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Ureteral Injuries in Colorectal Surgery: An Analysis of Trends, Outcomes, and Risk Factors Over a 10-Year Period in the United States

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BACKGROUND: Iatrogenic ureteral injuries during colorectal surgical procedures are rare. Little is known about their incidence, associated outcomes, and predisposing factors.

OBJECTIVE: The purpose of this study was to examine the trends of iatrogenic ureteral injuries in the United States over a decade, as well as their outcomes and risk factors.

DESIGN: This was a retrospective study.

SETTINGS: The nationwide inpatient sample from 2001 to 2010 was analyzed.

PATIENTS: Included were patients with colorectal cancer, benign polyps, diverticular disease, or inflammatory bowel disease undergoing colorectal surgery.

MAIN OUTCOME MEASURES: Trends of iatrogenic ureteral injuries occurring in colon and rectal surgical procedures were examined over a 10-year period. Mortality, morbidity, length of stay and total charge associated with ureteral injuries were analyzed on multivariate analysis. Finally, a predictive model for ureteral injuries was built using patient, hospital, and operative variables.

RESULTS: An estimated 2,165,848 colorectal surgical procedures were performed in the United States over the study period, and 6027 ureteral injuries were identified (0.28%). The rate of ureteral injuries was higher in the second half of the decade (2006-2010) compared with the first half (2001-2005; 3.1/1000 vs 2.5/1000; $p < 0.001$). Ureteral injuries were independently associated with higher mortality (OR, 1.45; $p < 0.05$), morbidity (OR, 1.66; $p < 0.001$), longer length of stay (mean difference, 3.65 days; $p < 0.001$), and higher hospital charges by $31,497 ($p < 0.001$). Risk factors for ureteral injuries included rectal cancer (OR, 1.85), adhesions (OR, 1.83), metastatic cancer (OR, 1.76), weight loss/malnutrition (OR, 1.08), and teaching hospitals (OR, 1.05). Protective factors included the use of laparoscopy (OR, 0.91), transverse colectomy (OR, 0.90), and right colectomy (OR, 0.43).

LIMITATIONS: This was a retrospective study from an administrative database.

CONCLUSIONS: Iatrogenic ureteral injuries are rare complications in colorectal surgery; however, their incidence appears to be rising. Ureteral injuries are associated with higher mortality, morbidity, hospital charge, and length of stay, and their incidence can be predicted by several factors.

Iatrogenic ureteral injuries (IUIs) are dreaded complications of abdominal and pelvic procedures that are associated with significant morbidity.[1] Because of the close proximity of the ureters to the field of dissection,[2] these complications appear more common in gynecologic surgery, where they have a reported incidence ranging from 0.07% to 1.70%.[2–12] In contrast, colorectal operations are the second most common cause of IUI,[2,13,14] with a reported incidence of 0.24% to 1.95%.[1,15,16] Although there are extensive data examining the incidence and outcomes of IUIs in gynecologic procedures, very few reports have specifically addressed these complications in colorectal surgery. Moreover, most data represent single-center experiences and are, thus, limited by small numbers, precluding a meaningful analysis of the associated risk factors and outcomes. To date, there have been no large-scale studies examining the incidence of IUI in colorectal surgery at the national level, recent trends, outcomes, and predisposing factors. This is a large, retrospective review of IUIs in colon and rectal surgical procedures performed for various indications. The incidence, trends, outcomes, and risk factors of IUI are presented over a 10-year period in the United States.

METHODS

Patient Population

The Healthcare Cost and Utilization Project-Nationwide Inpatient Sample (NIS) was retrospectively reviewed from January 1, 2001, to December 31, 2010, for colorectal surgical procedures performed for various indications. IUIs were identified using a combination of International Classification of Diseases (ICD) 9 diagnoses and procedures codes. The NIS is the largest all-payer inpatient care database in the United States. It represents a 20% stratified sample approximating 95% of all hospital discharges across the country. Data elements within the NIS are drawn from hospital discharge abstracts, which provide information on patient characteristics, length of stay, procedures performed, postoperative morbidity, and in-hospital mortality. Approval for the use of the NIS was obtained from the institutional review board of the University of California, Irvine Medical Center and the Healthcare Cost and Utilization Project-NIS.

