Parastomal hernia development after cystectomy and ileal conduit for bladder cancer: results from the Dartmouth ileal conduit enhancement (DICE) project

Michael E. Rezaee, MD,[1] Jenaya L. Goldwag, MD,[2] Briana Goddard, BA,[3] William Bihrle, III, MD,[3] Alexei Viazmenski, MD,[3,4] Matthew Z. Wilson, MD,[2,3] John D. Seigne, MBBCh[1,3]

[1]Section of Urology, Department of Surgery, Dartmouth-Hitchcock Medical Center, Lebanon, New Hampshire, USA
[2]Department of Surgery, Dartmouth-Hitchcock Medical Center, Lebanon, New Hampshire, USA
[3]Geisel School of Medicine, Hanover, New Hampshire, USA
[4]Department of Radiology, Dartmouth-Hitchcock Medical Center, Lebanon, New Hampshire, USA

REZAEE ME, GOLDWAG JL, GODDARD B, BIHRLE III W, VIAZMENSKI A, WILSON MZ, SEIGNE JD. Parastomal hernia development after cystectomy and ileal conduit for bladder cancer: results from the Dartmouth ileal conduit enhancement (DICE) project. *Can J Urol* 2020;27(5):10369-10377.

Introduction: *Limited information exists regarding parastomal hernia development in bladder cancer patients. The purpose of this investigation was to describe the natural history of parastomal hernias and identify risk factors for hernia development in patients who undergo cystectomy with ileal conduit urinary diversion.*

Materials and methods: *A retrospective cohort study was performed of bladder cancer patients who underwent cystectomy with ileal conduit urinary diversion between January 1st 2009 and July 31st 2018 at Dartmouth-Hitchcock Medical Center. The primary outcome of interest was the presence of a parastomal hernia as evident on postoperative cross-sectional imaging obtained for disease surveillance.*

Results: *A total of 107 patients were included with a mean age of 70.9 years and 29.9% being female. Parastomal hernias were identified in 68.2% of bladder cancer patients who underwent cystectomy with ileal conduit urinary diversion. Forty percent of patients with a parastomal hernia reported symptoms related to their hernia, while 12.5% underwent operative repair. After multivariate adjustment, patients with a postop body mass index (BMI) > 30 kg/m^2 (odds ratio [OR]: 21.8, 95% CI: 1.6-305.2) or stage III or IV bladder cancer (OR: 18, 95% CI: 2.1-157.5), had significantly greater odds of parastomal hernia development. Fifty percent of parastomal hernias were identified 1.3 years from surgery, while 75% were identified by 2 years after cystectomy.*

Conclusion: *Parastomal hernias developed in over two-thirds of bladder cancer patients and occurred rapidly following cystectomy and ileal conduit urinary diversion. Greater postoperative BMI and bladder cancer stage were identified as significant risk factors for parastomal hernia development. Significant opportunity exists to reduce morbidity associated with parastomal hernias in this population.*

Key Words: parastomal hernia, bladder cancer, ileal conduit, cystectomy

Introduction

More than 80,000 new cases of bladder cancer are diagnosed in the United States each year, with approximately 700,000 individuals currently living with this condition.[1] Radical cystectomy, bilateral pelvic lymphadenectomy, and neoadjuvant or adjuvant chemotherapy is the standard of care for patients with resectable, non-metastatic, muscle-invasive bladder cancer (MIBC).[2] Over 90% of patients undergoing cystectomy for bladder cancer will have an ileal conduit created for urinary diversion.[3] This procedure involves anastomosing the ureters to a segment of terminal ileum that is then brought through the abdominal wall as a stoma to allow urine to flow into an external collection device.[3]

Accepted for publication July 2020

Address correspondence to Dr. John D. Seigne, Section of Urology, Department of Surgery, Dartmouth-Hitchcock Medical Center, One Medical Center Drive, Lebanon, NH 03756 USA

Although technically easier and quicker to construct, ileal conduits can be associated with higher rates of global diversion-related complications compared to continent or neobladder urinary diversions.[3,4] Parastomal hernias or incisional hernias related to an ileal conduit are the most common diversion-related complications occurring in 17%-65% of patients.[5,6] These hernias can cause significant disfigurement and discomfort, and can be life-threatening when complicated by urinary or bowel obstruction or bowel incarceration. Consequently, 8%-75% of bladder cancer patients who develop a symptomatic parastomal hernia will undergo operative repair to reconstruct large fascial defects in the abdominal wall.[6]

