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Differences in Short-Term Outcomes Among Ileal Pouch-Anal Anastomosis Patients Receiving Preoperative Radiation Versus Not: A NSQIP Analysis

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Abstract

Background—Single institution studies demonstrate a correlation between preoperative pelvic radiation and poor long-term pouch function after ileal pouch-anal anastomosis. The rarity of the radiated pelvis prior to these procedures limits the ability to draw conclusions on the effects of preoperative radiation on short-term outcomes, which may contribute to long-term pouch dysfunction.

Objective—To better understand the impact of pelvic radiation on short-term outcomes in ileal pouch-anal anastomosis patients.

Design—A retrospective review of the American College of Surgeons National Surgical Quality Improvement Program database (2005 through 2011).

Patients—The cohort was composed of patients undergoing non-emergent ileal pouch-anal anastomosis procedures.

Main Outcome Measures—Proportions of patients experiencing postoperative complications within 30 days were compared by Fisher Exact and Wilcoxon Rank-Sum tests based on whether they received preoperative radiation. Multivariate logistic regression models controlled for the effects of multiple risk factors.

Results—Included were 3172 patients receiving ileal pouch-anal anastomosis; 162 received pelvic radiation. The post-operative complication rate was not significantly different in patients receiving pelvic radiation versus not receiving pelvic radiation ($p=0.06$). In a subset of patients with cancer diagnoses ($n=598$), 157 received pelvic radiation; complication rates were not significantly different ($p=0.16$). Patients receiving pelvic radiation had significantly lower rates of sepsis in both the overall and cancer-diagnosis groups ($p=0.005$ and $p=0.047$), a finding which persisted after controlling for the effects of multiple risk factors (multivariate p values = 0.03 and 0.047).

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Limitations—Retrospective database design with short-term follow up.

Conclusions—Patients who received radiation prior to ileal pouch-anal anastomosis had no difference in overall 30-day complication rates but had significantly lower rates of sepsis when compared to patients not receiving pelvic radiation. The perceived inferior long-term pouch function in patients undergoing preoperative pelvic radiation does not appear to be attributable to increases in 30-day complications.

CLASSIFICATIONS

ulcerative colitis; ileoanal reservoir; colon cancer; outcomes research; radiation oncology

Introduction

Restorative total proctocolectomy with ileal pouch-anal anastomosis (IPAA) is the surgical procedure of choice for patients with Ulcerative Colitis (UC) indicated for colectomy.¹ In a minority of these patients, the diagnosis of UC is in conjunction with an indication for preoperative pelvic radiotherapy, commonly rectal adenocarcinoma.^{2–5} While preoperative radiation therapy offers oncologic benefit to patients with concomitant rectal cancer and indications for IPAA, the outcomes associated with the preoperative radiation are unique for these restorative procedures.^{4–9}

The literature indicates that preoperative pelvic radiation significantly inhibits long-term ileal pouch function.^{10–12} The mechanism by which radiation inhibits pouch function is not clear, however, it may be related to radiation-induced sphincter damage.^{8, 9, 13} Significantly worse long-term functional outcomes for patients with IPAA, and their associated quality of life, have also been correlated with short-term complications such as anastomotic leaks and pelvic sepsis.^{14, 15} The literature on radiation and IPAA has had limited power to differentiate short-term outcomes as a contributor to long-term pouch function in radiated and non-radiated IPAA patients due to small sample sizes. The American College of Surgeons National Surgical Quality Improvement Program (NSQIP) dataset provides a larger, multi-institutional patient cohort for examination and delineation of differences in short-term outcomes for IPAA patients with and without preoperative pelvic radiation, with these short-term outcomes potentially serving as surrogate markers for long-term pouch function.

Our aim was therefore to investigate differences in short-term outcomes for patients who have undergone radiation prior to IPAA as compared to non-radiated IPAA patients. We hypothesized that patients undergoing ileal pouch-anal anastomosis formation with a history of radiation would have more NSQIP-recorded short-term complications compared to non-radiated patients.