Case Selection

Cases were selected using a combination of ICD-9 diagnoses and procedures codes. The following diagnoses were included (with ICD-9 diagnosis codes listed in brackets): colon cancer (153.0–153.9), rectal cancer (154.0–154.2, 154.8), colonic polyps (211.3, 230.3, V12.72), rectal polyps (211.4, 230.4, 230.5, 569.0), diverticular disease (562.10–562.13), ulcerative colitis (556.0–556.9), and Crohn's disease (555.0, 555.1, 555.2, 555.9). The following procedures were included in the analysis (with ICD-9 procedures

codes listed in brackets): right hemicolectomy (17.32, 17.33, 45.72, 45.73), transverse colectomy (17.34, 45.74), left hemicolectomy (17.35, 45.75), sigmoidectomy (17.36, 45.76), anterior resection (48.40–48.43, 48.49, 48.62, 48.63, 48.69), abdominoperineal resection (48.50–48.52, 48.59), and partial/total colectomy (45.79, 45.8, 45.81, 45.83). Ureteral injuries were identified using ICD-9 diagnosis codes (867.2, 867.3) or procedure codes (56.41, 56.61 56.71, 56.74, 56.75, 56.82–56.86, 56.89). The choice of these codes was based on data published previously.[17] Missing data listed in the tables were excluded from the analysis.

Study Design

In the first part of the analysis, trends of IUIs in colorectal surgical procedures were examined over a 10-year period. In the second part of the study, we analyzed patients' demographics and comorbidities in patients with ureteral injuires. The third part of the analysis lists the rates of IUI according to hospital setting, admission type, disease, and procedure types, as well as the intraoperative presence of adhesions. In the fourth part of the analysis, the unadjusted outcomes of IUIs were examined on univariate analysis, and selected end points were further examined on multivariate analysis. In the last part of the analysis, a prediction model for ureteral injuries was built using patient and hospital-level variables.

Study Variables

The following variables were adjusted for on multivariate analysis: age, sex, ethnicity, payer type, comorbidities provided by the NIS and based on the Elixhauser comorbidity index,18 and a comorbidity score based on the Elixhauser-Van Walraven model.19 We also included admission type (elective vs urgent/emergent), hospital type (teaching vs nonteaching), location (urban vs rural), size (small vs medium vs large hospitals), disease type, procedure type, presence of adhesions, and the use of laparoscopy (including converted cases), Laparoscopic procedures were identified by specific ICD-9 codes in the 2009 to 2010 data. For the 2001 to 2008 data, the ICD-9 laparoscopic modifiers codes 54.21 and 54.51 were used. All these variables were also used to build a predictive model for ureteral injuries.

End Points

The association of IUI with the following end points chosen a priori was examined on multivariate analysis: mortality, morbidity, length of stay, and total hospital charges. The other end point of our analysis was to build a prediction model for IUI.

Statistical Analysis

All of the statistical analyses were conducted using SAS version 9.3 (SAS Institute Inc, Cary, NC) and the R Statistical Environment. $\chi 2$ with Yates' correction and t test with unequal variance were used where appropriate. Multivariate linear and logistic regression were used to compare selected end points between the ureteral injury and the noninjury

groups. Estimates of adjusted mean differences and adjusted ORs were obtained with 95% CIs. Statistical significance was declared if $p < 0.05$. The LASSO algorithm for logistic regression was used to identify predictive variables for iatrogenic ureteral injuries. Predictive and protective variables were selected from the training data set, and 10-fold cross-validation and the 1-SE rule were used on the validation set to select for model size and to control for overfitting. Receiver operating characteristic curve and area under the curve statistic were used on the validation set to summarize how well the model predicted ureteral injuries. In contrast to the classic multivariate logistic regression where ORs are independent of each other and cannot be added together, LASSO assigns a coefficient to each variable. Depending on whether the coefficient is positive or negative, it is predictive or protective of the end point analyzed. The degree of positivity or negativity is proportional to the effect that the variable has on the end point under question. To calculate the predicted risk of ureteral injury, coefficients can be added together along with the intercept. For a coefficient of x, the risk of IUI is ex/(1+ex). Variables not selected by the LASSO are unlikely to predict ureteral injuries.

