Avoiding the Need for Bowel Anastomosis during Pelvic Exenteration—Urinary Sigmoid or Descending Colon Conduit—Short and Long Term Complications

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OBJECTIVE To educate surgeons of distal colon urinary diversion as an alternative to ileal conduit. To assess perioperative outcomes of distal colon conduit in pelvic exenteration including conduit-related, gastrointestinal, infectious, metabolic, and wound complications within 30 days, 31-89 days, and greater than 90 days from the time of surgery.

MATERIALS AND METHODS Forty-one patients who underwent distal colon urinary diversion for malignancy, fistula, or neurogenic bladder were identified in our IRB approved database from 1/2007 to 7/2017.

RESULTS Twenty-six (63.4%) were male with mean age of 54.1 years. Complications were stratified by early (≤30 days), intermediate (31-89 days), and late (≥90 days). Within 30 days, 2 (4.9%) had partial small bowel obstructions requiring nasogastric tube (NGT) placement and total parenteral nutrition (TPN); 8 (19.5%) prolonged ileus with 6 (14.6%) requiring TPN and 5 (12.2%) requiring NGT placement; 1 (2.4%) enterocutaneous fistula; 1 (2.4%) conduit hemorrhage, 10 (24.4%) treated urinary tract infections (UTIs). Between 31 and 89 days, 1 patient (2.4%) had urinary conduit leak and 3 (7.3%) treated UTIs. At ≥90 days, 2 (4.9%) had partial small bowel obstructions requiring NGT placement, 4 (9.8%) ureterocolonic strictures and 1 (2.4%) parastomal hernia, 3 (7.3%) treated UTIs. Readmission rate in ≤30 days was 10 (24.4%), 31-89 days was 13 (31.7%), and 90+ days was 16 (39%). Long-term metabolic complications at ≥90 days included 16 (39%) with hypokalemia, 10 (24.4%) with hyperchloremia, and 14 (34.1%) with metabolic acidosis.

CONCLUSION Distal colon urinary conduit is a relatively safe and feasible option and obviates the need for small bowel anastomosis and possible associated complications. UROLOGY 129: 228–233, 2019. © 2019 Elsevier Inc.

Radical cystectomy is a component of pelvic exenteration for advanced malignancy or fistula following radiation. Formation of a urinary conduit and colostomy for diversion of urine and fecal flow is a critical aspect of reconstruction following pelvic exenteration.[1] In general, any segment of bowel can be used to form a urinary conduit, but the distal ileum or transverse colon is utilized most commonly.[2-4] When an established colostomy exists from prior surgery or when a concomitant end colostomy is required, a descending or sigmoid colon has been utilized, particularly if the terminal ileum is grossly damaged by radiotherapy.[5] By utilizing the descending colon or sigmoid colon immediately distal to the end colostomy, no small or large bowel anastomosis is required, which may negate possible complications. While distal colon diversion is not a new surgical technique, many contemporary surgeons are unfamiliar with this technique and often utilize distal ileum out of familiarity.

Pelvic exenteration has a high-rate of complications including perioperative mortality of 0%-12% and %%complication rate of 50-85% in patients.[6-8] Complications that can occur following pelvic exenteration that are associated with urinary diversion include ureteric stricture, conduit leak, urinary obstruction, intestinal anastomotic breakdown, fistula, infection, and metabolic abnormalities.[6,9] Complications related to bowel anastomosis include bowel leak, anastomotic breakdown, and bowel obstruction.[6] Distal ileal and sigmoid colon

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conduits in the setting of pelvic exenteration have been shown to have similar rates of complications related to the conduit.[4] Bowel related complications, however, are less frequent with colon conduit without bowel anastomosis compared to separate colostomy with urinary diversion requiring bowel anastomosis.[6]

There is a paucity of data, particularly contemporary, in the literature specifically evaluating the rate of complications following pelvic exenteration with colon conduit. The aim of this study was to assess perioperative outcomes including conduit-related, gastrointestinal, infectious, and wound complications within 30 days, 31-89 days, and 90 days or greater from the time of surgery.

MATERIALS AND METHODS

This is a retrospective review of patients undergoing incontinent sigmoid or descending colon urinary diversion with curative intent by 4 physicians from 2007 through 2017, either alone or at the time of pelvic exenteration. Institutional Review Board approval was obtained for this study. Indications for surgery included malignancy, fistula, or neurogenic bladder. There were no exclusion criteria.