Methods

Data were obtained from the NSQIP Participant-Use-Data-Files for 2005–2011,^{16, 17} with variables defined and database parameters as described.^{18, 19} Included were non-emergent ileal pouch-anal anastomosis procedures (CPT codes 44158, 44211, 45113, and 44157)

performed by general and colorectal surgeons at NSQIP-participating hospitals. Recorded postoperative diagnoses were categorized as cancer, inflammatory bowel disease (IBD), or “other,” when cancer or IBD were not explicitly specified. Receipt of radiation within 90 days prior to surgery, as coded in NSQIP,¹⁶ was tested using univariate logistic regression for correlation with occurrence of 15 individual NSQIP-recorded 30-day complications,^{16, 17} and the composite variable of any complication. The “sepsis” variable was a composite of systemic sepsis and septic shock. Univariate p values were provided by Fisher Exact test comparisons of the proportions of patients experiencing each complication who did and did not receive preoperative radiation, with significance set at $p < 0.05$. Differences in NSQIP-recorded pre- and intraoperative patient characteristics between groups receiving and not receiving preoperative radiation were compared using Fisher Exact test for categorical variables and Wilcoxon Rank-Sum test for continuous variables. For categories with more than two levels, pairwise p values were adjusted using the false discovery rate correction for multiple comparisons.²⁰ Separate analyses included all patients and only those with cancer diagnoses. Patient factors showing unequal distribution between patients who did and did not receive preoperative radiation, or which showed univariate association with septic complications at $p < 0.2$ were included in multivariate logistic regression models to assess the independence of preoperative radiation’s effects. Overall preoperative risk was assessed using estimates from the validated Iowa Rectal Surgery Risk Model.¹⁹

Results

Patient Characteristics and Complications

Included in the analysis were 3172 patients who received non-emergent ileal pouch-anal anastomoses between the years 2005 and 2011. Of these, 162 received preoperative radiation. Patient diagnoses included IBD (64.0%), cancer (18.9%), and “other” (17.2%). The procedures performed were laparoscopic total proctocolectomy with IPAA (34.7%), proctectomy with IPAA (26.4%), total proctocolectomy with ileal-anal anastomosis (10.2%), and total proctocolectomy with IPAA (28.2%).

Pre-operative characteristics of the patient cohort appear in Table 1. Compared to all IPAA patients not receiving radiation, patients who received radiation were significantly older (median age 55 vs. 43 years, $p < 0.001$), more likely to require antihypertensive medication (33.3% vs. 20.1%, $p < 0.001$), and more often had unintentional weight loss of greater than 10% of total body weight (9.3% vs. 4.9%, $p = 0.02$). Patients receiving radiation also had an increased incidence of diabetes (13% vs. 6.4%, $p = 0.003$), cardiovascular disease (6.8% vs. 2.5%, $p = 0.003$), and smoking (20.4% vs. 11.7%, $p = 0.002$). The radiation group was significantly less likely to have used steroids or immunosuppressants in the 30 days prior to surgery (1.2% vs. 28.2%, $p < 0.001$), had lower average preoperative white blood cell count (mean 4.7 K cells/mL vs. 7.3 K cells/mL, $p < 0.001$), and less often had surgical wounds classified as contaminated or dirty/infected (4.3% vs. 13.9%, $p < 0.001$). To compare overall preoperative risk between patient groups, average Iowa Rectal Surgery Risk Model morbidity probabilities were determined for the groups receiving and not receiving preoperative radiation.¹⁹ The group receiving preoperative radiation had a significantly lower average predicted morbidity probability based on preoperative characteristics (30.2%

vs. 34.3%, $p<0.001$), indicating a slightly better general preoperative risk profile among patients receiving preoperative radiation.

Fifteen NSQIP-defined 30-day mortality and morbidity outcomes were analyzed, with an observed overall complication rate of 34.7%. The overall complication rate was lower among patients receiving preoperative radiation compared to those who did not, but this difference did not reach significance (27.8% vs. 35.1%, $p=0.06$). Rates of individual complications were compared between groups (Table 2). The only individual complication showing a significant difference between groups was sepsis, which occurred less frequently among patients receiving preoperative radiation (2.5% vs. 8.5%, $p=0.005$).

Subset of Patients with Cancer Diagnoses

Nearly all patients who received preoperative radiation had a postoperative diagnosis of cancer (157 of 164). To minimize the influence of possible unmeasured differences between patients with and without cancer, an analysis was performed limited to patients with postoperative cancer diagnoses ($n=598$). Characteristics of the subset of patients with cancer diagnoses who did not receive radiation ($n=441$) and those with cancer diagnoses who did receive preoperative radiation therapy ($n=157$) are shown in Table 1. As with the overall cohort, the cancer-limited preoperative radiation group remained significantly less likely than the cancer-limited no preoperative radiation group to be taking steroids or immunosuppressants, to have a surgical wound classified as contaminated or dirty/infected, and had a lower predicted rate of morbidity. Other perioperative characteristics were similar between the groups.