RESULTS

From 2001 to 2010, an estimated 2,165,848 colon and rectal surgical procedures were performed in the United States. IUIs occurred in 6027 cases (0.28%), and their incidence increased by 24% in the second half of the decade. From 2001 to 2005, 2639 ureteral injuries occurred in 1,073,283 cases (2.5/1000), whereas, in the second half of the decade (2006–2010), 3388 ureteral injuries occurred in 1,092,735 cases (3.1/1000; $p < 0.001$). Figure 1 depicts the yearly trends of ureteral injuries.

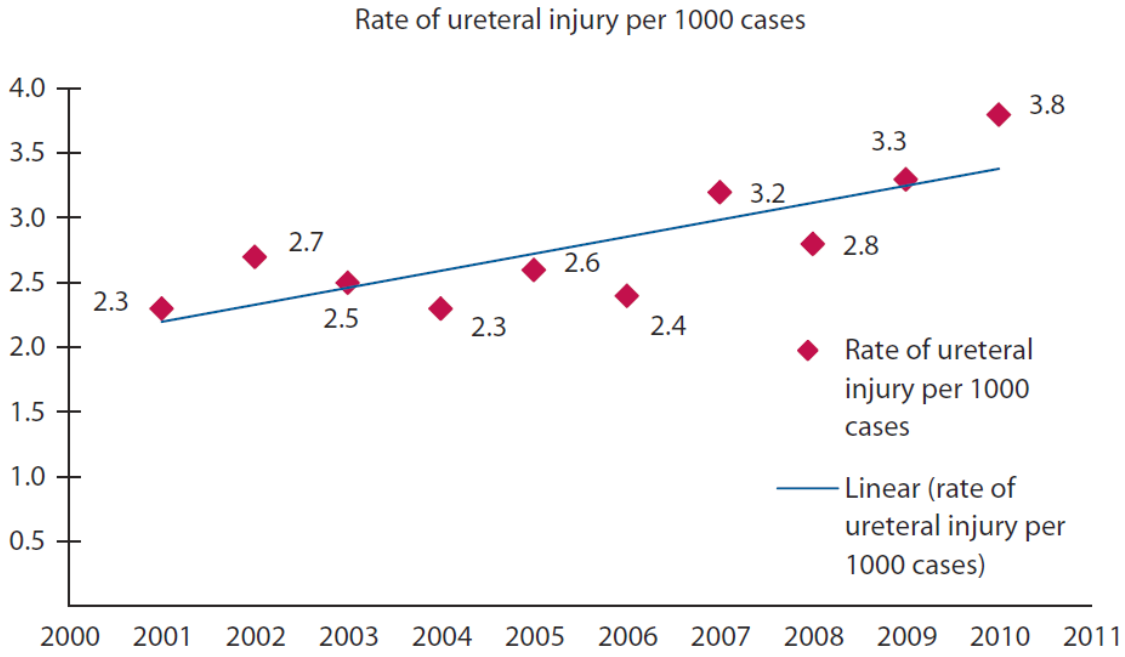

FIGURE 1. Trend of ureteral injuries in colon and rectal surgery.

Table 1 lists patient characteristics in each group. Patients with IUIs were slightly younger (63 years vs 64 years; $p < 0.05$), with a female predominance (56.26% vs 51.74%; $p < 0.01$). There was a higher percentage of blacks (8.40% vs. 6.87%; $p < 0.05$) and Medicaid patients (6.51% vs 4.01%; $p < 0.05$) in the IUI group. When examining different comorbidities, we found that patients with IUIs had lower incidences of major comorbidities, such as hypertension, diabetes mellitus, congestive heart failure, chronic pulmonary disease, and chronic kidney disease ($p< 0.05$). Patients with IUIs were more likely to have metastatic cancer, which includes lymph node and distant organ metastases (30.40% vs 15.72%; $p < 0.01$), and a history of recent weight loss or protein malnutrition (8.90% vs 5.25%; $p < 0.01$). They were also more likely to have a history of rheumatoid arthritis and other collagen vascular diseases necessitating the chronic use of steroids (2.39% vs 1.56%; $p < 0.05$).

