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Rectal prolapse surgery in males and females: An ACS NSQIP-based comparative analysis of over 12,000 patients

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ABSTRACT

Background: Rectal prolapse is relatively uncommon in male patients. The aim of this study was to compare males and females who underwent rectal prolapse surgery.
Study design: Retrospective analysis of the ACS NSQIP public use file.
Results: Among 12,220 patients, 978 (8%) were male and 11,242 (92%) were female. Males were younger, 56 (38–73) vs. 71 (58–83) years, less often white (83% vs. 71%), had lower ASA scores, and underwent more laparoscopic (33% vs. 27%), more open (33% vs. 29%), and less perineal (33% vs 44%) procedures (all $p < 0.05$). Morbidity (9.9% vs. 10.0%), reoperation (3.4% vs. 3.1%), and readmission (5.7% vs. 6.0%) were not different for males and females. In subgroup analysis by surgical procedure type, there remained no outcome differences. Propensity matched analysis revealed no difference in the use of laparoscopic, open, or perineal procedures.
Conclusions: Males with rectal prolapse are younger, have a different racial distribution, a lower surgical risk profile, and undergo different surgical procedures than females, which appears to be driven by patient age and surgical risk assessment.

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Introduction

In North American and European studies of rectal prolapse surgery, approximately 10% of the patients are male.[1–4] Previous studies based on the American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP) have shown that perineal operations are more commonly used in older and high risk patients with rectal prolapse.[3,5,6] In 2011, Fleming[5] reported decreased postoperative complications among patients who underwent perineal compared to abdominal operations, no difference in complications after abdominal rectopexy versus perineal procedures, and that while operative approach was an independent predictor of postoperative morbidity, age and comorbidities were not. A subsequent ACS NSQIP study showed no difference in risk-adjusted morbidity or mortality among patients who underwent laparoscopic compared to perineal surgery and, in agreement with Fleming, open resection rectopexy had the highest risk of postoperative complications.[6] Most recently, an ACS NSQIP-based longitudinal study of high-risk patients, 70 years of age or older, demonstrated that the use of open abdominal and perineal procedures are declining over time, laparoscopic procedures are on the rise, and contrary to Flemings findings,[5] the perineal surgical approach (but not age), was an independent predictor of postoperative major morbidity or mortality.[7] Aside from ACS NSQIP studies, a randomized prospective showed no differences in the long-term outcomes of perineal and abdominal surgical approaches to rectal prolapse repair.[8] The most recent Cochrane review demonstrated fewer complications and shorter length of stay with laparoscopic compared to open rectopexy but no differences in subsequent quality of life.[9]

It is notable that none of the published studies of rectal prolapse surgery have included a comparative analysis of male and female subjects. This gender-based comparison may be of value. Recent studies of patients with ulcerative colitis (UC) have shown that

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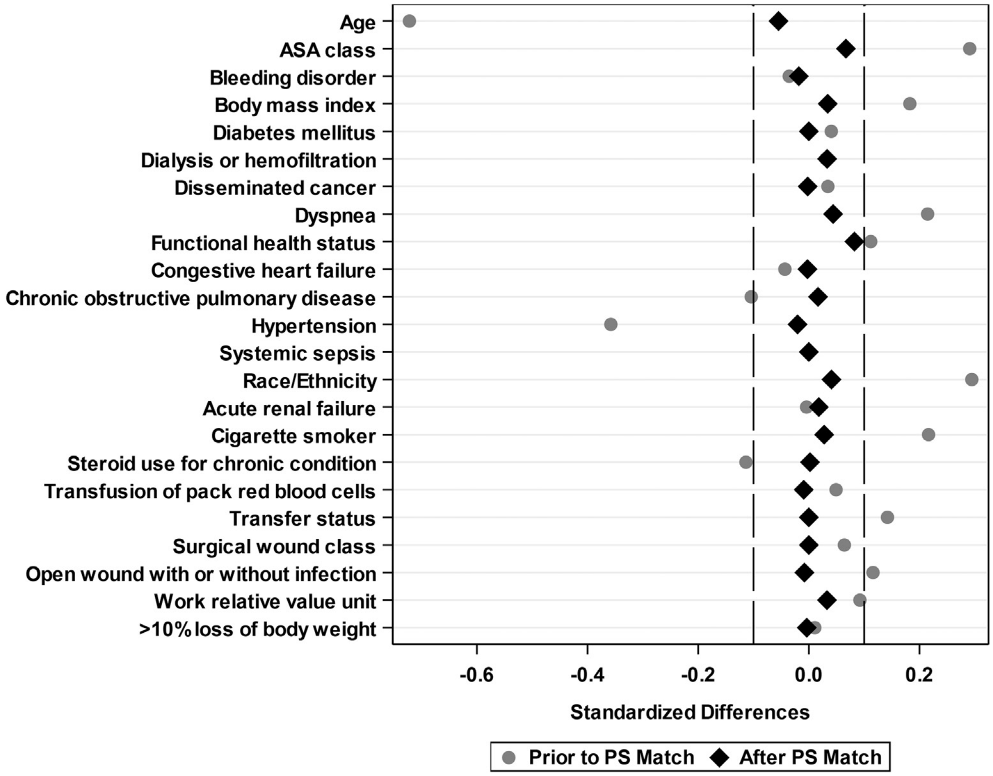

Fig. 1. Propensity matching.
Propensity score for each patient was calculated using a multivariable logistic regression model in which the dependent variable was gender and the independent variables were those listed in figure.

males were more likely to be treated with surgery and that UC medical therapies varied among men and women.[10,11] A NSQIP study indicated that venous thromboembolism after colorectal surgery occurred more often in males.[12] Male gender has been shown to be a risk factor for colorectal anastomotic leaks,[13] complications of ileal pouch anal anastomosis,[14] and overall postoperative morbidity and mortality.[15] These studies point to the importance of gender differences in the treatment of colorectal pathology, the outcomes of surgery, and in-turn, support the idea that male and female patients with rectal prolapse could have different surgical outcomes. The aim of this study is to compare the preoperative and operative variables and the postoperative outcomes of rectal prolapse surgery in males and females to better understand differences between these patient populations.