An overall complication rate of 32.1% was observed in the cancer-diagnosis cohort. Receipt of preoperative chemotherapy ($n=62$) was not significantly associated with the rate of total complications or sepsis in either the overall or cancer-diagnosis cohort ($p>0.05$ for all). Total complication rates for patients who received preoperative radiation did not significantly differ from patients who did not receive preoperative radiation (Table 2). As in the overall IPAA population, in this cancer-diagnosis subset, a significantly lower incidence of sepsis was recorded among patients who received preoperative radiation (2.5% vs. 7.9%, $p=0.02$).

Multivariate Analysis

To determine whether the unexpected finding of lower sepsis rates in patients receiving preoperative radiation was attributable to differences in patient and disease characteristics between the radiation and no-radiation groups, multivariate analysis was performed to determine independent predictors of sepsis after adjusting for these factors (Table 3). Multivariate models included factors potentially influencing the risk of sepsis such as the procedure performed, a history of cardiovascular disease, contaminated or dirty/infected wound classification, preoperative white blood cell count, use of antihypertensive medications, performance of additional procedures beyond the primary procedure, preoperative weight loss greater than 10% of total body weight, and the presence of disseminated cancer. After adjustment for these factors, receipt of preoperative radiation remained significantly correlated with lower rates of sepsis ($p=0.03$). Other factors

independently associated with postoperative sepsis included diabetes and use of antihypertensive medications ($p<0.05$).

Due to the smaller number of patients in the cancer-diagnosis subgroup, factors included in multivariate analysis of this cohort were limited to those showing significant univariate association with sepsis at $p<0.05$ (Table 4). As no patients in this cohort received both radiation and steroids, steroid or immunosuppressant use was not included in this model. After limiting the analysis to patients with cancer diagnoses, the multivariate model again showed radiation treatment to be a significant independent predictor of lower postoperative risk of sepsis ($p=0.047$). No other factor showed significant independent association with sepsis risk in the cancer-diagnosis subgroup.

Discussion

In comparison with patients not receiving radiation, radiation treatment in the 90 days prior to surgery did not portend worse overall 30-day outcomes and interestingly, was shown to correlate with lower rates of postoperative sepsis, even after multivariate adjustment for confounding factors. The impact of preoperative pelvic radiation on outcomes of IPAA has only been studied in small cases series, many of which include patients with postoperative pelvic radiation of the ileal pouch.^{1, 7, 12} Despite the small number of patients in these series, the results are striking in their findings of poor functional outcomes for radiated pelvis pouch patients.⁷ In one study, pouchitis occurred in 66% ($n=6/9$) of pelvic radiated IPAA patients and pouch failure occurred in 44.4% ($n=4/9$) of patients on long-term follow-up (median follow-up 49.9 months).⁷ One possible explanation for these poor functional outcomes can be extrapolated from data on low anterior resection for rectal cancer.^{8, 12, 13} In patients with locally advanced rectal cancer who undergo low anterior resection, pelvic radiation has been shown to significantly inhibit anorectal function.^{9, 12, 21} Some pouch dysfunction may therefore be attributable to analogous radiation-induced anorectal dysfunction in IPAA patients, however, this single mechanism is likely insufficient to explain the high rates of pouch failure and pouchitis observed by Wu *et al.*⁷

Another potential explanation of long-term pouch dysfunction and failure would be an increased incidence of pelvic sepsis in radiated IPAA patients.^{1, 14} Wu *et al.* found that patients who underwent IPAA after pelvic radiation experienced higher rates of pelvic sepsis.⁷ This difference was not statistically significant compared to non-radiated IPAA patients, but it was hypothesized that the study's small sample size resulted in limited power to detect this difference. In contrast to these findings, our results from a much larger sample show no increase in 30-day complications including surgical site infection and sepsis for IPAA after pelvic radiation. Thus, while it may be true that many pouches created in the radiated pelvis fail, our results support that this failure is not due to higher rates of short-term complications. Instead, the lack of increased sepsis after radiated IPAA suggests that pelvic radiation has deleterious effects on long-term pouch function in a manner that could not be measured within the time frame of NSQIP data collection. The exact mechanism by which this damage produces pouch failure remains uncertain. Future, multi-institutional studies, potentially including manometric assessment of pouch and anal function, will be

necessary to recruit the numbers of patients necessary to elucidate how preoperative radiation inhibits long-term pouch and anal sphincter function.