The burden of parastomal hernias to patients, surgeons, and the healthcare system is immense.[7] Significant opportunity exists to reduce patient morbidity, mortality and healthcare costs if parastomal hernias can be better understood and prevented. In fact, the European Hernia Society currently recommends placement of prophylactic mesh during construction of an end colostomy given the high incidence of parastomal hernias associated with this procedure.[8] To date, limited information exists regarding parastomal hernia development in bladder cancer patients. Therefore, the purpose of this investigation was to describe the natural history of parastomal hernias and identify risk factors for hernia development in bladder cancer patients who undergo cystectomy with ileal conduit urinary diversion.

Materials and methods

Study design

A retrospective cohort study was performed of all patients who underwent cystectomy with ileal conduit urinary diversion between January 1st 2009 and July 31st 2018 at Dartmouth-Hitchcock Medical Center (DHMC). DHMC is a rural, tertiary care academic medical center located in Lebanon, NH, that serves patients in Northern New England. DHMC's electronic medical record served as the primary data source for the study and was queried using a combination of automated and manual chart abstraction. This study was approved by the DHMC Committee for the Protection of Human Subjects (CPHS 315860) and was conducted in accordance with the Declaration of Helsinki.[9]

Patient population

Patients undergoing cystectomy with ileal conduit urinary diversion were identified using Current Procedural Terminology (CPT) codes. Patients were excluded from the analysis if they 1) did not have a cystectomy for bladder cancer, 2) did not have an ileal conduit created, 3) were missing postoperative cross-sectional surveillance imaging, 4) died within 1.5 years of surgery with no evidence of a parastomal hernia on available imaging, or 5) did not have cross-sectional imaging 1.5 years after surgery and no parastomal hernia identified on imaging performed within 1.5 years, Figure 1. In other words, patients were required to have cross-sectional imaging at greater than or equal to 1.5 years after cystectomy to qualify as not having a parastomal hernia; this cut off was used to account for the time-dependency of hernia development (assessing to early would underestimate hernia development). Patients could be categorized as having a parastomal hernia if they had radiographic evidence of a parastomal hernia on cross-sectional imaging obtained at any time point greater than 3 months after cystectomy.

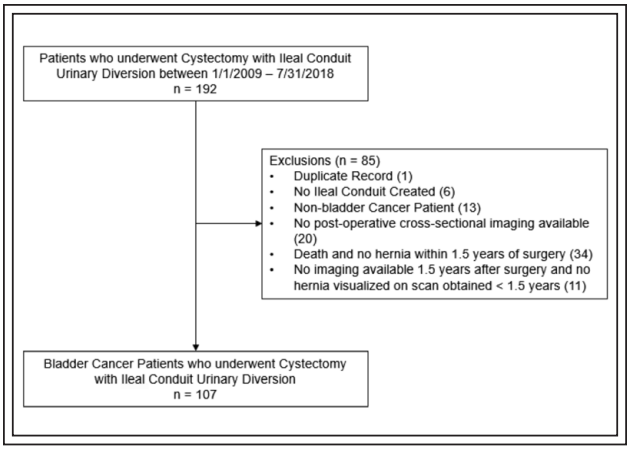

Figure 1. Patient selection flow diagram.

Outcomes

Our primary outcome was the development of a parastomal hernia after cystectomy and ileal conduit urinary diversion. A parastomal hernia was defined as radiographic evidence of abdominal contents, including intraperitoneal fat, protruding through the abdominal wall associated with an ileal conduit as seen on routine postoperative cross-sectional imaging for cancer surveillance. To identify the outcome, cross-sectional imaging obtained greater than 3 months after surgery was reviewed for each patient by two senior surgical residents. Two senior attending surgeons performed random quality checks to ensure reading accuracy. Discrepancies between resident and attending reads were refereed by an experienced genitourinary attending radiologist.

Our secondary outcomes included development of a ventral hernia not associated with the ileal conduit, the presence of symptomatic parastomal or ventral hernias, the occurrence parastomal or ventral hernia repairs, and mortality. Ventral hernias were identified using the same methodology as parastomal hernias and included umbilical hernias. Hernias were considered symptomatic if patients reported hernia-related pain or discomfort, experienced bowel obstruction, or underwent operative repair. Hernia repairs were identified based on mesh identification on cross-sectional imaging and/or from post-cystectomy general surgery operative notes. Mortality was measured using notification of death reports maintained in the health record.