Methods

Patients/data source

We identified patients aged 18 years and older who had undergone surgical procedures for rectal prolapse in the ACS NSQIP Participant Use File (PUF), 2005–2017. The ACS NSQIP PUF collects preoperative patient variables including demographics and comorbidities, operative data, and 30-day postoperative outcomes for a sample of patients undergoing major operations. Trained surgical clinical reviewers at each participating center collect the data. Thirty-day postoperative outcomes are determined through chart reviews and by patient and family contact after the index operation. Data are audited to ensure quality and standardization of collection.[16] Patients undergoing surgical procedures for rectal prolapse were identified using International Classification of Disease (ICD) Ninth Revision Clinical Modification (569.1) or Tenth Revision Clinical Modification (K62.3) codes and subsequently were divided into laparoscopic, open, and perineal groups using Current Procedural Terminology (CPT) codes.

Primary outcomes

The 18 reported ACS NSQIP 30-day perioperative morbidities were grouped into the following eight categories: (1) Respiratory (pneumonia, unplanned intubation, ventilator > 48 h, or septic shock); (2) Infection (sepsis, superficial surgical site infection [SSI], deep incisional SSI, organ/space SSI, or wound disruption); (3) urinary tract infection; (4) venous thromboembolism (occurrence of deep vein thrombosis [DVT]/thrombophlebitis or pulmonary embolism); (5) cardiac (cardiac arrest or myocardial infarction), (6) bleeding/transfusion; (7) renal (acute renal failure or progressive renal insufficiency), and (8) neurological/stroke.[17,18] Additional adverse outcome categories were: (9) Mortality; (10) Overall morbidity (occurrence of any of the 18 morbidities); (11) Unplanned reoperation, and (12) unplanned, related readmission. Unplanned, related readmission was defined by the ACS NSQIP PUF as readmission related to the index operation, occurring within 30 days of the initial operation without documented plans for readmission. Since, patients that died during their hospital stay are unable to have outcomes of reoperation or unplanned, related readmission they were excluded from the analyses of these two outcomes. Furthermore, the last two adverse outcomes were not added to the ACS NSQIP PUF until 2012 and therefore was a subset analysis of years 2012–2017.