That preoperative radiation was associated with a lower risk of sepsis, even after multivariate adjustment for confounding factors was unexpected. Given the well-established deleterious effects of radiation on healing and tissue quality, it is likely that this strong statistical association reflects the impact of unmeasured factors and selection biases not captured by NSQIP. For example, because pouch creation in an irradiated pelvis is known to be risky, it may be offered only to those patients perceived to be the best operative candidates. Results of the Iowa Rectal Surgery Risk Model predictions support this interpretation. Although the radiation group was older and had higher rates of some comorbidities (diabetes, hypertensive, heart disease, smoking history, weight loss) than the no-radiation group, the radiation group had significantly lower predicted morbidity, indicating that they were overall a more robust population.

Restricting the analysis to patients with cancer diagnoses attempted to minimize potential unmeasured differences between patients with cancer undergoing IPAA, and IPAA patients with benign diagnoses. Diabetes, which has been reported to confer greater risk of pouch failure,²² was associated with lower sepsis risk in the overall cohort but not in the cancer-only subset, suggesting that limiting the analysis to cancer patients was successful in controlling some unmeasured biases. Still, the persistent difference in rates of steroid and immunosuppressant use between radiated and non-radiated groups hints at residual unmeasured selection factors at work. Preoperative radiation may have been omitted in patients with ongoing inflammation from their IBD requiring steroids and concomitant rectal cancer due to concerns for patient tolerance and morbidity associated with radiating an already inflamed rectum.^{23, 24} Alternatively, these higher-risk patients may have received radiation, and then been offered operations other than IPAA. Due to the fact that no IPAA's were performed in cancer patients who received radiation and also required steroids, we favor the latter explanation. Knowing the difficulties of IPAA in the irradiated pelvis under the best of circumstances, surgeons likely did not offer this operation to patients requiring steroids, and this selection difference may account for the statistical association of radiation with lower rates of sepsis. Still, while higher rates of steroid exposure in non-radiated pouch patients likely contributed to their higher rates of sepsis, how much of the difference resulted from cumulative patient selection effects versus specifically from steroids cannot be determined from these data. Finally, IPAA in the irradiated pelvis is likely performed predominately by experienced surgeons at specialized centers, and the extent to which this influenced outcomes is not known.

When interpreting these results, several additional NSQIP-specific limitations must be considered. First, as with any retrospective NSQIP analysis, our data are limited in follow-up time, data included, and clinical dimensions captured.¹⁷ NSQIP-defined variables apply to a wide variety of surgical procedures and are potentially less applicable to this highly specialized procedure and patient population. For example, while pelvic sepsis and ileo-anal anastomotic leak is associated with worse pouch outcomes,^{14, 15} NSQIP-defined sepsis and surgical site infections do not specifically identify these outcomes as related to the pouch-anal anastomosis. Second, while many potential risk factors for complications are tracked by

NSQIP, patient selection criteria and any preventative measures taken prior to the procedure cannot be identified, which may lead to an underestimate of the risk of certain postoperative occurrences.¹⁷ NSQIP likewise does not record whether a diverting ostomy was performed. Lastly, preoperative radiation therapy is defined by NSQIP as receipt of radiation in the 90 days prior to surgery but the type, amount, and location are not recorded. Our results make the assumption that the radiation received was pelvic radiation for an associated rectal cancer, as it is likely that nearly all radiation was for this reason, but we are unable to exclude radiation given for other indications. Despite these limitations, NSQIP represents a robust and validated outcomes database and its multi-institutional nature permits study of a large cohort of radiated IPAA patients that is not likely available through any other methodology.

In conclusion, analysis of the NSQIP database indicates that patients who undergo IPAA after receipt of preoperative radiation have overall 30-day complication rates similar to patients who do not receive preoperative radiation. Receipt of radiation prior to IPAA was associated with a significantly lower risk of sepsis, a finding that persisted after multivariate adjustment for confounding factors. These results support that high rates of long-term pouch failure reported in the literature after IPAA in the irradiated pelvis are not due to increased short-term complications.

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Table 1

Patient characteristics. Rows indicate number of patients with clinical characteristic and (%) unless indicated.