Lastly, a random 15% sample of patients who met inclusion/exclusion criteria and developed a parastomal hernia were re-reviewed to further characterize their parastomal hernia according to fascial defect location (posterior fascial defect only versus anterior and posterior fascial defect) and hernia contents (primarily fat or bowel containing). Overall, there was no difference in identifying hernias between the two primary reviewers.

Predictors

Clinical and demographic characteristics were abstracted from patients' electronic medical records. Co-morbid conditions were identified using International Classification of Disease, Ninth Revision, Clinical Modification (ICD-9-CM) codes and were calculated into a Charlson Comorbidity Score.[10] Preoperative body mass index (BMI, kg/m^2) and serum albumin (g/dL) was obtained 1 month prior to surgery. Postoperative BMI and serum albumin was obtained 6 months after surgery. Tumor characteristics were obtained from pathology reports. Postoperative complications with the highest Clavien-Dindo Classification score within 30 days of surgery were recorded for each patient.[11] Pre-albumin was infrequently obtained on included patients and was not included in the analysis.

Statistical analysis

Univariate statistics (t-test and X^2) were used to examine patient characteristics by parastomal hernia status. All factors associated with parastomal hernias were used to build a multivariate logistic regression model to examine the relationship between parastomal hernia development and patient characteristics. A p value of 0.20 was used as a cut off for inclusion in the final model, as more traditional levels such as 0.05 can fail to identify variables known to be important.[12] Certain patient characteristics (i.e. smoking history, Charlson comorbidity score, and receipt of chemotherapy) were incorporated into the model regardless of univariate statistical significance, as they have previously been identified as risk factors for hernia development. Characteristics missing from greater than 50% of patients were excluded from the model. Interaction terms were tested to determine the presence of effect modification. A second logistic regression model was created for ventral hernia development. The c-statistic was used to approximate the validity of each model.[13] The p value used for statistical significance for the final models was < 0.05. Kaplan-Meier curves were generated to estimate time-to-hernia development among patients who developed parastomal and ventral hernias. The statistical software STATA 11.2 (StataCorp, College Station, TX, USA) was used for all analyses.

Results

A total of 107 patients were included with a mean age of 70.9 years and 29.9% being female. Parastomal hernias were identified in 68.2% of bladder cancer patients who underwent cystectomy with ileal conduit urinary diversion. Parastomal hernias were more common in patients with greater preop (31 versus 27.7 kg/m^2, $p < 0.01$) and postop BMI (40.5 versus 26.9 kg/m^2, $p < 0.01$), lower postop albumin (3.6 versus 4.1 g/dL, $p = 0.02$), in those with procedures by surgeon #1, and with higher pathological stage, Table 1. Approximately 40% of patients with a parastomal hernia reported symptoms related to their hernia, while 12.5% underwent operative repair and 27.4% died during the study period, Table 2.

After multivariate adjustment, patients with a postop BMI > 30 kg/m^2 (OR: 21.8, 95% CI: 1.6-305.2) or a stage III or IV bladder cancer diagnosis after surgery (OR: 18, 95% CI: 2.1-157.5), had significantly greater odds of parastomal hernia development. Patients operated on by surgeon #2 (OR: 0.26, 95% CI: 0.1-0.8) or #3 (OR: 0.11, 95% CI: 0.02-0.7) or who received adjuvant chemotherapy (OR 0.05, 95% CI: 0.01-0.48) had significantly decreased odds of parastomal hernia development, Table 3. The c-statistic for this model was 0.83. Fifty percent of parastomal hernias were identified 1.3 years from surgery, while 75% were identified 2.0 years after cystectomy, Figure 2.