Description of Surgery

All patients received a bowel prep, however, surgeon preference was used in regards to specific type of bowel prep, such as mechanical or antibiotic or both, given different patient characteristics and lack of standardized recommendations. Patients underwent exploratory laparotomy with total pelvic exenteration including removal of the bladder and rectum if not already removed prior. In men, the prostate and in females, the uterus and anterior vagina were removed. After exenteration, attention was turned to the urinary and fecal diversion (Figure 1). In patients who already had an end colostomy, the colon was traced proximally and based on the blood supply the bowel was divided with a stapler. The more distal colon was then used as a colon urinary conduit and the more proximal segment was brought up as a new end colostomy. Care should be taken to ensure adequate blood supply to the colon conduit, possibly with use of doppler, especially if the patient has had prior colon surgery or the inferior mesenteric artery has been taken, as the blood supply is more tenuous. In patients undergoing resection of the rectum de novo, the sigmoid was transected as distally as possible with a stapler. The blood supply to the distal sigmoid was maintained if possible and the bowel was transected proximal to the inferior mesenteric artery. This distal segment of sigmoid was used as the urinary conduit and the proximal segment of bowel was brought up as an end colostomy. The conduit can be oriented in either peristaltic or anti-peristaltic direction, depending on which end reaches the skin more easily, as this does not affect urine flow in a similar manner as an ileal conduit. In general, a slightly longer segment than what is used for an ileal conduit is harvested due to greater muscular contracture of the colon. The ureters were then anastomosed to the urinary colon conduit in a standard refluxing Bricker technique and the other end was brought through the skin and everted in a standard Brooke fashion.

Data Collection

From medical records, following preoperative information was abstracted: age, race, sex, body mass index, ASA score, comorbidities for Charlson score, history of pelvic surgery, previous urostomy, previous colostomy, history of pelvic radiation, preoperative laboratory values, smoking history, and surgical indication. For oncologic indications, neoadjuvant and adjuvant therapy along with TNM staging information was abstracted. Perioperative information that were abstracted include: date of operation, type of operation (diversion alone or concomitant diversion and pelvic exenteration), intraoperative blood loss, intraoperative and postoperative packed red blood cells transfusion, length of operation, length of stay, date of initiation of solid diet postoperatively, and discharge serum creatinine. The following postoperative information was abstracted for ≤30 days, 31-89 days, 90+ days: number of readmissions, date of discharge, readmission related to operation, packed red blood cell transfusions, urinary complications, gastrointestinal complications, metabolic complications, infectious complications, wound dehiscence, and death. All postoperative complications were classified by Clavien-Dindo system. The date of the last relevant clinical follow-up or death was recorded. Follow-up was limited to clinical notes and correspondence contained in the medical record. All the complications were recorded if noted on routine imaging or by symptomatology. We defined significant conduit-related complications as conduit leak, ureteral anastomotic leak, conduit stricture, conduit obstruction, conduit hemorrhage, and parastomal hernia.

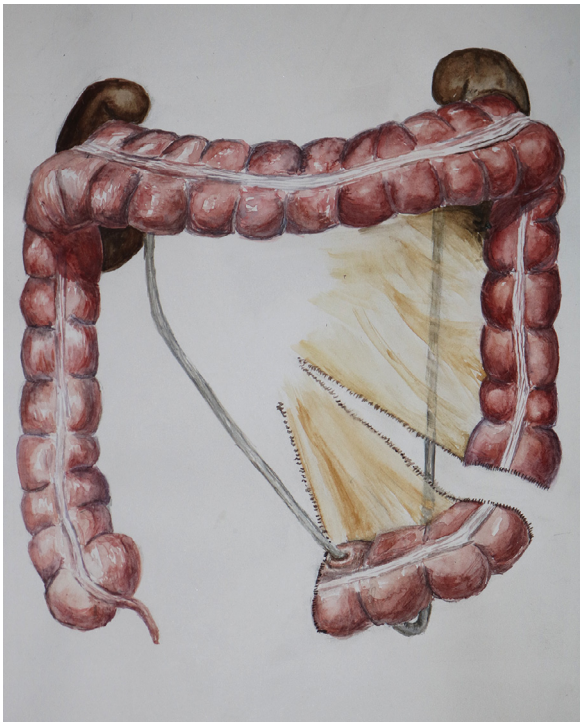

Figure 1. Sigmoid conduit urinary diversion (Illustration by Hannah Williams, BA).

RESULTS

Demographics

Forty-one patients underwent pelvic exenteration and urinary colon conduit (Table 1). The indications for surgery included