Clinical Characteristics	All IPAA Patients			IPAA Patients with Cancer		
	Overall	Received Radiation	No Radiation	Radiation	No Radiation	P value
Number of patients	3172	162 (5.1)	3010 (94.9)	157 (26.3)	441 (73.7)	
Female Sex	1415 (44.6)	66 (40.7)	1349 (44.8)	64 (40.8)	210 (47.6)	0.17
Age, median years (IQR)	44.0 (30.8–55.0)	55.0 (48.0–64.0)	43.0 (30.0–55.0)	55.0 (48.0–64.0)	56.0 (48.0–67.0)	0.3
Steroids/immunosuppression	852 (26.9)	2 (1.2)	850 (28.2)	0 (0.0)	17 (3.9)	0.009
Diabetes	215 (6.8)	21 (13.0)	194 (6.4)	21 (13.4)	56 (12.7)	0.9
Antihypertensive medication	659 (20.8)	54 (33.3)	604 (20.1)	54 (34.4)	177 (40.1)	0.2
Cardiovascular disease	85 (2.7)	11 (6.8)	74 (2.5)	11 (7.0)	22 (5.0)	0.4
Dyspnea	125 (3.9)	7 (4.3)	118 (3.9)	7 (4.5)	26 (5.9)	0.7
Smoking in last year	384 (12.1)	33 (20.4)	351 (11.7)	33 (21.0)	83 (18.8)	0.6
Wound classification 3	425 (13.4)	7 (4.3)	418 (13.9)	7 (4.5)	44 (10.0)	0.04
Additional procedures	1572 (49.6)	110 (67.9)	1462 (48.6)	108 (68.8)	278 (63.0)	0.2
BMI, median (IQR)	25.8 (22.5–29.9)	26.6 (23.4–27.5)	25.8 (22.5–26.7)	26.6 (23.2–31.4)	27.1 (23.0–31.2)	0.7
Require help with ADLs	42 (1.3)	1 (0.6)	41 (1.4)	1 (0.6)	12 (2.7)	0.2
History of CVA	16 (0.5)	2 (1.2)	14 (0.5)	2 (1.3)	3 (0.7)	0.6
Weight loss >10% body weight	161 (5.1)	15 (9.3)	146 (4.9)	14 (8.9)	25 (5.7)	0.19
Preop WBC, median (IQR)	7.2 (5.6–9.2)	4.7 (3.9–5.8)	7.3 (5.8–9.3)	4.7 (3.9–5.7)	6.4 (5.0–8.1)	<0.001
Preop Hct, median (IQR)	39 (35.3–42.0)	38.8 (36.4–40.9)	39.0 (35.3–42.1)	38.8 (36.4–40.9)	38.5 (34.9–41.6)	0.7
Iowa Model predicted morbidity, median % (IQR)	34.2 (28.5–41.4)	30.2 (32.6–37.8)	34.3 (28.7–41.5)	30.1 (25.6–37.8)	36.1 (30.5–44.1)	<0.001

P values are by Fisher Exact, Chi-Squared, or Wilcoxon Rank-Sum tests

Abbreviations: IPAA: Ileal pouch-anal anastomosis; IQR: Interquartile range; ADLs: Activities of daily living; CVA: Cerebrovascular accident; Preop WBC: Preoperative white blood cell count; Preop Hct: Preoperative hematocrit

Table 2

Complications in all IPAA patients and IPAA patients with cancer: radiation vs. no radiation. Rows show number of patients and percent.

	All IPAA Patients (n=3172)			IPAA Patients with Cancer (n=598)		
	Radiation: Yes (n=162)	Radiation: No (n=3010)	P Value	Radiation: Yes (n=157)	Radiation: No (n=441)	P Value
Any complication	45 (27.8%)	1056 (35.1%)	0.06	43 (27.4%)	149 (33.7%)	0.16
Sepsis	4 (2.5%)	255 (8.5%)	0.005	4 (2.5%)	35 (7.9%)	0.02
Superficial infection	13 (8.0%)	249 (8.3%)	0.9	13 (8.3%)	36 (8.2%)	0.9
Deep infection	4 (2.5%)	59 (2.0%)	0.6	3 (1.9%)	7 (1.6%)	0.7
Organ space infection	9 (5.6%)	258 (8.6%)	0.2	9 (5.7%)	33 (8.1%)	0.6
Death	0 (0.0%)	16 (0.5%)	0.9	0 (0.0%)	8 (1.8%)	0.12
Cardiac event	2 (1.2%)	12 (0.4%)	0.16	2 (1.3%)	5 (1.1%)	0.9
Deep vein thrombosis	1 (0.6%)	76 (2.5%)	0.18	1 (0.6%)	6 (1.4%)	0.4
Pulmonary embolism	1 (0.6%)	21 (0.7%)	0.9	1 (0.6%)	2 (0.5%)	0.9
Acute renal failure	1 (0.6%)	43 (1.4%)	0.7	1 (0.6%)	10 (2.3%)	0.3
Re-intubation	1 (0.6%)	32 (1.1%)	0.9	1 (0.6%)	7 (1.6%)	0.7
Failure to wean from ventilator >48 hours	0 (0.0%)	29 (1.0%)	0.4	0 (0.0%)	5 (1.1%)	0.3
Unplanned reoperation	9 (5.6%)	197 (6.5%)	0.7	8 (5.1%)	18 (4.1%)	0.7
Urinary tract infection	10 (6.2%)	161 (5.3%)	0.6	10 (6.4%)	19 (4.3%)	0.3
Dehiscence	4 (2.5%)	34 (1.1%)	0.13	4 (2.5%)	7 (1.6%)	0.5
Pneumonia	1 (0.6%)	40 (1.3%)	0.7	0 (0.0%)	8 (1.8%)	0.12