Ventral hernias not associated with the ileal conduits were identified in 49.5% of patients. These hernias were more common in patients with greater preop BMI (30 versus 28.9 kg/m^2, $p = 0.04$) and postop BMI (41.5 versus 31 kg/m^2, $p < 0.01$). Ventral hernias were symptomatic in 14.7% of patients and 5.7% underwent

TABLE 1. **Patient characteristics by parastomal hernia status**

	Overall (n = 107)	**No parastomal hernia 31.8 (n = 34)**	**Parastomal hernia 68.2% (n = 73)**	**p value**
Age, years	70.9	70.5	71.1	0.71
Female, %	29.9	32.4	28.8	0.71
White, %	100	100	100	1
Preop BMI (kg/m^2)	30.1	27.7	31.1	< 0.01
Preopp BMI, %				0.02
< 20	1.9	5.9	0	
> 20 to <= 25	14.0	23.5	9.6	
> 25 to <= 30	38.3	41.2	37.0	
> 30	45.8	29.4	53.4	
Postop BMI (kg/m^2)	36.2	26.9	40.5	< 0.01
Postop BMI, % - 6 months				< 0.01
< 20	3.7	8.8	1.4	
> 20 to <= 25	12.2	23.5	6.9	
> 25 to <= 30	38.3	38.2	38.4	
> 30	45.8	29.4	53.4	
Change in BMI (kg/m^2)	-1.1	-0.8	-1.3	0.4
Former smoker, %	80.4	73.5	83.6	0.2
Periop smoker, %	19.6	17.7	20.6	0.72
Postop smoker, %	13.1	11.8	13.7	0.78
Charlson Comorbidity score	7.6	7.3	7.8	0.52
Preop albumin (g/dL)	3.9	3.9	4	0.93
Postop albumin (g/dL) - 6 months	3.7	4.1	3.6	0.02
Surgeon				0.04
Surgeon #1	49.5	32.4	57.5	
Surgeon #2	39.3	50	34.3	
Other Surgeons (#3 & #4)	11.2	17.7	8.2	
Approach				0.39
Open	91.6	88.2	93.2	
Robotic	8.4	11.8		6.9
NGT placement, %	29.5	35.3	26.8	0.37
TPN, %	29.9	32.4	28.8	0.71
Days of TPN (days)	2.3	2.3	2.3	0.95
Length of stay (days)	10.7	10.8	10.7	0.94
Tumor stage at TURBT, %				0.3
Ta	0.9	2.9	0	
Tis	14.0	11.8	15.1	
T1	16.8	23.5	13.7	
T2	42.1	44.1	41.1	
T3	22.4	17.7	24.7	
T4	3.7	0	5.5	

TABLE 1 (cont'd). **Patient characteristics by parastomal hernia status**

	Overall (n = 107)	**No parastomal hernia 31.8 (n = 34)**	**Parastomal hernia 68.2% (n = 73)**	**p value**
Pathology, %				0.06
UCC, high grade	62.6	58.8	64.4	
UCC, low grade	4.7	8.8	2.7	
CIS	21.5	11.8	26	
Other	2.8	2.9	2.74	
No residual disease	8.4	17.7	4.11	
Variant histology, %	14.9	8.8	17.8	0.22
Pathological stage, %				< 0.01
Stage 0a	14.0	29.4	6.9	
Stage 0is	20.6	8.8	26	
Stage I	4.7	5.9	4.1	
Stage II	21.5	29.4	17.8	
Stage IIIa	22.4	5.9	30.1	
Stage IIIb	0.9	0	1.4	
Stage IVa	14.0	17.7	12.33	
Stage IVb	1.9	2.9	1.4	
Neoadjuvant chemotherapy, %	43.9	38.2	46.6	0.42
Neoadjuvant chemo period (days)	44.8	55.3	41.2	0.55
End of neoadjuvant chemo to surgery date (days)	54.4	57.9	53.2	0.69
Adjuvant chemotherapy, %	16.8	20.6	15.1	0.47
Adjuvant chemo period (days)	105.5	158	68	0.28
End of surgery to adjuvant chemo start date (days)	191.2	278	129.1	0.29
Highest Clavien-Dindo score, %				0.45
Zero	36.5	35.3	36.9	
I&II	45.8	52.9	42.5	
III-V	17.8	11.8	20.6	
Superficial wound infection, %	10.4	8.8	11.2	0.72
Superficial skin dehiscence,%	14.0	8.8	16.4	0.29
Facial dehiscence, %	4.7	5.8	4.1	0.69
Discharge Location, %				0.34
Home	76.6	82.4	73.9	
Rehab	23.4	17.7	26	
Average follow up time (years)	3.4	3.4	3.4	0.93

operative repair. After multivariate adjustment, no patient characteristics were significantly associated with ventral hernia development. The c-statistic for this model was 0.73. Fifty percent of ventral hernias were identified 1.6 years from surgery, while 75% were identified 2.3 years after cystectomy.