Statistical analyses

To characterize the study population between males and

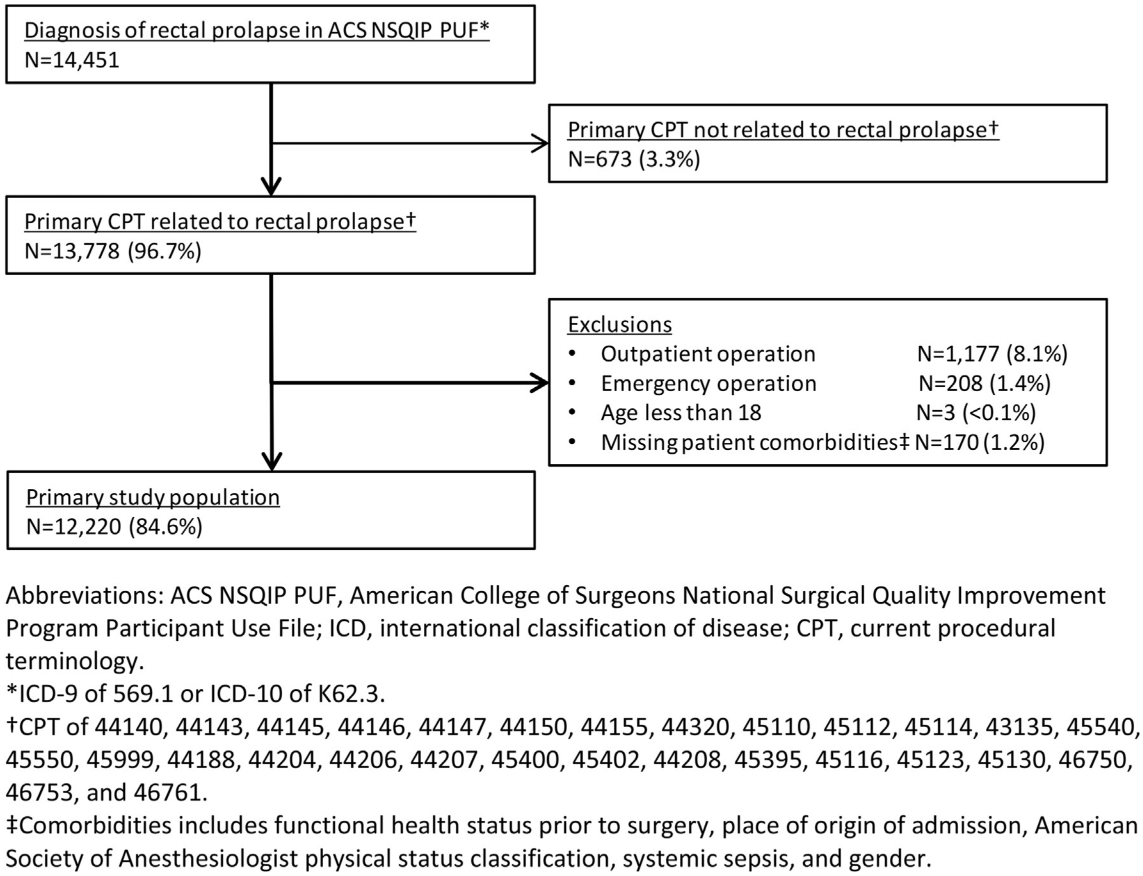

Fig. 2. STROBE (Strengthening the Reporting of Observational studies) Study Sample Development.
Abbreviations: ACS NSQIP PUF, American College of Surgeons National Surgical Quality Improvement Program Participant Use File; ICD, international classification of disease; CPT, current procedural terminology.
*ICD-9 of 569.1 or ICD-10 of K62.3.
†CPT of 44140, 44143, 44145, 44146, 44147, 44150, 44155, 44320, 45110, 45112, 45114, 43135, 45540, 45550, 45999, 44188, 44204, 44206, 44207, 45400, 45402, 44208, 45395, 45116, 45123, 45130, 46750, 46753, and 46761.
‡Comorbidities includes functional health status prior to surgery, place of origin of admission, American Society of Anesthesiologist physical status classification, systemic sepsis, and gender.

females, we calculated descriptive statistics using frequencies and percentage for categorical variables and tested them using either χ^2 or Fisher's exact test; and means and standard deviations (SD) or median and interquartile ranges (IQR) for continuous variables and tested them using *t*-test or Wilcoxon rank-sum test, respectively. We further evaluated the differences between males and females for the 12 adverse outcomes and by each surgical procedure with frequencies and percentages and used Fischer's exact test to evaluate any differences.

To evaluate whether gender was an independent predictor of surgical procedure, we utilized two approaches to risk-adjust. The primary risk-adjustment was propensity score match analysis; the secondary risk-adjustment was multivariable multinomial logistic regression.

Propensity score for each patient was calculated using a multivariable logistic regression model in which the dependent variable was gender and the independent variables were the other preoperative data points. Fig. 1 For the propensity model the β-coefficients were combined with the patient's values for each covariate to generate propensity scores for each patient. Patient-level propensity scores were used to match male patients 1:2 to female patients to produce the propensity-matched cohort using the nearest neighbor matching method.[19] In addition, we used a caliper of the logit of the propensity score of 0.2 to improve matching quality which resulted in a few males only matching with one female. The quality of the matching process was assessed by comparing the standardized differences for the covariates before and after matching.[20] Absolute standardized differences ≤ 0.1 generally indicates groups are well balanced for that characteristic. Multinomial generalized estimating equation with repeated measures model were used to test for association of gender with surgical procedure for the propensity score matched cohort to account for correlation within each matched pair.

All statistical tests were considered significant at a 2-sided $P < .05$. All analyses were performed using SAS software version 9.4 (SAS Inc., Cary, NC).

Results

Demographics and preoperative variables

We identified 14,451 patient who underwent a surgical procedure for rectal prolapse. Patients were excluded for the following reasons: 673 (4.7%) lacked details of surgical approach; 1558 (10.8%) were missing key demographic and pre-, intra-, and post-operative data. The resulting study cohort was 12,220 (84.6%). Fig. 2 Additional subset analysis was performed on 8107 patients where reoperative data was available, and 8096 patients where

Table 1a
Overall study sample: Preoperative variables.

Characteristics	Female (n = 11,242) N (%)*	Male (n = 978) N (%)*	P value
Age, years, median (IQR)	71 (58–83)	56 (38–73)	**<.0001**
Race/Ethnicity			
White, Not of Hispanic Origin	9314 (82.9)	701 (71.7)	**<.0001**
Black, Not of Hispanic Origin	335 (3.0)	72 (7.4)	
Asian or Pacific Islander	212 (1.9)	35 (3.6)	
Hispanic Origin	267 (2.4)	43 (4.4)	
American Indian or Alaska Native	79 (0.7)	22 (2.3)	
Null/unknown	1035 (9.2)	105 (10.7)	
Body mass index			
Underweight (<18.5)	856 (7.6)	48 (4.9)	**<.001**
Normal weight (18.5–24.9)	5570 (49.6)	464 (47.4)	
Overweight (25.0–29.9)	2977 (26.5)	314 (32.1)	
Obese class I (30.0–34.9)	1136 (10.1)	107 (10.9)	
Obese class II (35.0–39.9)	387 (3.4)	21 (2.2)	
Obese class III (≥40.0)	191 (1.7)	11 (1.1)	
Null/unknown	125 (1.1)	13 (1.3)	
Diabetes mellitus			
No	10,159 (90.4)	889 (90.9)	.32
Oral	697 (6.2)	64 (6.5)	
Insulin	336 (3.4)	25 (2.6)	
Dyspnea (within 30 days)			
No	10,177 (90.5)	924 (94.5)	**<.001**
Moderate exertion	998 (8.9)	51 (5.2)	
At rest	67 (0.6)	3 (0.3)	
Functional health status prior to surgery			
Independent	10,273 (91.4)	898 (91.8)	**<.001**
Partially dependent	879 (7.8)	61 (6.2)	
Totally dependent	90 (0.8)	19 (1.9)	
Congestive heart failure (within 30 days)	127 (1.1)	7 (0.7)	.23
Severe chronic obstructive pulmonary disease (COPD)	902 (8.0)	53 (5.4)	**.004**
Blood pressure >140/90 mm Hg or taking antihypertensive medications	5872 (52.2)	340 (34.8)	**<.0001**
Cigarette smoker (within 1 year)	1622 (14.4)	223 (22.8)	**<.0001**
Steroid use for chronic condition	733 (6.5)	39 (4.0)	**.002**
>10% loss of body weight (within 6 months)	158 (1.4)	15 (1.5)	.74
ASA class‡			
I	347 (3.1)	85 (8.7)	**<.0001**
II	4795 (42.7)	449 (45.9)	
III	5541 (46.3)	415 (42.4)	
IV	557 (5.0)	29 (3.0)	
V	2 (<.01)	0 (0)	

