Higher Risk of Wound Complications but No Clinically Significant Increase in Operative Time for Smokers Receiving Myomectomy for Uterine Fibroids

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ABSTRACT

Myomectomy is a common procedure to remove uterine fibroids. Smoking impacts outcomes across various surgeries; however, may limit fibroid growth. We sought to determine if smoking impacts myomectomy for uterine fibroid removal outcomes. Patients with and without a history of tobacco smoking receiving a myomectomy for uterine fibroid removal were compared. Compared to patients with no history of tobacco smoking, tobacco smokers had a significantly increased risk of wound complications. No other variables analyzed demonstrated a clinically significant difference. Future research is needed to examine how different frequency of tobacco smoking impacts outcomes.

RÉSUMÉ

La myomectomie est une intervention courante pour le retrait des fibromes utérins. Le tabagisme a un impact sur les résultats de différentes interventions chirurgicales, mais il peut aussi limiter la croissance des fibromes. Nous avons cherché à déterminer si le tabagisme a un impact sur les résultats de la résection des fibromes utérins par myomectomie. Nous avons comparé les patientes avec et sans antécédents de tabagisme ayant subi une myomectomie pour l'ablation d'un fibrome utérin. Comparativement aux patientes sans antécédents de tabagisme, les fumeuses présentaient un risque significativement plus élevé de complications de plaie. Aucune différence cliniquement significative n'a été relevée pour les autres variables analysées. D'autres recherches seront nécessaires pour examiner l'impact des différentes intensités de tabagisme sur les résultats.

Keywords: myomectomy; tobacco smokers; uterine fibroids; wound complications

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INTRODUCTION

Myomectomy is a gynecologic procedure commonly used to remove uterine fibroids and preserve uterine integrity such that future pregnancies are possible. Other procedures to remove fibroids include a hysterectomy or uterine artery embolization, however, these approaches do not preserve fertility.[1] Common complications following myomectomy include hemorrhage and infection.[2,3]

Smoking is associated with a wide range of obstetric, gynecologic, and surgical complications.[4,5] However, the antiestrogenic effect of smoking is thought to reduce the risk of endometrial cancer and uterine fibroids.[6] Additionally, tobacco smoking can reduce blood flow, preventing fibroid growth[6] but resulting in wound complications after surgery.

Quitting smoking reduces the risk of negative surgical outcomes, however, it is unclear how long one must quit to see a significant decrease.[7] In our study, we defined smokers as people who have smoked tobacco within the last year (SMK) and nonsmokers as people who have not smoked tobacco in the past year (NSMK). Due to the potential reduction in fibroids due to smoking, increase in

abdominal surgery risk, and impacted blood flow among smokers, we analyzed the impact that tobacco smoking has on outcomes following myomectomy. This retrospective study aims to assess the impact of tobacco smoking on outcomes during and after myomectomy to remove uterine fibroids.

METHODS

Data Source

Patients who had a diagnosis of uterine fibroid by International Classification of Diseases codes and underwent myomectomy by Current Procedural Terminology (CPT) were identified in the American College of Surgeons-National Surgical Quality Improvement Program (ACS-NSQIP) database from 2010 to 2022 (International Classification of Diseases and CPT codes shown in Supplementary Table 1). ACS-NSQIP is by the American College of Surgeons and is a validated national database for quality control for 30-day postoperative outcomes. ACS-NSQIP consists of nearly 700 medical institutions in the United States and 150 hospitals in other countries worldwide. The subjects were divided into 2 groups: SMK and NSMK. Patients with a history of tobacco smoking within the past year were assigned to the SMK group.

Preoperative Variables

Preoperative and intraoperative factors included race, ethnicity, admission year, age, and baseline characteristics/comorbidities. In addition, the myomectomy approach was noted by CPT codes (abdominal approach, 58140, 58146; vaginal approach, 58145; laparoscopic approach 58545, 58546) (Tables 1–3).

Postoperative Variables

The 30-day postoperative outcomes after myomectomy treatment in patients with and without a history of smoking were compared. Postoperative variables included in this study were 30-day mortality, major adverse cardiovascular events, venous thromboembolism, pulmonary complications, cardiac complications, stroke, renal complications, sepsis, bleeding requiring transfusion, wound complications, unplanned reoperation, discharge not to home, operative time, and length of stay.