TABLE 1. Patients characteristics in the ureteral injury and no-injury groups

	No injury	*Ureteral injury*	*p*
	2,159,821	*6027*	
Age, y	64 (54-76)	63 (53-73)	<0.05
Sex			
Male	48.26	43.74	<0.01
Female	51.74	56.26	
Ethnicity			
White	61.12	61.70	0.63
Black	6.87	8.40	<0.05
Hispanic	3.89	3.54	0.62
Other	2.77	3.13	0.29
Missing	25.34	23.23	
Primary payer			
Medicare	50.62	48.85	0.34
Medicaid	4.01	6.51	<0.01
Private	40.20	39.62	0.70
Other	5.02	4.86	0.85
Missing	0.15	0.16	
Comorbidities			
Anemia	14.06	15.65	0.12
Hypertension	40.83	37.56	0.02
Diabetes mellitus	14.00	9.72	<0.01
RA/CVD[a]	1.56	2.39	<0.05
Obesity	5.80	6.67	0.22
Congestive heart failure	6.25	4.70	<0.05
Chronic pulmonary disease	13.46	11.37	<0.05
Chronic liver disease	1.31	0.99	0.39
Chronic kidney disease	3.16	1.89	<0.01
Fluid and electrolyte disorders	17.89	21.09	<0.01
Peripheral vascular disorders	2.76	2.06	0.16
Metastatic cancer	15.72	30.40	<0.01
Weight loss	5.25	8.90	<0.01
Comorbidity scores[a]	4 (0–9)	6 (0–12)	<0.01

RA/CVD = rheumatoid arthritis/collagen vascular diseases.
Total numbers are reported in the second row. Continuous variables (age and comorbidity scores) are reported as mean and interquartile range, and categorical variables are reported as percent proportions.
[a] Data are based on the Elixhauser-Van Walraven model.[19]

Table 2 list the incidence of IUI in different hospital settings. IUIs occurred at higher rates in teaching as compared with nonteaching hospitals (3.4/1000 vs 2.3/1000; $p < 0.001$) and urban as compared with rural hospitals (2.8/1000 vs 2.3/1000; $p < 0.05$). Although no differences in IUIs were detected when comparing hospital sizes, on

post hoc analysis we found higher rates of ureteral injuries in large compared with small hospitals (2.8/1000 vs 2.3/1000; $p < 0.05$).

TABLE 2. Incidence of ureteral injuries in different hospital settings

	Ureteral injury per 1000 cases	*p*
Hospital type		
Teaching	3.4	<0.001
Nonteaching	2.3	
Hospital location		
Urban	2.8	0.03
Rural	2.3	
Hospital bed size		
Small	2.3	
Medium	2.8	0.13
Large	2.8	

Table 3 lists the incidence of IUI per 1000 cases rates per admission type, disease type, procedure type, surgery type, and the presence or absence of adhesions. Surprisingly, IUI rates were higher in elective as compared with urgent/emergent admissions (3.0/1000 vs 2.4/1,000; $p < 0.001$). When examining different disease types, we found that rectal cancer was associated with the highest rates of ureteral injuries (7.1/1000) followed by diverticular disease (2.9/1000), whereas benign colonic polyps had the lowest rates (0.9/1000). Cases completed laparoscopically had the lowest rate of ureteral injuries (1.1/1000), whereas converted cases had the highest rates of injuries (7.9/1000). However, when laparoscopic and converted cases were combined together on an intent-to-treat basis, there were no differences in IUI rates between laparoscopic and open procedures (2.5/1000 vs 2.8/1000; $p = 0.14$). The rates of IUI differed with respect to procedure types. Right and transverse colectomies had the lowest injury rates, whereas left-sided procedures carried higher rates. Pelvic procedures such as anterior resections and abdominoperineal resections had the highest rates of IUI. Finally, the presence of intraoperative adhesions was associated with a higher rate of IUI (5.5/1000 vs 2.4/1000; $p < 0.001$).

