2.618	0.861	7.937
Sepsis	.093	1.770	0.910	3.448
Death	.667	1.319	0.372	4.673
Extended LOS (> 2 days)	<.001	1.739	1.414	2.137

Bolding indicates significance $P < .05$.

CI, confidence interval; LOS, length of stay.

erative complications. This information will allow physicians to make better-informed clinical decisions on COPD patients undergoing hysterectomy.

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