Abbreviations: IPAA: Ileal pouch-anal anastomosis

Table 3

Multivariate model of factors associated with septic complications at $p < 0.2$ in all j-pouch patients.

Variable	OR	95% CI	P Value
Preoperative radiation within 90 days of operation	0.32	0.09–0.82	0.03
Primary procedure (Lap TPC IPAA pos. ileostomy reference)	1.00	-	0.5 ^a
Proctectomy IPAA pos. ileostomy	1.14	0.79–1.63	0.5
TPC IAA pos. ileostomy	1.10	0.65–1.80	0.7
TPC IPAA pos. ileostomy	1.25	0.89–1.74	0.19
Male sex	0.93	0.71–1.21	0.6
Age (per year)	0.99	0.98–1.00	0.053
BMI (Per unit kg/m ²)	1.01	0.99–1.04	0.3
Active smoker in past year	0.99	0.64–1.48	0.9
Race	1.00	-	0.14 ^a
Diabetes	0.48	0.23–0.91	0.04
Steroid or immunosuppressant use in past 30 days	1.15	0.92–1.61	0.4
Post-operative diagnosis (“Other” reference)	1.00	-	0.8 ^a
Cancer	1.01	0.61–1.66	0.9
Inflammatory Bowel Disease	0.92	0.63–1.36	0.7
History of cardiovascular problems	1.29	0.55–2.67	0.5
Contaminated or dirty/infected wound classification	1.31	0.91–1.86	0.14
Preoperative white count (per 1000/mL)	1.02	0.97–1.06	0.5
Use of antihypertensive medications	1.73	1.19–2.50	0.004
Additional procedures beyond primary performed	0.93	0.70–1.21	0.6
Preoperative weight loss >10%	1.22	0.65–2.11	0.5
Presence of disseminated cancer	0.98	0.23–2.89	0.9

^aIndicates chi-squared p value for category overall.

Abbreviations: OR: Odds ratio; CI: Confidence interval; Lap: Laparoscopic; TPC: Total proctocolectomy; IPAA: Ileal pouch-anal anastomosis; pos.: possible; IAA: Ileal-anal anastomosis; BMI: Body mass index;

Table 4

Multivariate model of preoperative radiation and septic complications, cancer-diagnosis group

Variable	OR	95% CI	P Value
Preoperative radiation within 90 days of operation	0.32	0.10–0.89	0.047
Primary procedure (Lap TPC IPAA pos. ileostomy reference)	1.00	-	0.5 ^a
Proctectomy IPAA pos. ileostomy	2.21	0.85–6.19	0.11
TPC IAA pos. ileostomy	1.66	0.59–4.82	0.3
TPC IPAA pos. ileostomy	1.45	0.54–4.12	0.5
Active smoker in past year	0.90	0.35–2.05	0.8
Diabetes	0.55	0.13–1.61	0.3
Contaminated or dirty/infected wound classification	0.74	0.17–2.20	0.6
Preoperative white count (per 1000/mL)	1.08	0.95–1.21	0.2

^aIndicates chi-squared p value for category overall.

Note: Steroid use could not be included in this model because no patients in the group who received radiation were also on steroids, making meaningful comparisons impossible.

Abbreviations: OR: Odds ratio; CI: Confidence interval; Lap: Laparoscopic; IPAA: Ileal pouch-anal anastomosis; pos.: possible; IAA: Ileal-anal anastomosis