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ORIGINAL ARTICLE

Perioperative Management of Patients with Colovesical Fistula

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Abstract

Background Colovesical fistula (CVF) is an uncommon complication of diverticulitis. Substantial heterogeneity exists in the perioperative management of this condition. We seek to evaluate the role of bladder leak testing, closed suction drainage, prolonged bladder catheter usage, and routine postoperative cystogram in the management of CVF.

Study Design This is a retrospective study from a single academic health center investigation patients undergoing operation for diverticular CVF from 2005 to 2015 ($n = 89$).

Results Patients undergoing operative repair for diverticular CVF resection had a mortality of 4% and overall morbidity of 46%. Intraoperative bladder leak test was performed in 36 patients (40%) and demonstrated a leak in 4 patients (11%). No patients with a negative intraoperative bladder leak test developed a urinary leak. Overall, five (6%) patients developed postoperative bladder leak. Three were identified by elevated drain creatinine and two by cystogram. The diagnostic yield of routine cystogram was 3%. All bladder leaks were diagnosed between postoperative day 3 and 7. Of patients with a postoperative bladder leak, none required reoperation and all resolved within 2 months.

Conclusions There is significant variability in the management of patients undergoing operation for CVF. Routine intraoperative bladder leak test should be performed. Cystogram may add cost and is low yield for routine evaluation for bladder leak after operation for CVF. Urinary catheter removal before postoperative day 7 should be considered.

Keywords Colovesical fistula · Diverticulitis · Cystogram

Abbreviations

CVF	Colovesical fistula
ICD	International Classification of Diseases
CT	Computed tomography
DC-SC	Drain creatinine to serum creatinine

Introduction

Colovesical fistula (CVF) is an uncommon condition defined by an abnormal connection between the bladder and colon. Diverticulitis accounts for 50–70% of cases of CVF.[1–7] Other etiologies for CVF include malignancy (~20%), Crohn's disease (~10%), iatrogenic fistula, trauma, and other less common conditions.[1–7] CVF is rarely self-limited and can be complicated by recurrent urinary tract infections (UTI), cystitis, pyelonephritis, urinary sepsis, and renal impairment, and as a result, operative management is the recommended treatment for CVF.[1,5–12]

After operative repair, there is a dearth of data on optimal postoperative management for patients with CVF. The role of routine postoperative cystogram is poorly defined without quality evidence to support its utilization.[10,13–15] Despite this, postoperative cystogram is commonly used in many surgeons' practices. The optimal duration of urinary catheter utilization is poorly understood with recommendations ranging from 7 days

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to greater than 2 weeks.[10,12,16] Prolonged urinary catheter duration is associated with complications including UTI, urine retention, and bladder atony; thus, minimizing urinary catheter duration, if safe, would be ideal.[10] Finally, there are no evidenced-based recommendations regarding the utility of intraoperative bladder leak testing or closed suction drainage in the setting of CVF.[17,18]

We seek to determine the ideal perioperative management of patients with diverticular CVF and evaluate the role of bladder leak testing, closed suction drainage, prolonged bladder catheter usage, and routine postoperative cystogram to create an evidenced-based treatment algorithm in the management of diverticular CVF.

We hypothesize that intraoperative bladder leak testing is associated with lower rates of postoperative bladder leak, and that routine cystogram is low yield for demonstration of postoperative bladder leak.

Materials and Methods

This is a single institution retrospective review of adult patients who underwent operative repair for CVF secondary to diverticulitis from January 2005 through December 2015. Appropriate institutional review board approval was obtained.

