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The effect of smoking on 30-day outcomes in elective hernia repair

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Abstract

Background: Adverse postoperative outcomes related to smoking are well established, yet current smokers continue to be offered elective surgery in the US. It is unknown whether patients undergoing low-risk, elective procedures, who actively smoke experience increased risk of complications. We sought to determine the increased burden of complications following elective hernia repair procedures in patients identified as current smokers.

Methods: We identified patients undergoing elective incisional, inguinal, umbilical, or ventral hernia repair from 2011 to 2014 using the American College of Surgeons National Surgical Quality Improvement Project (ACS NSQIP) database. Multivariable logistic regression analysis

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Disclosures

KB, DO, AY, and JS declare conflicts of interest not directly related to the submitted work (National Institutes of Health, Agency for Healthcare Research and Quality, American Board of Surgery, American College of Surgeons, Accreditation Council for Graduate Medical Education, Health Care Services Corporation and Blue Cross Blue Shield of Illinois, Mallinkrodt, and Northwestern University). JD, DH, EB, KE, and JH have nothing to disclose.

Appendix A. Supplementary data

Supplementary data related to this article can be found at <https://doi.org/10.1016/j.amjsurg.2018.03.004>.

was used to examine the association between current smoking and 30-day postoperative outcomes, adjusting for demographics and comorbidities.

Results: Of 220,629 patients who underwent elective hernia repair, 40,446 (18.3%) self-identified as current smokers within the past 12 months. Current smokers experienced an increased likelihood (Odds Ratio [95% Confidence interval]) of reoperation (OR 1.23 [95% CI 1.11–1.36]), readmission (OR 1.24 [95% CI 1.16–1.32]), and death (OR 1.53 [95% CI 1.06–2.22]). Furthermore, smokers experienced an increased risk of postoperative pulmonary, infectious, and wound complications, but there was no increased risk of requiring transfusion or of postoperative cardiac or thromboembolic events.

Conclusions: Current smokers were more likely to experience serious postoperative complications within 30 days. Given the volume of elective hernia surgery performed in the US, encouraging smoking cessation prior to offering elective repair could reduce postoperative complications, reoperation, readmission, and mortality.

1. Background

Smoking is the leading cause of preventable mortality in the United States.¹ Despite a decrease in smoking prevalence since the 1950s, an estimated 36.5 million individuals or more than 15% of the adult US population continues to smoke.^{2,3} The adverse effects of smoking on surgical outcomes and mortality is well documented. Smoking is an independent predictor with a dose-dependent increase in a number of postoperative complications across a variety of surgical procedures.^{4,5} In addition, health care costs after a surgical procedure are higher in current smokers.^{6,7}

The benefits of smoking cessation prior to surgery are well documented and studies demonstrate that smoking cessation even within 4 weeks of surgery has resulted in improved surgical outcomes and reduced healthcare costs.^{7,8} However, these studies often focus on major surgical events, requiring long hospital stays and considered to be high risk procedures. In an effort to curb health care costs, other countries have advocated for refusing to perform elective surgical procedures in patients who smoke until they have quit, even though it is unknown whether patients undergoing lower risk elective procedures also experience a clinically significant increased risk of poor outcomes (e.g., complications, mortality).⁹

Hernia repairs are some of the most common operations performed in the United States, with over 800,000 inguinal hernia repairs performed annually, many electively.¹⁰ Furthermore, smoking is a known risk factor for development of a hernia and increases the risk of a hernia recurrence. However, most general surgeons continue to offer elective hernia repair surgery to current smokers. Therefore, we sought to determine the association between current smoking and 30-day postoperative complications in patients undergoing elective hernia repair procedures.

2. Methods

2.1. Data source

The American College of Surgeons National Surgical Quality Improvement Project (ACS NSQIP) collects clinical, procedural, and 30-day outcome data on patients undergoing surgery at participating hospitals. The variables are abstracted by trained, certified Surgical Clinical Reviewers.

2.2. Study population

We identified patients undergoing open or laparoscopic incisional, inguinal, umbilical, or ventral hernia repair using the ACS NSQIP database, based on Current Procedural Terminology (CPT) codes. From 2011 to 2014, the ACS NSQIP database further classified procedures as “elective” or “emergent”. Patients who underwent a hernia repair classified as “elective” in the ACS NSQIP database were included. Patients were excluded if they underwent a hernia repair classified as “emergent”, the hernia was incarcerated or strangulated, the patient was classified as American Society of Anesthesia (ASA) class V, or with missing smoking status. Smoking status was classified as “current smoker” or “non-smoker” based on patient self-report of smoking cigarettes within the last year. The NSQIP database does not distinguish between “former” or “never” smokers and discontinued collection of data on pack-years of smoking after 2010. Recurrent hernias were not included as part of our analyses.