The 15% random sample of parastomal hernias showed that 27% of hernias were primarily fat-containing compared to 73% being primarily bowel-containing. All re-sampled parastomal hernias were located through both an anterior and posterior fascial defects.

TABLE 2. **Secondary outcomes by parastomal hernia status**

	Overall	No parastomal hernia 31.8 (n = 34)	Parastomal hernia 68.2% (n = 73)	p value
Symptomatic parastomal Hernia (%)	27.2	0	40.6	
Ventral hernia (%)	45.8	41.2	53.4	0.24
Symptomatic ventral hernia (%)	14.7	14.7	14.7	1
Parastomal hernia repair (%)	8.6	0	12.5	
Ventral hernia repair (%)	5.7	6.1	5.6	0.92
Mortality (%)	21.5	8.8	27.4	0.03

Discussion

In this retrospective cohort study, we observed a parastomal hernia rate of 68.2% in bladder cancer patients who underwent cystectomy with ileal conduit urinary diversion. Approximately 40% of these hernias were symptomatic and 12.5% were subsequently corrected with operative repair. The majority of parastomal hernias (75%) were present on postoperative cross-sectional imaging obtained within 2 years of cystectomy. Postoperative BMI > 30 kg/m^2 and stage III or IV bladder cancer were significant risk factors for parastomal hernia development.

Ileal conduit urinary diversion was established as a standard surgical technique by Bricker in 1950.[14] In 1975, Marshall et al published one of the first studies describing parastomal hernias in patients with ileal conduits. In this study, the authors reported a clinical hernia rate of 4.5% and discussed options for management, including in situ and translocation stoma repairs.[15] With improvements in survival, imaging, and disease follow up practices, parastomal hernias are currently estimated to occur in 17%-65% of bladder cancer patients after cysectomy.[5,6] Prior research has shown that 23%-50% of bladder cancer patients will have radiographic evidence of a parastomal hernia 2 years after cystectomy.[16,17]

TABLE 3. **Adjusted multiple logistic regression analysis displaying risk factors for parastomal hernia development**

		95% CI		
	Odds ratio	**Lower**	**Upper**	**p value**
Postop BMI - 6 months				
< 20	Ref			
> 20 to <= 25	2.4	0.16	35.8	0.54
> 25 to <= 30	13.7	0.94	200.6	0.06
> 30	21.8	1.6	305.2	0.02
TNM staging				
Stage 0	Ref			
Stage I & II	0.76	0.21	2.7	0.67
Stage III & IV	18	2.1	157.5	0.01
Surgeon	Ref (Surgeon #1)			
Surgeon #2	0.26	0.08	0.81	0.02
Other Surgeons (#3 & #4)	0.11	0.02	0.66	0.02
Smoking history	2.4	0.65	8.59	0.19
Charlson Comorbidity score	º1.1	0.87	1.2	0.2
Receipt of neoadjuvant chemotherapy	1.9	0.62	5.77	0.26
Receipt of adjuvant chemotherapy	0.05	0.01	0.48	0.01

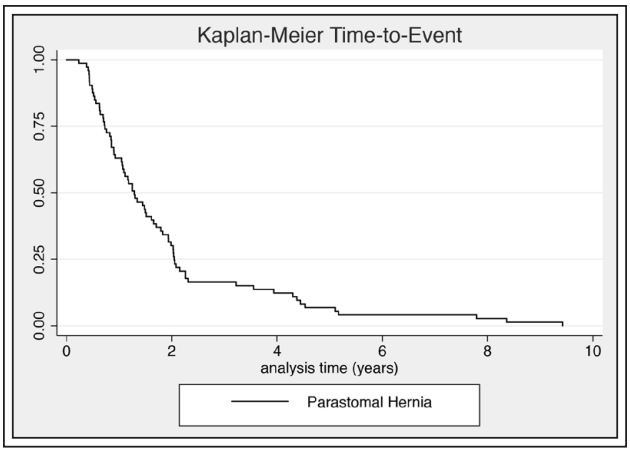

Figure 2. Kaplan-Meier curve displaying time-to-parastomal hernia development.