Patients with CVF were identified based on an International Classification of Diseases (ICD)-9 code of 596.1 or an ICD-10 code of N32.1. Charts for all patients identified from this search were then investigated and only patients with a fistula between the colon and bladder secondary to diverticular disease who underwent operative repair were included. Minimizing inclusion to diverticular CVF was designed to create a more homogeneous population of patients, as postoperative outcomes in CVF repair are different depending on etiology.[19]

Multiple preoperative, operative, and postoperative variables were recorded. Preoperative CVF-specific characteristics included etiology of fistula, method of fistula diagnosis, and location of fistula on colon. Operative characteristics included type of operation performed (colonic resection and anastomosis with or without proximal diversion vs colonic resection with end colostomy), operative approach (laparoscopic vs open), utilization of ureteral stents, location of fistula on bladder, utilization of intraoperative bladder test, utilization of closed suction drainage, and method of bladder repair. Intraoperative bladder leak tests, when performed, were either performed via instillation of saline mixed with methylene blue or sterile saline alone until adequate distension of the bladder was achieved (normally after about 250 mL of irrigating agent) or a defect was observed. Method of bladder repair was characterized based on who performed the repair (surgeon vs urologist), the type of repair performed (simple closure vs partial excision and repair), and whether an omental flap was used to buttress the repair. Postoperative information specific to CVF included the presence of a postoperative bladder leak, duration of bladder catheter drainage, utilization of postoperative cystogram, and values of postoperative drain and serum creatinine. Postoperative cystogram at our institution has routinely been performed under fluoroscopy after instillation of a radiopaque contrast agent into the urinary catheter via gravity with multiple views. Other postoperative information collected included length-of-stay, 30-day mortality, anastomotic leak, surgical site infection, postoperative sepsis, postoperative urinary tract infection (UTI) requiring antibiotics, postoperative ileus, or reoperation within 30 days. The date of last follow-up and whether the fistula recurred was also recorded.

Continuous variables are presented as mean values with standard deviation (SD) or median values with interquartile range (IQR) depending on the normality of the variable. Univariate data analysis was performed with chi-squared, Fisher's exact, or Wilcoxon Rank Sum tests as appropriate. All analyses were performed with SAS version 9.4 (Cary, NC).

Results

Demographics, Comorbidities, and Method of Diagnosis

During the study period, 89 patients underwent operation for diverticular CVF. Patients were on average 63 ± 13 years old, had a BMI of 28 (IQR 23–34), and were more commonly male (61%) (Table 1).

The diagnosis of CVF was made by CT scan in the majority of patients (92%). Other methods of diagnosis included colonoscopy (40%), cystoscopy (31%), barium enema (13%), poppy seed test (1%), or intraoperatively (1%). Those patients without diagnostic colonoscopy to exclude malignancy had undergone recent colonoscopy prior to CVF which was deemed adequate to exclude malignancy. Fistulas were primarily a communication between the sigmoid colon and the

Table 1 Preoperative characteristics of patients with diverticular colovesical fistula

Preoperative characteristics	
Age (years, mean ± standard deviation)	63 ± 13
Gender (% male)	60.7%
Body mass index (median, IQR)	28 (23–34)
Charlson comorbidity index, %	
0	47.2%
1	15.7%
≥2	37.1%
ASA, %	
2	27.0%
3	56.2%
4	16.9%

Table 2 Operative characteristics of patients undergoing repair of diverticular colovesical fistula

Operative characteristics	
Operation performed, %	
Colonic resection and anastomosis without diversion	75.3%
Colonic resection and anastomosis with diversion	7.9%
Colonic resection with end colostomy	16.9%
Operative approach (% laparoscopic)	40.5%
Fistula location on bladder, %	
Dome	64.4%
Body	33.6%
Bladder repair performed, %	74.2%
Type of bladder repair performed, %	
Simple closure	72.7%
Partial excision and repair	27.3%
Team to perform bladder repair, %	
Surgical	62.1%
Urological	37.9%
Intraoperative bladder test performed, %	40.5%
Postoperative closed-suction drain utilized, %	71.9%
Omental flap performed, %	55.1%
Ureteral stents performed, %	65.2%
Operative time (minutes, mean ± standard deviation)	239 ± 84

dome of the bladder (64%), but a substantial number of fistulas involved the body of the bladder (36%).