Major adverse cardiovascular event is a combination of stroke, myocardial infarction, and cardiac arrest requiring cardiopulmonary resuscitation. Cardiac complications include cardiac arrest and myocardial infarction. Wound complications included wound dehiscence and surgical site infections. Renal complications refer to progressive renal insufficiency (increase in serum creatinine by >2 mg/dL

Table 1. Demographics comparing patients who have smoked tobacco within the past year to patients who have not smoked tobacco within the past year before and after propensity-score matching

		Pre-match		Post-match	
Variable	Smoker (n = 3823)	Nonsmoker (n = 40 471)	*P* value	Nonsmoker (n = 3820)	*P* value
Race and ethnicity, n (%)					
Caucasian	1404 (36.73)	13 097 (32.36)	< 0.0001	2784 (36.47)	0.7733
African American	1505 (39.37)	15 193 (37.54)	0.0266	2988 (39.14)	0.8551
Hispanic	300 (7.85)	4398 (10.87)	< 0.0001	587 (7.69)	0.7668
Asian American	195 (5.1)	3721 (9.19)	< 0.0001	387 (5.07)	0.9282
American Indian or Alaska Native	25 (0.65)	156 (0.39)	0.0228	67 (0.88)	0.2234
Native Hawaiian or Pacific Islander	25 (0.65)	156 (0.39)	0.0228	46 (0.6)	0.8008
Other races	581 (15.2)	7048 (17.41)	0.0005	1175 (15.39)	0.8046
Age, n (%)					
18 ≤ age <25 y old	73 (1.91)	591 (1.46)	0.0363	158 (2.07)	0.6218
25 ≤ age <35 y old	1257 (32.88)	12 396 (30.63)	0.0043	2588 (33.9)	0.2941
35 ≤ age <45 y old	1895 (49.57)	21 071 (52.06)	0.0032	3776 (49.46)	0.8897
45 ≤ age <55 y old	490 (12.82)	5123 (12.66)	0.7797	934 (12.23)	0.4172
55 ≤ age <65 y old	76 (1.99)	827 (2.04)	0.8576	124 (1.62)	0.1975
65 ≤ age <75 y old	29 (0.76)	332 (0.82)	0.7776	48 (0.63)	0.4669
75 ≤ age <85 y old	2 (0.05)	109 (0.27)	0.0059	3 (0.04)	1
Age ≥ 85 y old	1 (0.03)	22 (0.05)	0.7168	3 (0.04)	1

Table 2. Baseline characteristics comparing patients who have smoked tobacco within the past year to patients who have not smoked tobacco within the past year after propensity-score matching

		Pre-match		Post-match	
Variable	Smokers (n = 3820)	Nonsmokers (n = 40 471)	*P* value	Nonsmokers (n = 7634)	*P* value
Baseline characteristics, n (%)					
BMI >30 kg/m^2	1703 (44.55)	15 586 (38.51)	< 0.0001	3443 (45.1)	0.5501
DM	152 (3.98)	1434 (3.54)	0.1718	291 (3.81)	0.681
Dyspnea	58 (1.52%)	273 (0.67)	< 0.0001	107 (1.4)	0.802
Independent functional status	3810 (99.66)	40 284 (99.54)	0.3752	7614 (99.74)	0.4636
Partially dependent functional status	4 (0.1)	42 (0.1)	1	5 (0.07)	0.4928
COPD	22 (0.58)	52 (0.13)	< 0.0001	27 (0.35)	0.2734
CHF	6 (0.16)	23 (0.06)	0.0347	12 (0.16)	1
Hypertension	513 (13.42)	4204 (10.39)	< 0.0001	986 (12.92)	0.5177
AKI	1 (0.03)	8 (0.02)	0.5562	2 (0.03)	1
Dialysis	3 (0.08)	17 (0.04)	0.2461	3 (0.04)	0.4075
Preoperative sepsis	45 (1.18)	307 (0.76)	0.0075	68 (0.89)	0.1908
Disseminated cancer	8 (0.21)	88 (0.22)	1	9 (0.12)	0.302
Infection	4 (0.1)	23 (0.06)	0.2876	5 (0.07)	0.4928
Steroid use	27 (0.71)	328 (0.81)	0.5688	41 (0.54)	0.3018
Weight loss	9 (0.24)	31 (0.08)	0.0061	13 (0.17)	0.4989
Bleeding disorders	35 (0.92)	252 (0.62)	0.0349	68 (0.89)	0.9165
eGFR<60 mL/min/1.73 m^2	33 (0.86)	293 (0.72)	0.3223	41 (0.54)	0.0619
Serum albumin <3.4 g/L	70 (1.83)	548 (1.35)	0.0207	99 (1.3)	0.0266
WBC >11 000 counts/mL	262 (6.85)	1336 (3.3)	< 0.0001	489 (6.41)	0.4228
Hematocrit <37%	1367 (35.76)	15 031 (37.14)	0.0926	2739 (35.88)	0.8687
Platelet <150 000 counts/mL	44 (1.15)	494 (1.22)	0.7577	63 (0.83)	0.0989
BUN >23 mg/dL	30 (0.78)	296 (0.73)	0.6919	51 (0.67)	0.6342
INR >2	626 (16.37)	6434 (15.9)	0.4456	1215 (15.92)	0.5174
ASA score of 4 or 5	23 (0.6)	140 (0.35)	0.0171	34 (0.45)	0.3939
Inpatient	2039 (53.34)	20 488 (50.62)	0.0014	4098 (53.68)	0.7207
Outpatient	1784 (46.66)	19 983 (49.38)	0.0014	3536 (46.32)	0.7207
Emergency presentation	74 (1.94)	484 (1.2)	0.0002	116 (1.52)	0.1034
Open abdominal approach	2013 (52.65)	20 554 (50.79)	0.0278	4033 (52.83)	0.8582
Vaginal approach	359 (9.39)	3334 (8.24)	0.0156	712 (9.33)	0.9457
Laparoscopic approach	1466 (38.35)	16 694 (41.25)	0.0005	2910 (38.12)	0.7909