Abbreviations: SD, standard deviation; IQR, interquartile range; ASA Class, American Society of Anesthesiology physical status classification.
*Data are frequency and column percent unless otherwise indicated. P values were *t*-test or Wilcoxon rank sum for continuous variables and chi-square or Fisher's exact for categorical variables and bolded if < .05.
‡ASA class definitions: I, a normal health patient; II, a patient with mild systemic disease; III, a patient with severe systemic disease; IV, a patient with severe systemic disease that is a constant threat to life; V, a moribund patient who is not expected to survive without the operation.

readmission data was available. Of the 12,220 patients in the final study sample, there were 978 (8%) males and 11,242 (92%) females. Male patients were younger than females with a median age of 56 (IQR 38–73) years compared to 71 (IQR 53–83) years, respectively (p < .001). Male subjects were less often white (72% vs. 83%) and the overall racial distribution differed between genders (p < .0001). Males were more often cigarette smokers (23% vs. 14%, p < .0001) but less often had severe chronic obstructive pulmonary disease (COPD) (5.4% vs. 8.0%, p = 0.004), were less likely to be a chronic steroid user (4.0% vs. 6.5%, p = .002), and had lower American Society of Anesthesiology (ASA) Physical Status classifications (p < .001). Table 1a Patient age, comorbid conditions, and ASA class were all higher in the male and female perineal surgery cohorts. Tables 1b and 1c.

Operative data

There were 32 unique procedures performed for rectal prolapse. Of these, the 5 most frequently performed, in both females and males, were perineal proctectomy with anastomosis (49% and 37%), laparoscopic proctopexy (17% and 21%), laparoscopic proctopexy with sigmoid resection (12 and 15%), open proctopexy (11% and 14%), and open proctopexy with sigmoid resection (11% and 13%), which, in total, accounted for 74% of all procedures that were performed. Among the top 5 procedures there was significant variation between males and females. Table 2 When categorized into procedure types there were differences among females and males in each category with laparoscopy, open surgery, and perineal operations performed in 27% and 33%, 29% and 33%, and 44% and 33%, respectively. (all p ≤ 0.01) Table 3 Among unmatched subjects, males were more likely to undergo laparoscopic (odds ratio (OR) 1.646 [95% confidence interval (CI) 1.402–1.932]) and open (OR 1.531 [95% CI 1.305–1.796]) procedures than females. Table 4.

Postoperative data

In the unmatched male and female cohorts, including all operations performed, postoperative morbidity (9.9% and 10%), mortality (0.6% and 1.0%), reoperations (3.4% and 3.1%), length of hospital stay (median 3 (IQR 2–5) and median 2 (IQR 2–4) days),

Table 1b
Preoperative variables, male subjects.

Characteristics	Laparoscopic	Open	Perineal	P value
	(n = 326)	(n = 328)	(n = 324)	
	N (%)*	N (%)*	N (%)*	
Age, years, median (IQR)	47.0 (31.0–62.0)	51.0 (35.5–67.0)	70.0 (55.5–82.0)	**<.0001**
Race/Ethnicity				
White, Not of Hispanic Origin	230 (70.6)	231 (70.4)	240 (74.1)	.84
Black, Not of Hispanic Origin	26 (8.0)	23 (7.0)	23 (7.1)	
Asian or Pacific Islander	15 (4.6)	8 (2.4)	12 (13.7)	
Hispanic Origin	13 (4.0)	17 (5.2)	13 (4.0)	
American Indian or Alaska Native	8 (2.5)	9 (2.7)	5 (1.5)	
Null/unknown				
Body mass index				
Underweight (<18.5)	19 (5.8)	10 (3.1)	19 (5.9)	**.001**
Normal weight (18.5–24.9)	167 (51.2)	138 (42.1)	159 (49.1)	
Overweight (25.0–29.9)	92 (28.2)	107 (32.6)	115 (35.5)	
Obese class I (30.0–34.9)	35 (10.7)	51 (15.6)	21 (6.5)	
Obese class II (35.0–39.9)	10 (3.1)	6 (1.8)	5 (1.5)	
Obese class III (≥40.0)	2 (0.6)	8 (2.4)	1 (0.3)	
Null/unknown	1 (0.3)	8 (2.4)	4 (1.2)	
Diabetes mellitus				
No	309 (94.8)	296 (90.2)	284 (87.7)	**.01**
Oral	10 (3.1)	22 (6.7)	32 (9.9)	
Insulin	7 (2.2)	10 (3.1)	8 (2.5)	
Dyspnea (within 30 days)				
No	310 (95.1)	311 (94.8)	303 (93.5)	.68
Moderate exertion	15 (4.6)	17 (5.2)	19 (5.9)	
At rest	1 (0.3)	0 (0)	2 (0.6)	
Functional health status prior to surgery				
Independent	305 (93.5)	306 (93.3)	287 (88.6)	.12
Partially dependent	17 (5.2)	17 (5.2)	27 (8.3)	
Totally dependent	4 (1.2)	5 (1.5)	10 (3.1)	
Congestive heart failure (within 30 days)	1 (0.3)	1 (0.3)	5 (1.5)	.19
Severe chronic obstructive pulmonary disease (COPD)	14 (4.3)	14 (4.3)	25 (7.7)	.08
Blood pressure >140/90 mm Hg or taking antihypertensive medications	83 (25.5)	104 (31.7)	153 (47.2)	**<.0001**
Cigarette smoker (within 1 year)	86 (26.4)	82 (25.0)	55 (17.0)	**.01**
Steroid use for chronic condition	8 (2.5)	18 (5.5)	13 (4.0)	.14
>10% loss of body weight (≤6 months)	3 (0.9)	8 (2.4)	1 (1.2)	.25
ASA class‡				
I	41 (12.6)	31 (9.5)	13 (4.0)	**<.0001**
II	172 (52.8)	175 (53.4)	102 (31.5)	
III	109 (33.4)	112 (34.2)	194 (59.9)	
IV	4 (1.2)	10 (3.1)	15 (4.6)	
V	0 (0)	0 (0)	0 (0)	