2.3. Outcomes

The outcomes of interest were complications within 30 days after surgery. The outcomes include death, return to the operating room, readmission, need for transfusion, wound complication (superficial surgical site infection, deep surgical site infection, organ space surgical site infection, or dehiscence), sepsis or septic shock, pulmonary complication (pneumonia, re-intubation, failure to wean from the ventilator), thromboembolic event (deep venous thrombosis or pulmonary embolism), or cardiac event (myocardial infarction or cardiac arrest).

2.4. Statistical analysis

Descriptive statistics were used to evaluate associations between demographic factors and smoking status using Chi-squared tests for categorical variables and t-tests for continuous variables. We evaluated differences in complication rates using univariate logistic regression prior to adding variables with significant associations to the multivariable model. We used multivariable logistic regression analysis to examine associations between smoking and 30-day postoperative outcomes, adjusting for gender, age, race (White, Black, Hispanic, Asian/Pacific Islander, other/unknown), BMI (<18.5, 18.5–25, 24.1–30, >30), hernia repair type (open or laparoscopic inguinal, ventral, umbilical, or incisional), ASA class, and pre-existing comorbidities (diabetes, chronic obstructive pulmonary disease (COPD), and hypertension). In order to evaluate the burden of complications potentially associated with smoking, we also calculated the number needed to harm.

The level of statistical significance was set at 0.05 and all tests were two sided. Statistical analyses were performed using Statistical Analysis Software (SAS) v9.4. This study was deemed exempt by the Institutional Review Board of Northwestern University.

3. Results

Of 220,629 patients who underwent elective hernia repair, 40,446 (18.3%) self-identified as current smokers, consistent with known population-based smoking prevalence in the United States.² The mean age among smokers was 50 years, compared to 57 years in non-smokers (Table 1). African Americans were more likely to report current smoking (25.7%) than White (17.9%), Hispanic (15.8%), or Asian/Pacific Islander (11.4%) patients ($p < 0.05$). Current smokers more frequently had lower BMI and more frequently reported consumption of two or more alcoholic beverages daily ($p < 0.05$) compared to non-smokers. Current smokers were also more likely to have comorbid diabetes (15.8%), hypertension (15.7%), COPD (40.7%), peripheral vascular disease (28.8%) and myocardial infarction (23.7%) compared to non-smokers ($p < 0.05$). Patients who identified as current smokers were also more likely to be classified as ASA class 2 (19.9%) or 3 (19.7%) compared to ASA class 1 (9.3%) ($p < 0.05$).

A total of 2565 (6.34%) current smokers experienced at least one complication compared to 8509 (4.72%) of patients who were not current smokers ($p < 0.05$; Table 2). Univariate analyses revealed that current smokers experienced a higher unadjusted rate of each of the 30-day complications examined, with the exception of death, thromboembolic events, cardiac events, and the need for transfusion. Based on the 1.6% absolute increased risk of experiencing any complication among smokers, the number of elective hernia repairs performed on smokers in order to observe an increased complication compared to non-smokers in this population was 62 (see Table 3).

After adjustment for demographic and clinical factors and hernia repair type, current smokers more frequently experienced (Odds Ratio [95% Confidence interval]) any complication (OR 1.30 [95% CI 1.23–1.37]), readmission (OR 1.24 [95% CI 1.16–1.32]), reoperation (OR 1.23 [95% CI 1.11–1.36]), and death (OR 1.53 [95% CI 1.06–2.22]; Table 2). Furthermore, current smokers experienced an increased risk of postoperative wound infection [(superficial: (OR 1.34 [95% CI 1.22–1.48]), deep: (OR 1.31 [95% CI 1.11–1.54]), organ space: (OR 1.45 [95% CI 1.17–1.79])], and dehiscence (OR 1.41 [95% CI 1.11–1.80]); sepsis (OR 1.30 [95% CI 1.09–1.56]) and septic shock (OR 1.51 [95% CI 1.07–2.14]); pneumonia (OR 2.30 [95% CI 1.92–2.76]); reintubation (OR 1.82 [95% CI 1.47–2.24]); and failure to wean from the ventilator (OR 1.77 [95% CI 1.38–2.26]). We did not observe an increased odds of requiring transfusion or postoperative cardiac or thromboembolic events.