Operative Information

A total of 23 attending surgeons performed at least 1 repair of a CVF. The highest volume surgeons at our institution performed 22, 9, 6, and 5 repairs over the study period. The repair was most commonly a colectomy with primary anastomosis (75%), followed by colectomy with end colostomy (17%) and then colectomy with anastomosis and proximal diversion (8%). Laparoscopy was commonly used (40% of cases) (Table 2).

A bladder repair was performed in 66 cases (74%). When performed, it was more commonly performed by the colorectal or general surgeon (62%) compared to a urologist. If performed, the repair involved a simple suture closure in 72% of the cases ($n = 48$) and a partial excision and repair in 27% of the cases ($n = 18$). An omental flap was used in 55% of the cases. A closed suction drain was utilized 71% of the time.

Bladder Leak

Five patients (6%) had a postoperative bladder leak. Details of these patients are shown in Table 3. All patients had a suspicion for bladder leak by postoperative day 7. All resolved with continued bladder drainage and abdominal drainage with the exception of one patient who died due to unrelated causes.

Bladder Leak Testing

An intraoperative bladder test was performed 40% ($n = 36$) of the time. Four patients had an abnormal intraoperative bladder test (11%), and they all underwent a simple suture repair of the revealed defect. One of these patients still had a postoperative bladder leak. Thus, 2.7% of patients with intraoperative bladder leak testing eventually had a persistent bladder leak compared with 7.6% of patients without bladder leak testing (p value = 0.64). No patients with a normal intraoperative bladder leak test developed a postoperative bladder leak.

Closed Suction Drainage

Patients with a drain had a similar rate of bladder leak to those without a drain (6.3% vs 4.0% respectively; p value = 1.0). Patients with a closed suction drain without a bladder leak had the drain removed on postoperative day (POD) no. 7 on average (IQR 5–11; range 3–47 days). Patients with a closed suction drain with a bladder leak had the drain removed on POD no. 35 on average (IQR 15–40).

Eighteen patients (28%) had a drain creatinine checked prior to removal. In patients without a bladder leak, the drain creatinine to serum creatinine (DC-SC) ratio was on average 1.1 with a range of 0.9–1.82 compared to 12.0 with a range of 0.9–18.9 in patients with a bladder leak. If a cutoff of 2.0 for a DC-SC ratio was used to identify patients with bladder leak, no patients would have been inappropriately classified as having a bladder leak (specificity = 100%). One patient who had very high volume drain output and end-stage liver disease had an initial DC-SC ratio that was normal (0.88) on POD no. 5. On POD no. 15, this patient's DC-SC was elevated (> 10). Thus, the DC-SC ratio correctly initially identified 3 out of 4 bladder leaks for which it was utilized (sensitivity = 75%). The positive and negative predictive value of the DC-SC ratio was 100% and 93% respectively.

Routine Postoperative Cystogram

Sixty-seven patients had a cystogram (75%). This demonstrated a bladder leak in four patients. However, the diagnosis of bladder leak was already made by an elevated DC-SC ratio in two of the four patients with a positive cystogram. In these patients, the cystogram was used to evaluate the size of the leak or for resolution of the leak. In only two patients was the diagnosis of CVF initially made by cystogram (3%, $n = 2/67$).

Foley Cather Management

Patients without a bladder leak had their Foley catheter removed on POD no. 8 on average (IQR 6–11). Patients with a bladder leak had their Foley catheter removed on POD no. 36 on average (IQR 31–43). Increased length of Foley catheter