Abbreviations: SD, standard deviation; IQR, interquartile range; ASA Class, American Society of Anesthesiology physical status classification.
*Data are frequency and column percent unless otherwise indicated. P values were *t*-test or Wilcoxon rank sum for continuous variables and chi-square or Fisher's exact for categorical variables and bolded if < .05.
‡ASA class definitions: I, a normal health patient; II, a patient with mild systemic disease; III, a patient with severe systemic disease; IV, a patient with severe systemic disease that is a constant threat to life; V, a moribund patient who is not expected to survive without the operation.

and unplanned readmission (5.7% and 6.0%) did not differ by gender. Table 5 In subgroup analysis, by procedure type, there were differences in specific outcomes between the procedure groups but no differences among unmatched males and female subjects. Table 6 In the propensity matched groups, there was no difference in adverse outcomes, length of stay, or readmission among males and females who underwent open or perineal procedures but increased venous thromboembolism (0.9.% vs. 0, p = 0.04) and respiratory complications (2.5% vs. 0.3%, p = 0.003) in males who underwent laparoscopic operations. Table 7.

Discussion

In this comparative study of rectal prolapse surgery in males and females, we have identified gender-related differences in patient age, race, and surgical risk profiles. The frequency in which males and females undergo laparoscopic, open, or perineal procedures also differs and, in keeping with previous studies, this difference appears to be driven by age and comorbid conditions.[3,5,6] As other studies have shown, we also observed differences in the post-operative outcomes for open, laparoscopic, and perineal prolapse procedures. However, in our analyses by procedure type, we observed only a few differences in the outcomes of males and females.

Rectal prolapse is most common in older female patients.[2,4,8,21] This pattern was observed in our study population which included >90% females with a median age of 71 years. The male patients were notably younger, with a 15-year difference compared to females. As would be expected, the younger male patients had fewer comorbidities and lower surgical risk. An unexpected finding was the racial differences among males and females, with an approximately 2-fold increase in the percentage of blacks, Asian or Pacific Islanders, Hispanics, and American Indian or Alaska natives in the male cohort. Racial disparities in pelvic organ prolapse have been reported with relatively fewer cases among African American women compared to whites or Latinas and different types of pelvic organ prolapse in Caucasian compared to East Asian women.[22–25] Racial disparities have also been demonstrated in the surgical

Table 1c
Preoperative variables, female subjects.

Characteristics	Laparoscopic (n = 3024) N (%)*	Open (n = 3271) N (%)*	Perineal (n = 4947) N (%)*	P value
Age, years, median (IQR)	62.0 (51.0–73.0)	65.0 (53.0–78.0)	81.0 (70.0–87.0)	**<.0001**
Race/Ethnicity				
White, Not of Hispanic Origin	2543 (84.1)	2706 (82.7)	4065 (82.2)	**<.0001**
Black, Not of Hispanic Origin	74 (2.5)	81 (2.5)	180 (3.6)	
Asian or Pacific Islander	51 (1.7)	53 (1.6)	108 (2.2)	
Hispanic Origin	78 (2.6)	82 (2.5)	107 (2.2)	
American Indian or Alaska Native	34 (1.1)	22 (0.7)	23 (0.5)	
Null/unknown	244 (8.1)	327 (10.0)	464 (9.4)	
Body mass index				
Underweight (<18.5)	193 (6.4)	213 (6.5)	450 (9.1)	**<.0001**
Normal weight (18.5–24.9)	1525 (50.4)	1556 (47.6)	2489 (50.3)	
Overweight (25.0–29.9)	822 (27.2)	890 (27.2)	1265 (25.6)	
Obese class I (30.0–34.9)	311 (10.3)	365 (11.2)	460 (9.3)	
Obese class II (35.0–39.9)	115 (3.8)	141 (4.3)	131 (2.7)	
Obese class III (≥40.0)	34 (1.1)	67 (2.1)	90 (1.8)	
Null/unknown	24 (0.8)	39 (1.2)	62 (1.3)	
Diabetes mellitus				
No	2821 (93.3)	2969 (90.8)	4369 (88.3)	**<.0001**
Oral	136 (4.5)	207 (6.3)	354 (7.2)	
Insulin	67 (2.2)	95 (2.9)	224 (4.5)	
Dyspnea (within 30 days)				
No	2843 (94.0)	2997 (91.6)	4337 (87.7)	**<.0001**
Moderate exertion	172 (5.7)	258 (7.9)	568 (11.5)	
At rest	9 (0.3)	16 (0.5)	42 (0.9)	
Bleeding disorder requiring hospitalization	48 (1.6)	94 (2.9)	199 (4.0)	**<.0001**
Functional health status prior to surgery				
Independent	2917 (96.5)	3062 (93.6)	4294 (86.8)	**<.0001**
Partially dependent	96 (3.2)	193 (5.9)	590 (11.9)	
Totally dependent	11 (0.4)	16 (0.5)	63 (1.3)	
Congestive heart failure (within 30 days)	15 (0.5)	30 (0.9)	82 (1.7)	**<.0001**
Severe chronic obstructive pulmonary disease (COPD)	169 (5.6)	244 (7.5)	489 (9.9)	**<.0001**
Blood pressure >140/90 mm Hg or taking antihypertensive medications	1196 (39.6)	1499 (45.8)	3177 (64.2)	**<.0001**
Cigarette smoker (within 1 year)	539 (17.8)	597 (18.3)	486 (9.8)	**<.0001**
Steroid use for chronic condition	145 (4.8)	180 (5.5)	408 (8.3)	**<.0001**
>10% loss of body weight (≤6 months)	31 (1.0)	41 (1.3)	86 (1.7)	**.03**
ASA class‡				
I	170 (5.6)	117 (3.6)	60 (1.2)	**<.0001**
II	1690 (55.9)	1557 (47.6)	1548 (31.3)	
III	1089 (36.0)	1461 (44.7)	2991 (60.5)	
IV	75 (2.5)	136 (4.2)	346 (7.0)	
V	0 (0)	0 (0)	2 (<0.1)	