TABLE 3. Incidence of ureteral injuries according to admission type, disease type, surgery type, procedure type, and the intraoperative presence of adhesions

	Ureteral injury per 1000 cases	*p*
Admission type		
Elective	3.0	<0.001
Urgent/emergent	2.4	
Disease type		
Colon benign polyps	0.9	
Colon cancer	2.1	
Diverticular disease	2.9	
Crohn's disease	1.9	<0.001
Ulcerative colitis	1.7	
Rectal benign polyps	2.3	
Rectal cancer	7.1	
Surgery type		
Laparoscopic	1.1	
Converted	7.9	<0.001
Open	2.8	
Procedure type		
Right hemicolectomy	0.8	<0.001
Transverse colectomy	0.5	
Left hemicolectomy	2.8	
Sigmoidectomy	3.3	
Subtotal/total colectomy	3.5	
Anterior resection	5.8	
Abdominoperineal resection	7.6	
Proctocolectomy	2.6	
Adhesions		
Yes	5.5	<0.001
No	2.4	

Table 4 lists the unadjusted outcomes in the injury and no-injury groups. On univariate analysis, IUIs were associated with higher hospital charges ($81,870 vs $50,761; $p < 0.001$) and longer lengths of stay (13 vs 9 days; $p < 0.001$). There were also higher incidences of respiratory failure, anastomotic leak, acute renal failure, urinary tract infections, wound complications, and postoperative bleeding in the IUI group ($p < 0.05$).

TABLE 4. Postoperative outcomes in the ureteral injury and no-injury groups

	No injury	*Ureteral injury*	*p*
N	2,159,821	6027	
Total charge ($)	50,761 (22,265-56,484)	81,870 (35,590-91,053)	<0.001
Length of stay, d	9 (5-11)	13 (7-15)	<0.001
In-hospital mortality	2.73	3.30	0.26
Postoperative complications			
CVA	0.13	0.33	0.12
Cardiac complications	2.22	2.64	0.38
Pneumonia	3.66	3.71	1
Respiratory failure	5.25	6.75	0.02
Ileus/bowel obstruction	18.13	19.19	0.36
Anastomotic leak	13.76	17.38	<0.01
Acute renal failure	6.77	13.43	<0.01
UTI	5.07	9.80	<0.01
Urinary retention	2.05	1.40	0.14
DVT	0.48	0.58	0.78
Wound complications	5.24	9.23	<0.01
Postoperative bleeding	1.95	3.38	<0.01

CVA = cerebrovascular accident; UTI = urinary tract infection; DVT = deep venous thrombosis.
Total numbers are reported in the second row. Continuous variables (total charge and length of stay) are reported as mean and interquartile range, and categorical variables are reported as percent proportions.

On multivariate analysis, IUIs were associated with increased odds of mortality (OR, 1.45; $p < 0.05$), morbidity (OR, 1.66; $p < 0.001$), longer length of stay (mean difference, 3.65 days; $p < 0.001$), and increased hospital charges by $31,497 ($p < 0.001$; Table 5).

TABLE 5. Multivariate regression analysis examining the association of ureteral injuries with selected outcomes

	Adjusted OR/MD (95% CI)	*p*
Mortality	1.45 (1.01-2.68)	<0.05
Morbidity	1.66 (1.45-1.90)	<0.001
Length of stay, d	3.65 (2.94-4.36)	<0.001
Total charge, $	31,497 (26,053-36,942)	<0.001

MD = mean difference (for length of stay and total charge).
The no-injury group was used as a reference.