Table 3 Characteristics of patients who had postoperative bladder leak

POD of diagnosis	Abdominal drainage at operation	Method of diagnosis	Additional diagnostic test	Treatment of leak	Resolution of leak	Length of time to resolution	Additional information
7	Yes	Drain creatinine	CT scan	Continued urinary catheter and drain. Serial cystograms.	Yes	6 weeks	
3	Yes	Drain creatinine	NA	Continued urinary catheter and drain.	NA	NA	Developed fulminant liver disease and died from this prior to resolution of bladder leak.
11	Yes	Drain creatinine	Cystogram	Continued urinary catheter and drain. Serial cystograms.	Yes	8 weeks	Urine with significant sediment on POD no. 1. CT with pelvic fluid collection on POD no. 7
6	No	Cystogram	None	Continued urinary catheter. Serial cystograms.	Yes	6 weeks	
7	Yes	Cystogram	Drain creatinine	Continued urinary catheter and drain. Serial cystograms.	Yes	4 weeks	Very high output from drain (900 mL/day). Initial drain creatinine on POD no. 5 was normal

POD postoperative day

duration was associated with increased odds of UTI. For every 5 additional days of Foley catheter duration, the odds of UTI increased by 52% (odds ratio = 1.52; 95% confidence interval 1.12–2.07). Increased Foley catheter duration was also significantly associated with increased length of stay, wherein each additional day of Foley catheter utilization was associated with a 0.5 day increased length of stay ($R^2 = 0.38$, p value < 0.01). Amongst patients without bladder leaks, patients discharged with a Foley catheter had the catheter in place for an additional 4.5 days compared with patients who had the Foley catheter removed prior to discharge (6.5 days vs 11.0 days, p value < 0.01).

Minimally Invasive Procedures

Thirty-six (40%) of the diverticular CVF repairs were performed laparoscopically. No patients with a laparoscopic repair developed a bladder leak (0.0% vs 9.4%, p value = 0.08). Fewer patients undergoing a laparoscopic procedure required a bladder repair (61% vs 83%, p value = 0.02). Amongst patients who required a repair, the bladder repair was more likely to be a simple closure (rather than a partial excision and repair) if the operation was performed laparoscopically (91% vs 64%, p value = 0.02). Overall morbidity was significantly lower in patients with a laparoscopic repair (33.3% vs 54.7%, p value = 0.05). In patients without a bladder leak, patients with a laparoscopic repair had a 2-day shorter Foley duration (7 vs 9 days, p value = 0.06) and a 3-day shorter length of stay (6 days vs 9 days, p value < 0.001).

Operative Approach

The rate of bladder leakage was significantly lower in patients who underwent colonic resection and anastomosis compared with patients who underwent colonic resection with end colostomy (2.7% vs 20.0%, p value = 0.03). There was not a statistically significant difference in overall morbidity between approaches (43.2% in primary anastomosis vs 60.0% in end colostomy, p value = 0.24). All anastomotic leaks occurred in patients with colonic resection and anastomosis without proximal diversion (7.5%, $n = 5/67$).

Bladder Repair Techniques

The rate of bladder leak was similar whether an omental flap was used or not (6.1% vs 5.0% respectively, p value = 1.0). If ureteral stents were used, there was a significantly decreased rate of bladder leak (1.7% vs 12.9%, p value = 0.05). There were no ureteral injuries in either group. There was no significant difference in bladder leak rates if a bladder repair was performed or not (4.6% vs 8.7% respectively, p value = 0.60). In patients who had a bladder repair, there was no difference in the bladder leak rate if the surgery or urology team performed the repair (2.4% vs 8.0%, p value = 0.55). There was no difference in bladder leaks if a simple suture closure or partial excision and repair were performed (4.2% vs 5.6% respectively, p value = 1.0). Urologists were more likely to perform a partial excision and repair compared with surgeons (68.0% vs 2.4% respectively, p value < 0.001). If urology performed the repair, the Foley catheter was left in place for 4 days longer on average after excluding patients who had a bladder leak (10 vs 6 days, p value < 0.001).

Long-Term Follow-Up

The median duration of follow-up was 15 months (IQR 2–46 months). One patient experienced a CVF recurrence. This

recurrence was detected on POD no. 6 and resolved with continued bladder drainage.