Abbreviations: SD, standard deviation; IQR, interquartile range; ASA Class, American Society of Anesthesiology physical status classification.
*Data are frequency and column percent unless otherwise indicated. P values were *t*-test or Wilcoxon rank sum for continuous variables and chi-square or Fisher's exact for categorical variables and bolded if < .05.
‡ASA class definitions: I, a normal health patient; II, a patient with mild systemic disease; III, a patient with severe systemic disease; IV, a patient with severe systemic disease that is a constant threat to life; V, a moribund patient who is not expected to survive without the operation.

Table 2
Top 5 rectal prolapse procedures.

CPT	Procedure Description	Female (n = 8359) N (%)	Male (N = 684) N (%)
45130	EXC RECTAL PROCIDENTIA W/ANAST PERINEAL APPROACH	4063 (48.6)	253 (37.0)
45400	LAPAROSCOPY PROCTOPEXY	1464 (17.5)	144 (21.1)
45402	LAPAROSCOPY PROCTOPEXY W/SIGMOID RESECTION	966 (11.6)	104 (15.2)
45540	PROCTOPEXY ABDOMINAL APPROACH	951 (11.4)	95 (13.9)
45550	PROCTOPEXY W/SIGMOID RESECTION ABDOMINAL APPROACH	915 (11.0)	88 (12.9)

CPT: Common Procedural Terminology.

treatment of sigmoid diverticulitis,[26,27] the use of minimally invasive colorectal surgery,[28] surgery for ulcerative colitis,[29] and the short-term outcomes of surgery for Crohn's disease.[30]

In our analysis, smoking was more frequent among males (22.8%) compared to females (14.4%). The percentage of adults who are current cigarette smokers in the USA decreased during our study period, from 21%, in 2005, to 15% in 2015. In that same period, the percentage of black male smokers remained a high-outlier even with a drop from 27% to 21%.[31] Smoking is harmful to connective tissues and has been linked to the pathogenesis of diseases with

Table 3
Operative procedure groups.

Procedure	Female (n = 11,242) N (%)	Male (n = 978) N (%)	P value*
Laparoscopic	3024 (26.9)	326 (33.3)	<.0001
Open	3271 (29.1)	328 (33.5)	.01
Perineal	4947 (44.0)	324 (33.1)	<.0001

*P values are from chi-square and are comparison of the Given procedure compared to all other procedures and Adjusted for multiple comparisons by Bonferroni method.

Table 4
Unadjusted, Multivariable adjusted, and Propensity Matched Association of Rectal Prolapse Surgical Approach by Male versus Female.

Model	Odds Ratio (95% CI)	P value
Unadjusted*		
Laparoscopic vs. Perineal	1.646 (1.402–1.932)	<.0001
Open vs. Perineal	1.531 (1.305–1.796)	
Multivariable adjusted*		
Laparoscopic vs. Perineal	0.885 (0.713–1.099)	.54
Open vs. Perineal	0.928 (0.760–1.134)	
Propensity matched†		
Laparoscopic vs. Perineal	1.000 (0.841–1.189)	.96
Open vs. Perineal	1.099 (0.920–1.312)	

Abbreviation: CI, confidence interval.
*Male n = 978 and female n = 11,242.
†Male n = 965 and female n = 1875. In a few cases a male could only be matched to a single female.

abnormal connective tissue including aortic aneurysm,[32] chronic obstructive pulmonary disease,[33] and sigmoid diverticular disease.[34] Abnormalities in connective tissue, whether due to cigarette smoking or other pathways (e.g. hereditary diseases), have been shown to occur in combination, in effected individuals. For example, a recent population-base study from New Zealand has shown that diverticulosis is associated with rectal prolapse, aortic aneurysm, and other connective tissue diseases.[35] We were not able to identify a published study that has linked cigarette smoking to rectal or pelvic organ prolapse. However, when the available information is put together, and with the relatively high percentage of male smokers in this study, we believe it is conceivable that connective tissue damage from cigarette smoking may be associated with the development of rectal prolapse and that further investigation of this potential link is warranted.