The LASSO algorithm for logistic regression found several predictors of ureteral injuries (Table 6), the strongest being rectal cancer (OR, 1.85), followed by adhesions (OR, 1.83). Metastatic cancer, weight loss, and teaching hospitals also appeared to be associated with a higher risk of IUI. The algorithm also found protective factors, such as the use of laparoscopy, transverse colectomy, and right hemicolectomy. The area under the curve of the receiver operating characteristic curve was 0.73. If all of the predictive factors are present together, the risk of IUI was 1.65%. On the other hand, a patient undergoing a laparoscopic right hemicolectomy has a risk of only 0.1%.

TABLE 6. Prediction model for ureteral injuries based on the LASSO

	Coefficient	*LASSO OR*
Intercept	–6.00	0.00
Predictive variables		
Rectal cancer	0.61	1.85
Adhesions	0.60	1.83
Metastatic cancer	0.57	1.76
Weight loss	0.08	1.08
Teaching hospital	0.05	1.05
Protective variables		
Laparoscopy	–0.10	0.91
Transverse colectomy	–0.11	0.90
Right hemicolectomy	–0.85	0.43

To calculate the predicted risk for ureteral injury, coefficients and the intercept can be added together if the scenario is true. For a coefficient total of x, the ureteral injury risk is ex/(1 + ex). ORs provided by the LASSO are statistically significant.

DISCUSSION

Ureteral injuries are rare complications in colon and rectal surgical procedures, occurring in only 0.28% of cases. Their incidence, however, appears to be increasing. Although it is difficult to determine the exact reasons behind this trend, the rising incidence of IUI over the past decade may be secondary to changes in the complexity of surgical cases. For example, in diverticular disease, which was the second most common diagnosis associated with IUI, patients were usually offered a sigmoidectomy after a second attack of diverticulitis.[20] However, because of the publications of several reports highlighting the successful conservative management of acute diverticulitis and the low recurrence rates of perforated diverticulitis managed nonoperatively,[21–23] newer practice guidelines were issued, recommending that the decision for elective sigmoidectomy be made on a case-by-case basis.[24] Thus, we can hypothesize that a larger number of complicated cases of diverticulitis are being referred for operative management. These cases would be complicated by the presence of intraoperative adhesions, a factor that we found to significantly increase the risk of IUI. In rectal cancer surgery, strong evidence in favor of preoperative chemoradiotherapy for the management of locally advanced disease started appearing in 2004.[25] Operating on an irradiated pelvis is challenging, which, along with the proximity of the ureters to the dissection plane, may lead to higher rates of IUI. Our prediction model found that rectal cancer and metastatic cancer cases were strong predictors of IUI. Metastatic cancer in the NIS data set includes ICD-9 codes for lymph node and distant metastasis, thus indicating advanced cancer stage and a higher likelihood of receiving preoperative chemoradiotherapy. We have to reiterate that these explanations remain tentative.

IUIs were independently associated with higher mortality, morbidity, length of stay, and hospital charges. To our knowledge, a multivariate regression analysis has not been performed previously for this type of complication because of its rare occurrence. These findings are important in view of the fact that patients with IUIs were relatively younger and had a lower incidence of major comorbidities. The reasons for the significantly worse outcomes associated with IUIs are related to the fact that several procedures are usually required to address this complication.[13] Moreover, a collection of urine in a fresh surgical field may cause fever, abdominal pain,[1,26] and sepsis, 27 which could also explain the worse outcomes in this group. The higher incidence of acute renal failure, urinary tract infection, wound complications, and anastomotic leak adds more evidence to the detrimental effects of IUIs.

The large numbers in our study enabled us to build a predictive model that revealed several predictive factors for IUI. These variables were significant enough to appear among all of the other variables included. Rectal cancer was the strongest predictor for IUI because of the close proximity of the ureters to the dissection plane. This finding agrees well with the bulk of the gynecologic literature that described a higher incidence of ureteral injuries in pelvic procedures as compared with abdominal ones. Adhesions were the second factor associated with IUIs. This finding confirms the observations made by smaller reports.[1,7,9,26] Metastatic cancer was another strong predictor of IUI. Cancer cases may involve bulky tumors and require extensive dissection to achieve adequate oncologic margins, all of which may increase the likelihood of ureteral injury.[1,2,26] Weight loss also appeared to be associated with higher rates of IUI. The codes used to build this variable include protein malnutrition and hypoalbuminemia, which may occur in the setting of cancer and in patients who have received chemoradiotherapy. The finding that teaching hospitals are associated with a higher rate of IUIs may be attributed to selection bias, because more complicated cases are usually referred to large teaching centers.