Discussion

This series represents the largest series on the management of patients with diverticular CVF and provides evidence regarding the utilization of bladder leak testing, closed-suction drainage, postoperative cystogram, Foley catheter, minimally invasive approaches, and different operative approaches to the diseased colon and hole in the bladder. Data from this study and a literature review were combined to create a treatment algorithm (Fig. 1).

Based on this data, all patients undergoing repair for diverticular CVF should undergo intraoperative bladder leak testing. This recommendation is for two reasons. First, if the bladder leak test is negative, there were no patients who went on to develop a bladder leak. Thus, a negative bladder leak test may be used as a criterion to not place a closed-suction drain and not perform postoperative cystography. This finding is concurrent with the urologic literature, in which it has been found that a negative intraoperative leak test in patients undergoing vesicourethral anastomosis obviated the need for cystography prior to Foley removal.[17] Second, positive bladder leak tests changed patient management. While one patient still had a bladder leak after repair of a visualized defect, three patients were spared the morbidity of prolonged Foley catheter drainage and closed suction drainage as a result of detecting a previously not visualized bladder leak at the time of the initial surgery.

Patients with a positive bladder leak test should be considered for closed-suction drainage. Closed-suction drainage has been found to not routinely be required in patients with low pelvic anastomoses.[20,21] However, there may be benefits to closed-suction drainage in patients at highest risk for postoperative bladder leak who are selected via bladder leak testing. In particular, the drain creatinine to serum creatinine ratio was found to be useful in identifying bladder leaks with a positive and negative predictive value of 100% and 93% respectively. Thus, rather than obtaining a more costly and invasive postoperative cystogram, a DC-SC is an effective method in high-risk patients to rule out or diagnose a bladder leak.

Regarding duration of Foley catheter utilization, this study provides strong evidence for Foley catheter removal prior to POD no. 7, possibly prior to POD no. 5, and certainly prior to discharge. All patients with bladder leak were discovered to have a bladder leak by POD no. 7. Additionally, there was a suspicion of bladder leak or anastomotic leak in all patients by POD no. 5 based on exceptionally cloudy and brownish Foley drainage, high closed-suction drainage output, or failure to progress as expected. Prolonged Foley catheter duration in this study was associated with increased catheter-associated UTI rates and increased length of stay. Thus, early removal is preferred. The current literature is congruent with a recommendation for Foley catheter removal prior to POD no. 7.[10,16,22,23]