4. Discussion

Current smokers were more likely to experience several serious postoperative complications following a lower-risk elective procedure, hernia repair.

The impact of smoking on postoperative complications is well established. Prior analyses of NSQIP data have revealed that smokers undergoing major cardiovascular or oncologic surgery experienced worse postoperative pulmonary, wound, and infectious complications.⁴ Less well known is the association between current smoking and serious postoperative outcomes in elective surgeries, although current smokers undergoing elective surgery have been found to have an increased risk of developing surgical site infections.¹¹

Although complications following elective hernia repairs are rare, with nearly a million hernia operations being performed in the United States annually, decreasing the number of complications related to current smoking represents a significant opportunity for cost reduction, as postoperative complications lead to increased hospital costs and improved outcomes.^{5,12}

This raises the question of whether elective surgeries should be offered to patients who are current smokers. Considering that greater than 80% of current smokers who seek medical care desire to quit, the preoperative surgical encounter is an opportunity for providers to perform smoking cessation counseling.^{3,13} Furthermore, some studies suggest that smoking cessation may be more successful immediately prior to surgery.^{14,15} There is also evidence that the likelihood of sustained smoking cessation at one year is greatest when performed preoperatively. In a randomized study of patients undergoing elective orthopedic and general surgery procedures, individuals provided with smoking cessation counseling preoperatively were more likely to maintain abstinence at one year after surgery compared to those who received standard care.¹⁴ From a policy standpoint, given the volume of elective hernia surgeries performed in the US, requiring smoking cessation prior to offering elective hernia repair may prevent poor outcomes and help contain increased costs associated with surgical complications.

Strengths of this study include a large, national cohort, and the ability to focus the analysis on an elective surgery. However, the study should be interpreted in light of several limitations. First, the classification of current smoker includes any patient who reported smoking in the past year and, for example, classifies patients who may have quit smoking less than one year prior to surgery as current smokers. However, this classification decreases the effect size and, therefore, the estimate of the effect of current smoking on complications of elective hernia surgery is conservative. Second, the ACS NSQIP smoking variable does not identify prior smokers. Multiple studies have also demonstrated a significant increase in postoperative complications and mortality in patients described as “prior” smokers when compared to never smokers.^{4,5} However, again this limitation would likely bias the estimates towards the null. Third, NSQIP reporting only includes outcomes up to 30 days after surgery and, as a result, we were unable to assess the long-term effects from smoking on surgical outcomes and mortality. In addition, the dataset does not include information regarding pack-years of smoking and were unable to adjust for the duration or intensity of smoking, prior to surgery. Furthermore, a hierarchical logistic regression was not used for our model because NSQIP does not provide hospital identifiers in their dataset which precludes accounting for clustering of smokers and cases within hospitals.

In conclusion, we found that current smokers had an increased risk of rare but serious complications following elective hernia repair. This further emphasizes the importance of smoking cessation counseling prior to surgery, a time of increased success in smoking cessation.¹⁵ However, given the overall low rate of complications following elective hernia surgery, the effect size is inadequate to conclude that current smoking alone be used as an indication to deny a patient an elective hernia repair. Therefore, the risks and benefits of surgery should be carefully weighed by the operating surgeon and patient in light of these findings in order to make a more informed decision regarding the timing of surgery.

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Table 1

Demographic characteristics of elective hernia repair patients by smoking status.

	Smoking Status		P-value ^a
	Current Smoker N(%)	Non-smoker N(%)	
Total	40,630 (18.3)	181,018 (81.7)	
Age, median (IQR)	50 (40–59)	57 (46–68)	
Sex			
Male	27,889 (18.5)	123,020 (81.5)	0.010
Female	12,732 (18.0)	57,930 (82.0)	
Race			
White	28,264 (17.9)	129,251 (82.1)	<0.001
Black	5271 (25.7)	15,242 (74.3)	
Hispanic	2672 (15.8)	14,282 (84.2)	
Asian/Pacific Islander	481 (11.4)	3745 (88.6)	
Other/Unknown	3568 (16.7)	17,751 (83.3)	
Body Mass Index (BMI)			
<18.5	509 (32.3)	1068 (67.7)	<0.001
18.5–25	10,751 (21.3)	39,913 (78.8)	
25.1–30	13,076 (16.9)	64,349 (83.1)	
>30	16,002 (17.7)	74,155 (82.3)	
Alcohol (drinks per day)			
<2	40,275 (18.3)	180,296 (81.7)	<0.001
2	355 (33.0)	722 (67.0)	
Comorbidities			
Diabetes	3921 (15.8)	20,873 (84.2)	<0.001
Hypertension	14,100 (15.7)	75,798 (84.3)	<0.001
COPD	2911 (40.7)	4248 (59.3)	<0.001
CVA	132 (19.5)	545 (80.5)	0.567
PVD	76 (28.8)	188 (71.2)	<0.001
CHF	75 (18.8)	323 (81.2)	0.791
Myocardial infarction	9 (23.7)	29 (76.3)	0.043
ASA Class			
1: No Disturbance	2947 (9.3)	28,808 (90.7)	<0.001
2: Mild Disturbance	24,060 (19.9)	96,758 (80.1)	
3: Severe Disturbance	13,623 (32.8)	55,452 (80.3)	
Anesthesia			
General	37,601 (18.9)	161 (575 (81.1)	<0.001
Epidural/Regional/Spinal	425 (17.0)	2083 (83.0)	
MAC/IV Sedation	2478 (13.2)	16,233 (86.8)	
Other/Unknown			
Hernia repairtype			