It is interesting to note that laparoscopy appeared in our model as a protective factor. Data examining the association of laparoscopy and IUIs are conflicting. Several authors have found that laparoscopy may increase the risk of IUIs,1,28,29 whereas others found no association [7,12,16] or even a decreased risk.[17] It may be the case that laparoscopy is used in simpler colonic cases or for benign disease[30] where the risk of IUI is already low. Because of the retrospective nature of our study, more evidence is needed to confirm this finding. Right and transverse colectomies were associated with lower rates of injuries, an effect significant enough to appear in the model as a protective factor. This finding can be explained anatomically and by the surgical indication itself: right and transverse colectomies are usually performed for benign polyps or colon cancer, which were associated with a lower incidence of IUI compared with diverticular disease.

Our predictive model can be used for risk stratification and patient counseling, especially in cases where the risk is elevated. Several variables that appeared on univariate analysis to be associated with IUI did not make it to the prediction model, because their effect was masked by more powerful predictors. Finally, it is interesting to note that elective admissions were associated with higher rates of IUI compared with urgent and emergent admissions. This variable, however, does not tell us whether the operation itself was performed emergently; therefore, strong conclusions cannot be made.

Our study is limited by its retrospective design and its inherent selection bias. The use of an administrative database may be prone to coding errors. The incidence of IUI may be underestimated, because the NIS provides information related to a single hospital stay. It is estimated that 12.5% to 65.0% of IUIs are discovered intraoperatively, [1,11,13,14,26] whereas 60.0% to 94.0% are detected during the index hospitalization.[11,14] The predictive power of our model was limited by the unavailabitiy of several variables, such as surgeon experience, which has been shown to affect the incidence of IUI,[31] and intraoperative bleeding, which may obscure tissue planes and lead to a higher rate of IUI.[26,32] Perhaps the most important factor that we were not able to account for was the prophylactic use of ureteral catheters, because the NIS database does not allow differentiation between catheters placed to prevent IUIs versus catheters placed for treatment. However, data are conflicting regarding whether prophylactic ureteral catheters lower the incidence of IUIs.[6,16,33] Ureteral catheter placement is not a risk-free procedure, because it may itself result in IUI.[34,35] Therefore, it is generally agreed that, whereas prophylactic ureteral catheters do not assure the prevention of IUIs, they may assist in their immediate recognition,[34] an important fact, because prompt recognition and treatment of IUI at the time of surgery is associated with less morbidity and renal failure compared with cases where diagnosis was delayed.[3,9] Ureteral catheters should be considered when extensive surgery is required.[36] Their presence should not supplant meticulous surgical techniques, direct visualization, and proper identification of the ureter at the pelvic brim.[37] The NIS does not provide information regarding whether injuries were detected intraoperatively or postoperatively, the site, or the type of ureteral injuries, such as partial or complete transection, ligation, or even excision. The latter may be required in cases where malignant tumors invade the ureters and would thus be intentional. However, this number is likely to be small and would not affect outcomes appreciably. Nevertheless, to our knowledge, this study is the largest investigating the incidence, trends, outcomes, and risk factors of IUIs in colorectal surgery.

CONCLUSION

Ureteral injuries are rare complications in colorectal surgery associated with significant mortality and morbidity. The increase in the length of stay of almost 4 days and increased charges of more than $31,000 in patients experiencing IUIs provide dramatic evidence of the significant impact that this type of injury has. Ureteral injuries occur at different rates depending on disease types, procedure types, and hospital settings. Although their incidence appears to be rising, knowledge of the associated risk factors may help in patient counseling and risk stratification. Because most of the risk factors cannot be modified, an increased awareness on the part of the surgeon, as well as meticulous technique, may help in reducing the incidence of IUIs.

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