AKI: acute kidney injury; ASA: American Society of Anesthesiology; BMI: body mass index; BUN: Blood urea nitrogen; CHF: congestive heart failure; COPD: chronic obstructive pulmonary disease; DM: diabetes mellitus; eGFR: estimated glomerular filtration rate; INR: international normalized ratio; WBC: white blood cells.

relative to the preoperative value) and acute renal failure requiring renal replacement therapy. Pulmonary complications included pneumonia, unplanned reintubation, and mechanical ventilation over 48 hours.

Statistical Analysis

Fisher exact test was performed to compare the preoperative factors (listed in Tables 1 and 2). To account for preoperative differences and a mismatched sample size, a propensity-score matching was conducted in a 1:3 ratio (SMK: NSMK) using the Greedy Matching Algorithm with a 2% caliper. After the propensity-score matching, binary outcomes were contrasted by Fisher exact tests; 2-tailed independent *t* tests were used to compare continuous outcomes.

SAS (version 9.4) was used for all statistical analysis, which was done entirely by the authors. ACS-NSQIP data was used for this retrospective study and therefore this study was exempt from the IRB approval by George Washington University. The authors are responsible for the integrity of the data analysis and have full access to all data. The ACS-

Table 3. Comparing the thirty-day postoperative outcomes of patients who have smoked tobacco within the past year to patients who have not smoked tobacco within the past year after propensity-score matching

Variable	Smoker (n = 3823)	Nonsmoker (n = 40 471)	*P* value
Mortality	3 (0.08)	1 (0.01)	0.1112
MACE	2 (0.05)	4 (0.05)	1
Cardiac complications	1 (0.03)	4 (0.05)	0.6706
Stroke	1 (0.03)	0 (0)	0.3335
Pulmonary complications	14 (0.37)	16 (0.21)	0.125
Renal complications	4 (0.1)	9 (0.12)	1
Sepsis	26 (0.68)	37 (0.48)	0.1826
DVT	10 (0.26)	24 (0.31)	0.7177
Bleeding requiring transfusion	314 (8.22)	705 (9.24)	0.0758
Wound complications	109 (2.85)	169 (2.21)	0.0392
Unplanned operation	33 (0.86)	56 (0.73)	0.4984
Discharge not to home	747 (19.83)	1829 (24.18)	<.0001
30-day readmission	74 (1.94)	124 (1.62)	0.2247
	Mean ± SD	Mean ± SD	*P* value
Operation time (mins)	136.10 ± 81.05	140.60 ± 81.09	<0.01
Length of stay (days)	1.49 ± 2.15	1.47 ± 2.68	0.65

All values are n (%) unless otherwise specified.

DVT: deep vein thrombosis; MACE: major adverse cardiovascular events.

NSQIP data was accessed from, and all subsequent analyses were performed within, George Washington University.

RESULTS

There were a total of 44 294 patients who received a myomectomy for uterine fibroid removal in this study. These patients were further categorized into 3823 SMK patients and 40 471 NSMK patients. All SMK were propensity-score-matched to 7623 NSMK patients. This study accounted for significant preoperative differences between the 2 groups and compared the 30-day perioperative outcomes to examine whether a history of smoking impacts the postoperative outcomes in patients receiving myomectomy.