	Smoking Status		P-value ^a
	Current Smoker	Non-smoker	
	N(%)		
Open Inguinal	11,332 (18.3)	50,585 (81.7)	0.826
Open Ventral	11,087 (19.7)	45,286 (80.3)	<0.001
Open Umbilical	7461 (17.2)	35,944 (82.8)	<0.001
Laparoscopic inguinal	4357 (16.8)	21,527 (83.2)	<0.001
Laparoscopic ventral/umbilical	3189 (18.6)	13,952 (81.4)	0.335
Laparoscopic incisional	3204 (18.9)	13,724 (81.1)	0.037

^a p-value for Chi-square test.

Table 2

Incidence of postoperative complications following elective hernia repair by smoking status.

	Current Smoker	Non-Smoker	p-value ^a
N(%)			
Any Complication	2565 (6.34)	8509 (4.72)	<0.001
Death	53 (0.13)	186 (0.10)	0.124
Return to OR	552 (1.36)	1870 (1.04)	<0.001
Readmission	1446 (3.69)	4972 (2.85)	<0.001
Wound Complication			
Any Wound Complication	1044 (2.58)	3039 (1.69)	<0.001
Superficial Wound Infection	631 (1.56)	1864 (1.03)	<0.001
Deep Incisional Infection	221 (0.55)	638 (0.35)	<0.001
Organ Space Infection	142 (0.35)	394 (0.22)	<0.001
Wound Dehiscence	106 (0.26)	272 (0.15)	<0.001
Sepsis/Septic Shock	254 (0.63)	716 (0.40)	<0.001
Pulmonary			
Pneumonia	241 (0.60)	481 (0.27)	<0.001
Reintubation	166 (0.41)	392 (0.22)	<0.001
Failure to Wean from Vent	118 (0.29)	268 (0.15)	<0.001
Thromboembolic (DVT/PE)	87 (0.22)	475 (0.26)	0.080
Cardiac			
Cardiac Arrest	28 (0.07)	103 (0.06)	0.368
Myocardial Infarction	37 (0.09)	154 (0.09)	0.710
Transfusion	147 (0.36)	671 (0.37)	0.789

^a p-value for Chi-squared test.

Table 3

Associations between smoking and 30-day postoperative complications following elective hernia repair.

	<u>Adjusted Odds^a</u>
	<u>OR (95% CI)</u>
Any Complication	1.30 (1.23–1.37)
Death	1.53 (1.06–2.22)
Return to OR	1.23 (1.11–1.36)
Readmission	1.24(1.16–1.32)
Wound Complication	
Any Wound Complication	1.36 (1.26–1.47)
Superficial Wound Infection	1.34 (1.22–1.48)
Deep Incisional Infection	1.31 (1.11–1.54)
Organ Space Infection	1.45 (1.17–1.79)
Wound Dehiscence	1.41 (1.11–1.80)
Sepsis/Septic Shock	1.31 (1.09–1.59)
Pulmonary	
Pneumonia	2.30 (1.92–2.76)
Reintubation	1.82 (1.47–2.24)
Failure to Wean from Vent	1.77 (1.38–2.26)
Thromboembolic (DVT/PE)	0.87 (0.63–1.19)
Cardiac	
Cardiac Arrest	1.43 (0.90–2.28)
Myocardial Infarction	1.27 (0.82–1.95)
Transfusion	0.90 (0.74–1.09)

^a Logistic regression model adjusted for gender, age, race, BMI, hernia repair type, ASA class and related comorbidities including diabetes, chronic obstructive pulmonary disease (COPD), and hypertension.