We observed a higher rate (68.2%) of parastomal hernias with 75% identified on imaging obtained within 2 years of cystectomy. The higher hernia rate and faster time to hernia development observed in our study may be explained by our rural study population and lengthy follow up period. Rural patients face unique barriers to postoperative care, including travel distance, limited home health services, and social and financial pressures resulting in early return to activity and work.[18] These burdens may accelerate time to hernia development in certain high-risk patients. In addition, our follow up period was greater than 9 years for some patients, which increases the likelihood of identifying a hernia given the extended surveillance period.

In 2014, Donahue et al examined risk factors for parastomal hernia development in 433 patients who underwent open radical cystectomy. The authors found that female gender, higher BMI and lower preoperative albumin were significantly associated with parastomal hernias.[16] Similarly, Liu et al identified prior history of exploratory laparotomy and obesity as risk factors for parastomal hernia development.[19] Later in 2018, Hussein et al evaluated risk factors for hernia development in 383 robotic cystectomies. Longer operative time, larger fascial defect, and lower postoperative glomerular filtration rate were significantly associated with parastomal hernias in this cohort.[17] Similar to the above studies, we found that obesity or a BMI > 30 kg/m^2 was a significant risk factor for parastomal hernia development. We also identified stage III or IV bladder cancer as a risk factor. Higher stage bladder cancer is associated with greater morbidity, mortality, receipt of chemotherapy, as well as declining nutritional and functional status.[20] As such, the consequences of having later stage bladder cancer may explain why these patients are at increased risk of parastomal hernia development.

Interestingly, total parenteral nutrition, nasogastric tube placement, length of stay, and postoperative complications were not associated with parastomal hernias in our study. This may suggest that a patient's immediate postoperative course does not significantly influence future parastomal hernia development. However, we did not evaluate all perioperative factors including the role of enhanced recovery pathways after surgery (ERAS) in cystectomy. ERAS promotes goal-directed fluid management, prevention of nausea/vomiting, and early oral nutrition, ambulation, and hospital discharge.[21] At this point, it's unclear how ERAS may impact hernia development; different components of ERAS may actually have opposing effects on parastomal hernia risk. Similarly, the role of preoperative and postoperative stoma therapy needs to be evaluated.

Unlike prior published studies, we found that surgeon and receipt of adjuvant chemotherapy were protective against parastomal hernias. It's unclear why differences were observed between surgeons, but this may be explained by surgical technique, resident involvement, or other unmeasured variables. Of note, all surgeons (n = 4) were interviewed and reported constructing ileal conduits in a similar fashion in regards to approach, suture material, and stoma location. In brief, a cruciate incision was made in the anterior rectus fascia, the rectus muscle belly was split, and an opening in the abdominal wall large enough to accommodate two finger-breaths was created to deliver the ileal conduit to the abdominal skin. Tacking sutures were not placed to fix ileal conduits to the fasica. A similar method was used for robotic cystectomies, as all diversions were performed in an open manner. Surgeons were a mix of fellowship trained urologic oncologists and reconstruction specialists. In addition, receipt of adjuvant chemotherapy would typically be suspected to increase parastomal hernia risk. However, candidates for adjuvant chemotherapy can be "healthier" bladder cancer patients without clinical contraindications (e.g. renal function) effecting their candidacy for adjuvant chemotherapy.[22]

Ventral hernias after cystectomy are also not well understood. In 2018, Edwards et al examined the incidence of incisional hernias after cystectomy in 469 patients. The authors observed an incisional hernia and hernia repair rate of 14.3% and 9.0%, respectively.[23] Despite investigating a number of patient and clinical factors, only supraumbilical diastasis width was

an independent predictor of incisional hernia in cystectomy patients.[23] We observed a much larger ventral hernia rate (49.5%), while only 5.7% of our patients underwent operative repair. The large difference in hernia rates may be partially explained by our inclusion of umbilical hernias, as well as not comparing preoperative to postoperative imaging to identify existing hernias. However, similar to Edwards et al, although greater BMI was associated with ventral hernia development in our univariate analysis, no patient factors were significant in our multivariate analysis. Thus, further research is needed to better understand ventral hernia development after cystectomy. Of note, ventral fascia closure technique varied over the course of our study. The most common fascial closure techniques consisted of using two looped 0 or #1 PDS sutures or two 1-0 prolene sutures (with or without interrupted reinforcing vicryl sutures) placed in a running fashion.