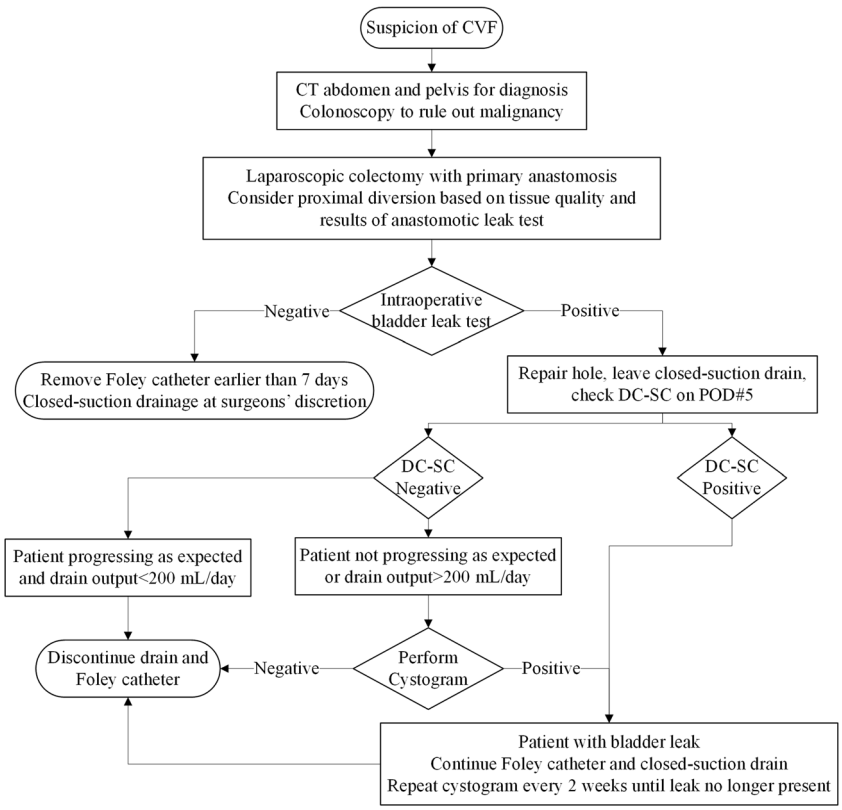

Fig. 1 Algorithm for management of colovesical fistula. DC-SC = drain creatinine to serum creatinine

This study provides strong evidence on the safety and potential beneficial aspects of a minimally invasive operative approach to patients with CVF. No patients with a laparoscopic approach had a bladder leak. This may be a result of selection bias as patients undergoing laparoscopic repair had a lower rate of bladder repair and were more amenable to a simple repair when required. The overall morbidity and hospital length of stay in patients with a minimally invasive approach were significantly lower than patients with an open approach. Smaller case series have shown that laparoscopy in the setting of CVF is safe and well tolerated, but these series were either very small (5 patients or less) or included all types of CVF.[24–29] Thus, this study adds evidence to use laparoscopy in these complex cases.

This study also adds evidence that a primary anastomosis in the setting of CVF is safe and well tolerated. However, the anastomotic leak rate amongst patients with primary anastomosis without proximal diversion was 7.5% in this series. This rate is near the highest in the current literature.[5,11,12,21] Given the high rate of anastomotic leak, proximal diversion should be considered based on the difficulty of dissection, the comfort of the surgeon, and the results of the anastomotic leak test.

In regard to the management of the bladder, these results show that if a defect in the bladder is not identified and the bladder leak test is negative, there is no need for further assessment, which is consistent with the current literature.[12,16,23] These results demonstrate that general and colorectal surgeons are capable of repairing bladder injuries with similar outcomes to urologists, although referrals to urologist in this series were likely in the setting of more complex anatomical defects, as demonstrated by the increased rate of partial excision and repair in that subgroup. Deciding to perform a simple repair or a partial excision and complex repair should be based on the patient anatomy and size of the defect.

These findings need to be viewed in light of limitations inherent in this method of investigation. While this is the largest series investigating the treatment of diverticular CVF, it still suffers from possible bias and confounding. There was a great deal of heterogeneity in the perioperative management based on who the attending surgeon was with no standard care pathway. Twenty-three different attending surgeons were involved in repair of the CVF, which explains the lack of a standard pathway of intraoperative or postoperative management. Comparisons of operative approaches and techniques outside of a randomized trial can be plagued with selection bias wherein the healthiest patients with favorable anatomy and pathology are selected for laparoscopy and primary anastomosis, whereas the most complicated patients are selected for open colectomy with end colostomy, which is a risk in this study. This study also has low power given the rarity of this condition.

Conclusions

This study, in conjunction with prior case series, forms the basis for an evidenced-based algorithm for management of patients with CVF. Utilization of this algorithm has the potential to decrease morbidity, expedite Foley catheter removal and hospital discharge, and reduce hospital cost via decreased utilization of closed-suction drainage, decreased utilization of postoperative cystography, and reduced length-of-stay. Future studies will aim to validate this algorithm in a prospective fashion.

Author Contribution Dr.'s Dolejs, Penning, Guzman, Fajardo, Holcomb, Robb, and Waters made substantial contributions to the conception of the work, revising the work for important intellectual content, final approval of the version to be published, and agree to be accountable for all aspects of the work. Dr.'s Dolejs, Penning, and Waters made substantial contributions to the acquisition, analysis, and interpretation of data and drafting the work.

Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflict of interest.

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