Table 1 summarizes the demographics and ages of SMK or NSMK patients who underwent myomectomy for uterine fibroid removal. Statistically significant differences were addressed by propensity-score matching. Table 2 shows the baseline characteristics and approach of SMK versus NSMK patients who underwent myomectomy for uterine fibroid removal. These differences were addressed by 1:3 propensity-score matching. Table 3 refers to a comparison of 30-day postoperative outcomes between 2 groups, NSMK and SMK of all ages, including in the hospital and after discharge after 1:3 propensity-score matching.

DISCUSSION

We compared the 30-day outcomes following myomectomy for fibroid removal between SMK and NSMK patients and observed a nearly 30% increased risk of wound complications among SMK patients compared to NSMK patients. However, we did not see a significant difference in the other variables analyzed. Previous literature has examined how tobacco smoking contributes to developing fibroids and complications across various surgeries. Specifically, since smoking reduces perfusion, it has been shown to decrease the risk of developing fibroids.[6] However, research on how the opposing effects of smoking—one that reduces fibroid burden and one that increases surgical complication risk—impacts myomectomy outcomes is more limited.

Increased wound complications following surgery for tobacco smokers compared to nonsmokers have been documented. In a meta-analysis, Liu et al. analyzed 11 trials with over 218 567 subjects across various surgeries and found an increased risk of wound healing problems and infection among smokers.[5] The likely pathophysiology explaining an increase in wound healing complications involves decreased perfusion and changes in collagen metabolism which causes necrosis of tissues with fragile blood supply and dehiscence.[5] Our result of increased risk

of wound complications, which includes surgical site infections, among SMK compared to NSMK patients, aligns with these findings.

The uterus requires blood to heal and fibroids blood to grow. These 2 forces may oppose each other resulting in fewer complications following myomectomy. Specifically, we do not see an increased risk of returning to the operating room or bleeding among smokers. Additionally, although we observed that SMK patients had a shorter operative time, the difference is small and not clinically significant. This implies that surgical complications that require reoperation or prolonged myomectomy were not significantly different among SMK compared to NSMK patients. The literature between increased risk of bleeding and return to the operating room among smokers following surgery is mixed, with some studies showing an increased risk among smokers and others not.[5,8,9] This suggests that the impact smoking has on outcomes is procedure-dependent. In our study, we apply this to a specific procedure, myomectomy for fibroid removal.

This study has limitations. First, the NSQIP database does not account for the duration or frequency of smoking, meaning subjects who frequently smoke were grouped with those who smoke much less as long as they have smoked tobacco within the past year. Additionally, a lifelong smoker who quit 2 years ago would be grouped with never-smokers. Second, outcomes such as future fertility, uterine rupture, and risk of having to do a total hysterectomy due to perioperative complications could not be analyzed due to NSQIP database limitations. Third, we could not stratify by the size, location, or amount of fibroids present in patients undergoing due to a lack of these variables in NSQIP.

As a retrospective study, there is potential for unknown or uncontrolled bias. NSQIP only tracks outcomes within 30 days of surgery, and it is possible that specific adverse outcomes occur beyond this period. Additionally, we grouped 3 different myomectomy approaches together in our analysis (laparotomy, laparoscopy, and vaginal approach). Due to insufficient power, we could not analyse each approach individually. Using NSQIP, one cannot account for different hospital volumes, resources, socioeconomic factors, and physician experience, all of which may impact outcomes. Additionally, there may be bias in which hospitals participate in NSQIP.

Despite limitations, NSQIP offers a large sample size that is unparalleled by most databases. Further research is needed analyzing other nicotine products, outcomes beyond the 30-day period, and additional variables such as uterine rupture and fertility between smokers and nonsmokers after myomectomy. Additionally, research that stratifies groups based on the frequency and duration of smoking, as well as providing follow-ups for patients, is needed.

We observed that SMK patients have an increased risk of wound complications following myomectomy compared to NSMK patients. These results may suggest that quitting tobacco smoking for one year has no impact on improving outcomes for the variables analyzed other than decreasing wound complications. Additionally, our results suggest that in the context of myomectomy smoking mainly impacts wound healing. Our analysis aims to provide health care providers with further information regarding the risks of performing a myomectomy on smokers compared to nonsmokers such that they can plan patient management accordingly.

AUTHOR CONTRIBUTIONS

William Rienas: Protocol/project development, Manuscript writing/editing.

Renxi Li: Data collection or management, Data analysis.

Lianne Ryan: Manuscript writing/editing.

SeungEun Lee: Manuscript writing/editing.

Rubin Frenkel: Protocol/project development, Manuscript writing/editing.

ETHICAL APPROVAL

This study was data was exempt from the IRB approval by The George Washington University.

SUPPLEMENTARY DATA

Supplementary data related to this article can be found at https://doi.org/10.1016/j.jogc.2024.102706.

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