Mortality was significantly higher among patients who development parastomal hernias compared to those who did not (27.4% versus 8.8%, p = 0.03). Increased mortality in the parastomal hernia group may be due to complications related to the hernia or the fact that many of these patients had a later stage bladder cancer. However, the mortality rate may also be artificially inflated in this group as patients who had more complete surveillance imaging also were more likely have mortality data available.

The retrospective design, moderate sample size, and homogenous patient population (e.g. 100% Caucasian) may limit the generalizability of our findings. In addition, given that DHMC is a rural, tertiary medical center, many patients travel long distances for their urologic care. As a consequence, many patients obtain surveillance imaging at local, remote hospitals for their convenience. Unfortunately, the quality and accessibility of images performed at these hospitals is varied, which may have influenced our results to a small degree. In addition, all patients in our study underwent prone cross-sectional imaging. Prior research has demonstrated that up to 15% of parastomal hernias may be missed on supine imaging, but identified when a patient is in the prone position.[24] As such, our study may somewhat under-estimate the true prevalence of parastomal hernias among cystectomy patients. Oppositely, our exclusion criteria that required patients to have cross-sectional imaging at greater than or equal to 1.5 years after cystectomy to qualify as not having a parastomal hernia may have over-estimated our parastomal hernia rate. However, half of parastomal hernias in our cohort were visualized 1.3 years after surgery, suggesting that the non-formation of a parastomal hernia cannot be accurately assessed with short term follow up. The primary strengths of our study include a comprehensive assessment of patient and clinical risk factors for hernia development and standardized review strategy with quality assurance practices.

The incidence of parastomal hernia repair is increasing nationwide and only half of patients who develop this type of hernia will undergo repair.[25] Unfortunately, parastomal hernia repair is frequently unsuccessful with up to 17% of patients experiencing a recurrence.[26] Amongst colorectal surgeons, parastomal hernia management has shifted from repair to prevention. In fact, prophylactic mesh placement is now recommended by the European Hernia Society to prevent parastomal hernia after colostomy creation.[8] Parastomal hernia prevention in bladder cancer patients who undergo cystectomy with ileal conduit urinary diversion is a novel concept that has been proposed, but which has not yet been rigorously evaluated.[5,27,28] Surgical techniques, such as anterior fascial fixation, to prevent parastomal hernia development have been attempted, but have proven ineffective to date.[29] Our findings support the need for parastomal hernia prevention strategies and provides additional information that will be useful in designing future trials to assess these interventions. In regards to prophylactic mesh placement, trials are needed to examine the efficacy, safety (i.e. erosion, infection risk), effectiveness, and patient-reported outcomes associated with this intervention in the cystectomy population.

Conclusion

Parastomal hernias were present in 68.2% of bladder cancer patients who underwent cystectomy with ileal conduit urinary diversion. Greater postoperative BMI and bladder cancer stage were significant risk factors for parastomal hernia development. On cross-sectional imaging, 75% of parastomal hernias were evident by 2 years after cystectomy. Significant opportunity exists to reduce morbidity associated with parastomal hernias amongst bladder cancer patients. Rigorous prospective clinical trials to evaluate parastomal hernia prevention strategies are needed in this population. □

References

1. National Cancer Institute: Surveilance E, and End Results Program. Cancer Stat Facts: Bladder Cancer https://seer.cancer.gov/statfacts/html/urinb.html. Published 2019. Accessed August, 15th 2019.