This study and previous ACS NSQIP-based analyses have shown that perineal operations are performed more often in older and higher risk surgical patients.[3,5–7] Perhaps as expected, in our unadjusted analyses, the relatively younger and healthier males underwent more laparoscopic and open procedures and fewer perineal procedures than females. The variable use of high (e.g. open resection rectopexy) and low (e.g. laparoscopic rectopexy) risk procedures in individual subjects with unique risk profiles is a conceivable explanation for our finding that the incidence of adverse outcomes (morbidity, mortality, reoperation, unplanned readmission) were not different for the unmatched male and female cohorts. To determine if there were independent predictors of adverse outcomes for rectal prolapse surgery, we performed a propensity–matched analyses. These analyses allowed us to compare males and females of similar age and surgical risk. Largely unchanged from the unmatched analysis, adverse outcomes in the matched cohorts also revealed differences by procedure type, with the highest morbidity and unplanned readmission after open surgery, the highest mortality after perineal operations, and no difference in reoperation by procedure types, for the entire unmatched study sample. This relationship between the type of prolapse surgery performed and adverse outcomes, including mortality, was also described by Fang et al., who observed a 4-fold increase in the risk of death after perineal procedures[3] and, by Fleming and colleagues, who noted the absence of a link between patient age or comorbidity and prolapse surgery complications.[5] To add to Flemings work, and also that of Daniel and colleagues,[7] we have shown that similar to age and comorbidities, and aside from the differences in venous thromboembolism and respiratory complication after laparoscopic prolapse surgery, the outcomes of matched males and females were not different.

Table 5
Postoperative outcomes.

Adverse outcomes*	Female (n = 11,242) N (%)	Male (n = 978) N (%)	P value†
Mortality (30 day)	115 (1.0)	6 (0.6)	.31
Overall morbidity	1124 (10.0)	97 (9.9)	1.0
Respiratory complication	232 (2.1)	20 (1.0)	1.0
Infection complication	538 (4.8)	53 (5.4)	.39
Urinary tract infection	356 (3.2)	21 (2.2)	.08
Venous thromboembolism	41 (0.4)	4 (0.4)	.78
Cardiac complication	69 (0.6)	4 (0.4)	.66
Bleeding/transfusion	281 (2.5)	26 (2.7)	.75
Renal complication	33 (0.3)	2 (0.2)	1.0
Neurological complication	25 (0.2)	1 (0.1)	.72
	(n = 7494)	(n = 613)	
Reoperation	235 (3.1)	21 (3.4)	.63
Length of Hospital Stay (days) (median, IQR)	3 (2–4)	3 (2–5)	.93
	(n = 7486)	(n = 610)	
Unplanned, related readmission	446 (6.0)	35 (5.7)	.93

Abbreviations: SSI, surgical site infection; IQR, interquartile range.
*Respiratory: occurrence of pneumonia, unplanned intubation, ventilator >48 h, or septic shock; SSI: occurrence superficial SSI, deep incisional SSI, organ/space SSI, or wound disruption; Venous thromboembolism: occurrence deep vein thrombosis/thrombophlebitis or pulmonary embolism; Cardiac: occurrence of cardiac arrest or myocardial infarction; Renal: the occurrence of acute renal failure or progressive renal insufficiency.
†P values were from Fischer's exact test.

Table 6
Postoperative outcomes: Unmatched procedure groups.

Adverse outcomes*	Laparoscopic			Open			Perineal		
	Female (n = 3024) N (%)	Male (n = 326) N (%)	P value†	Female (n = 3271) N (%)	Male (n = 328) N (%)	P value†	Female (n = 4947) N (%)	Male (n = 324) N (%)	P value†
Mortality (30 day)	10 (0.3)	1 (0.3)	1.0	36 (1.1)	1 (0.3)	.25	69 (1.4)	4 (1.2)	1.0
Overall morbidity	230 (7.6)	28 (8.6)	.51	476 (14.6)	46 (14.0)	.87	418 (8.5)	23 (7.1)	.47
Respiratory complication	33 (1.1)	8 (2.5)	.06	78 (2.4)	9 (2.7)	.70	121 (2.5)	3 (0.9)	.09
Infection complication	103 (3.4)	15 (4.6)	.27	280 (8.6)	27 (8.2)	.92	155 (3.1)	11 (3.4)	.74
Urinary tract infection	70 (2.3)	7 (2.2)	1.0	138 (4.2)	8 (2.4)	.14	148 (3.0)	6 (1.9)	.31
Venous thromboembolism	7 (0.2)	3 (0.9)	.07	16 (0.5)	0 (0)	.40	18 (0.4)	1 (0.3)	1.0
Cardiac complication	13 (0.4)	3 (0.9)	.20	18 (0.6)	1 (0.3)	1.0	38 (0.8)	0 (0)	.17
Bleeding/transfusion	63 (2.1)	3 (0.9)	.21	125 (3.8)	13 (4.0)	.88	93 (1.9)	10 (3.1)	.14
Renal complication	8 (0.3)	1 (0.3)	.60	14 (0.4)	0 (0)	.63	11 (0.2)	1 (0.3)	.53
Neurological complication	3 (0.1)	0 (0)	1.0	4 (0.1)	1 (0.3)	.38	18 (0.4)	0 (0)	.62
	(n = 2278)	(n = 231)		(n = 1957)	(n = 186)		(n = 3259)	(n = 196)	
Reoperation	70 (3.1)	4 (1.7)	.31	60 (3.1)	9 (4.8)	.19	105 (3.2)	8 (4.1)	.53
	(n = 2276)	(n = 229)		(n = 1955)	(n = 185)		(n = 3255)	(n = 196)	
Unplanned, related readmission	109 (4.8)	9 (3.9)	.74	145 (7.4)	13 (7.1)	1.0	192 (5.9)	13 (6.6)	.64

Abbreviations: SSI, surgical site infection; IQR, interquartile range.
*Respiratory: occurrence of pneumonia, unplanned intubation, ventilator >48 h, or septic shock; SSI: occurrence superficial SSI, deep incisional SSI, organ/space SSI, or wound disruption; Venous thromboembolism: occurrence deep vein thrombosis/thrombophlebitis or pulmonary embolism; Cardiac: occurrence of cardiac arrest or myocardial infarction; Renal: the occurrence of acute renal failure or progressive renal insufficiency.
†P values were from Fischer's exact test.

A strength of this study is that it is the first, to our knowledge, to perform a comparative analysis of males and females who underwent rectal prolapse surgery. We used the ACS NSQIP database, which provides a very large sample size, uniformly collected preoperative, operative, and 30-day postoperative data. We have identified important differences in the demographics, risk factors, and surgery performed in males and females who undergo rectal prolapse surgery. Our study has some limitations. We are not able to determine the precise pathological conditions (e.g. rectocele, obstructed defecation, prolapsed hemorrhoids, etc.) that resulted in a diagnosis of rectal prolapse. To mitigate this limitation we limited our study to patients who underwent inpatient surgical procedures only. Procedure selection bias and surgeon specialization cannot be accounted for in our study. By limiting our study to the NSQIP general public use file, we are not able to determine the rates of colorectal specific adverse outcomes such as anastomotic leak and ileus. As the ACS NSQIP PUF does not include mental health variables we were not able to analyze this potential influencer of functional gastrointestinal disease.[36] However, this limitation may be mitigated by our observation that over 90% of female and male patients were classified as functionally independent. Also due to limitations of the dataset, we were not able to evaluate the use of

Table 7
Postoperative outcomes: Propensity-matched procedure groups comparing male and female patients.

Adverse outcomes*	Laparoscopic			Open			Perineal		
	Female (n = 643) N (%)	Male (n = 321) N (%)	P value†	Female (n = 587) N (%)	Male (n = 322) N (%)	P value†	Female (n = 645) N (%)	Male (n = 322) N (%)	P value†
Mortality (30 day)	1 (0.2)	1 (0.3)	1.0	8 (1.4)	1 (0.3)	.17	8 (1.2)	4 (1.2)	1.0
Overall morbidity	45 (7.0)	32 (10.0)	.13	92 (15.7)	47 (14.6)	.70	56 (8.7)	26 (8.1)	.81
Respiratory complication	2 (0.3)	8 (2.5)	**.003**	7 (1.2)	9 (2.8)	.11	8 (1.2)	3 (0.9)	1.0
Infection complication	22 (3.4)	15 (4.7)	.37	49 (8.4)	26 (8.1)	1.0	18 (2.8)	11 (3.4)	.69
Urinary tract infection	15 (2.3)	7 (2.2)	.64	21 (3.6)	8 (2.5)	.43	17 (2.6)	6 (1.9)	.51
Venous thromboembolism	0 (0)	3 (0.9)	**.04**	3 (0.5)	0 (0)	.56	1 (0.2)	1 (0.3)	1.0
Cardiac complication	1 (0.2)	3 (0.9)	.11	3 (0.5)	0 (0)	.56	3 (0.5)	0 (0)	.55
Bleeding/transfusion	9 (1.4)	3 (0.9)	.76	25 (4.3)	12 (3.7)	.86	12 (1.9)	10 (3.1)	.25
Renal complication	1 (0.2)	1 (0.3)	1.0	1 (0.2)	0 (0)	1.0	1 (0.2)	1 (0.3)	1.0
Neurological complication	0 (0)	0 (0)	1.0	0 (0)	1 (0.3)	.35	2 (0.3)	0 (0)	1.0
	(n = 448)	(n = 227)		(n = 352)	(n = 183)		(n = 363)	(n = 191)	
Reoperation	10 (2.2)	4 (1.8)	.78	17 (4.8)	9 (4.9)	1.0	14 (3.9)	7 (3.7)	1.0
	(n = 441)	(n = 222)		(n = 334)	(n = 183)		(n = 382)	(n = 191)	
Unplanned, related readmission	25 (5.7)	9 (4.1)	.47	21 (6.3)	13 (7.1)	.71	22 (5.8)	12 (6.3)	.85

Abbreviations: SSI, surgical site infection; IQR, interquartile range.
*Respiratory: occurrence of pneumonia, unplanned intubation, ventilator >48 h, or septic shock; SSI: occurrence superficial SSI, deep incisional SSI, organ/space SSI, or wound disruption; Venous thromboembolism: occurrence deep vein thrombosis/thrombophlebitis or pulmonary embolism; Cardiac: occurrence of cardiac arrest or myocardial infarction; Renal: the occurrence of acute renal failure or progressive renal insufficiency.
†P values were from Fischer's exact test.

mesh prosthetics or robotic techniques, and we could not evaluate disease recurrence, functional, or other long-term outcomes.

Conclusion

Males with rectal prolapse are younger, have a different racial distribution, a lower surgical risk profile, and undergo different surgical procedures than females. The increased use of laparoscopic and open abdominal surgical procedures, as opposed to perineal procedures, in males appears to be driven by patient age and surgical risk profile. While there are procedure related differences in the outcomes of rectal prolapse surgery, differences attributable to gender alone are few.

Author contribution

Each of the authors of this manuscript made a substantial contribution to the design of the work (Vogel, Bronsert), or the acquisition (Bronsert), analysis (Vogel, Bronsert) or interpretation of data (Vogel, Lobato, Chapman, Birnbaum, Meguid) for the work. Each of the authors contributed to drafting of the work (Vogel, Lobato, Bronsert, Chapman, Meguid) or critical revisions (Birnbaum) and final approval of the version to be published (Vogel, Lobato, Chapman, Bronsert, Birnbaum, Meguid).

Declaration of competing interest

Jon Vogel, Luiz Lobato, Brandon Chapman, Michael Bronsert, Elisa Birnbaum, and Robert Meguid report no financial or personal relationships with other people or organizations that could inappropriately influence (bias) their work.

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The ACS NSQIP and participating hospitals are the source of this data; they have not verified and are not responsible for the statistical validity of the data analysis or the conclusions derived by the authors.

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