2. Chang SS, Bochner BH, Chou R et al. Treatment of non-metastatic muscle-invasive bladder cancer: AUA/ASCO/ASTRO/SUO Guideline. *J Urol* 2017;198(3):552-559.
3. Farber NJ, Faiena I, Dombrovskiy V et al. Disparities in the use of continent Urinary diversions after radical cystectomy for bladder cancer. *Bladder Cancer* 2018;4(1):113-120.
4. Pycha A, Comploj E, Martini T et al. Comparison of complications in three incontinent urinary diversions. *Eur Urol* 2008;54(4):825-832.
5. Donahue TF, Bochner BH. Parastomal hernias after radical cystectomy and ileal conduit diversion. *Investig Clin Urol* 2016;57(4):240-248.
6. Narang SK, Alam NN, Campain NJ et al. Parastomal hernia following cystectomy and ileal conduit urinary diversion: a systematic review. *Hernia* 2017;21(2):163-175.
7. Aquina CT, Iannuzzi JC, Probst CP et al. Parastomal hernia: a growing problem with new solutions. *Digestive Surgery* 2014;31(4-5):366-376.
8. Antoniou SA, Agresta F, Garcia Alamino JM et al. European Hernia Society guidelines on prevention and treatment of parastomal hernias. *Hernia* 2018;22(1):183-198.
9. World Medical Association Declaration of Helsinki: ethical principles for medical research involving human subjects. *JAMA* 2013;310(20):2191-2194.
10. Deyo RA, Cherkin DC, Ciol MA. Adapting a clinical comorbidity index for use with ICD-9-CM administrative databases. *J Clin Epidemiol* 1992;45(6):613-619.
11. Clavien PA, Barkun J, de Oliveira ML et al. The Clavien-Dindo classification of surgical complications: five-year experience. *Ann Surg* 2009;250(2):187-196.
12. Mickey RM, Greenland S. The impact of confounder selection criteria on effect estimation. *Am J Epidemiol* 1989;129(1):125-137.
13. Harrell F. Regression modeling strategies: with applications to linear models, logistic regression, and survival analysis. In: New York: Springer-Verlag;2001.
14. Pannek J, Senge T. History of urinary diversion. *Urol Int* 1998;60(1):1-10.
15. Marshall FF, Leadbetter WF, Dretler SP. Ileal conduit parastomal hernias. *J Urol* 1975;114(1):40-42.
16. Donahue TF, Bochner BH, Sfakianos JP et al. Risk factors for the development of parastomal hernia after radical cystectomy. *J Urol* 2014;191(6):1708-1713.
17. Hussein AA, Ahmed YE, May P et al. Natural history and predictors of parastomal hernia after robot-assisted radical cystectomy and ileal conduit urinary diversion. *J Urol* 2018;199(3):766-773.
18. McCullough LE, Flowers CR. Identifying and addressing disparities in survival outcomes for rural patients with cancer disparities in survival outcomes for rural patients with cancer invited commentary. J*AMA Network Open* 2018;1(4):e181243-e181243.
19. Liu NW, Hackney JT, Gellhaus PT et al. Incidence and risk factors of parastomal hernia in patients undergoing radical cystectomy and ileal conduit diversion. *J Urol* 2014;191(5):1313-1318.
20. Ebbing J, Heckmann RC, Collins JW et al. Oncological outcomes, quality of life outcomes and complications of partial cystectomy for selected cases of muscle-invasive bladder cancer. *Scientific Reports* 2018;8(1):8360.
21. Tyson MD, Chang SS. Enhanced recovery pathways versus standard care after cystectomy: a meta-analysis of the effect on perioperative outcomes. *Eur Urol* 2016;70(6):995-1003.
22. Apolo AB, Grossman HB, Bajorin D, Steinberg G, Kamat AM. Practical use of perioperative chemotherapy for muscle-invasive bladder cancer: summary of session at the Society of Urologic Oncology annual meeting. *Urol Oncol* 2012;30(6):772-780.
23. Edwards DC, Cahn DB, Reddy M et al. Incisional hernia after cystectomy: incidence, risk factors and anthropometric predisposition. *Can J Urol* 2018;25(6):9573-9578.
24. Jänes A, Weisby L, Israelsson LA. Parastomal hernia: clinical and radiological definitions. *Hernia* 2011;15(2):189-192.
25. Gavigan T, Rozario N, Matthews B, Reinke C. Trends in parastomal hernia repair in the United States: a 14-y review. *J Surg Res* 2017;218:78-85.
26. Hansson BM, Slater NJ, van der Velden AS et al. Surgical techniques for parastomal hernia repair: a systematic review of the literature. *Ann Surg* 2012;255(4):685-695.
27. Styrke J, Johansson M, Granasen G, Israelsson L. Parastomal hernia after ileal conduit with a prophylactic mesh: a 10 year consecutive case series. *Scand J Urol* 2015;49(4):308-312.
28. Mirza B, Chand B. Laparoscopic repair of ileal conduit parastomal hernia using the sling technique. *JSLS* 2008;12(2):173-179.
29. Pisters AL, Kamat AM, Wei W et al. Anterior fascial fixation does not reduce the parastomal hernia rate after radical cystectomy and ileal conduit. *Urology* 2014;83(6):1427-1431.