Table 1. Demographics

Number of patients, *n*	41
Age (years), mean (SD)	54.1 (12.3)
Follow-up (months), mean (SD)	16.9 (26.2)
Race	
White, *n* (%)	30 (77)
Black, *n* (%)	9 (23)
Unknown, *n* (%)	2 (4.9)
Gender	
Male, *n* (%)	26 (63.4)
Female, *n* (%)	15 (36.6)
Baseline characteristics	
BMI (kg/m^2), mean (SD)	26.3 (5.7)
Current smoker, *n* (%)	12 (29.3)
Diabetes, *n* (%)	7 (17.1)
HTN, *n* (%)	14 (34.1)
CAD, *n* (%)	3 (7.3)
ASA score	
1	0 (0)
2	11 (26.8)
3	29 (70.7)
4	1 (2.4)
5	
Charlson Comorbidity Index	
0	3 (7.3)
1	2 (4.8)
2	9 (22)
3	11 (26.8)
4	3 (7.3)
5	8 (19.5)
6	1 (2.4)
7	2 (4.9)
8	2 (4.9)
Preoperative labs	
Creatinine (mg/dL), mean (SD)	1.2 (0.9)
Hemoglobin (g/dL), mean (SD)	11.1 (2.2)
Albumin (g/dL), mean (SD)	3.5 (0.7)
Neoadjuvant radiation, *n* (%)	13 (31.7)
Neoadjuvant chemotherapy, *n* (%)	15 (36.5)
Previous pelvic radiation, *n* (%)	19 (46.3)
Previous pelvic surgery, *n* (%)	23 (56.1)
Previous colostomy, *n* (%)	12 (29.3)
Indication for surgery, *n* (%)	
Rectal cancer	9 (22.0)
Colon cancer	1 (2.4)
Bladder cancer	9 (22.0)
Prostate cancer	5 (12.2)
Cervical cancer	1 (2.4)
Appendiceal cancer	1 (2.4)
Neurogenic bladder	7 (17.1)
Fistula	14 (34.1)

rectal cancer (9, 22.0%), colon cancer (1, 2.4%), bladder cancer (9, 22.0%), prostate cancer (5, 12.2%), cervical cancer (1, 2.4%), appendiceal cancer (1, 2.4%), neurogenic bladder (7, 17.1%), and fistula (14, 34.1%), 9 (75%) of which are radiation induced. Some patients had multiple indications for surgery. Twenty-six (63.4%) were male, mean age was 54.1 years and mean body mass index of 26.3. Nineteen (46.3%) had history of prior pelvic radiation and 23 (56.1%) had a history of prior pelvic surgery, 15 (36.5%) received neoadjuvant chemotherapy. Eleven (26.8%) had ASA 2, 29 (70.7%) had ASA 3, and 1 (2.4%) had ASA 4. Three (7.3%) had Charlson comorbidity index of 0, 2 (4.9%) had score of 1, 9 (22%) had score of 2, 11 (26.8%) had score of 3, 3 (7.3%) had score of 4, 8 (19.5%) had score of 5, 1 (2.4%) had score of 6, 2 (4.9%) had score of 7 and 8 each. Seven patients (17.1%) had diabetes and 14 (34.1%) had hypertension and 3 (7.3%) had coronary artery disease. The mean preoperative creatinine was 1.2, preoperative hemoglobin was 11.1, and preoperative albumin was 3.5. Mean postoperative follow-up was 16.9 months.

Perioperative Outcomes

Average length of operation was 9 hours and 10 minutes with mean intraoperative blood loss of 922.5 mL and average intraoperative RBC transfusions of 2.2 units. Six patients underwent diversion alone, 35 patients underwent pelvic exenteration and diversion. The average length of stay was 15 days with a mean of 8 days to initiate solid diet. The mean change in creatinine at discharge compared to pre-op was −0.2.

Conduit-related Complications and Surgical Morbidity

The primary outcome for this study was the rate of significant conduit-related complications at ≤30 days, 31-89 days, and 90+ days (Table 2). Of 41 patients, 1 (2.4%) experienced a significant conduit-related complication within 30 days postoperatively, 1 (2.4%) at 31-89 days, and 5 (12.2%), at 90+ days, for an overall rate of 17.1%. There was 1 patient (2.4%) with conduit hemorrhage within 30 days. One patient (2.4%) developed conduit leak within 31-89 days. There were no ureteral anastomotic leaks. There were 4 (9.8%) patients with ureteral strictures that occurred at 90+ days, with average onset of 3.08 years There was 1 patient (2.4%) with parastomal hernia at 90+ days .

Gastrointestinal complications included 11 (286.%) who developed prolonged ileus, small bowel obstruction (SBO) or enterocutaneous fistula within 30 days and 2 (4.9%) developed SBO at 90+ days. Of the 8 (19.5%), who developed prolonged ileus within 30 days, 6 (14.6%) required total parenteral nutrition (TPN) and 5 (12.2%) required nasogastric tube (NGT) placement. Of the 2 (4.9%) developing SBO within 30 days, both required NGT placement and TPN. One who had received neoadjuvant radiation and chemotherapy for recurrent rectal cancer developed an enterocutaneous fistula within 30 days and was conservatively managed with dressing changes and TPN. Of the 2 (2.9%) who developed SBO at 90+ days both were treated with temporary NGT placement and no further intervention was required.

Overall, 21 (51%) experienced an infectious complication within 30 days postoperatively, 9 (22.0%) from 31-89 days, and 14 (34.1%) at 90+ days. Of infectious complications within 30 days, 10 (24.4%) had urinary tract infection, 7 (17.1%) had sepsis, 3 (7.3%) had abscess requiring drainage, 1 (2.4%) had superficial wound infection, and 1 (2.4%) had pyelonephritis. Of infectious complications from 31-89 days, 3 (7.3%) were treated UTIs, 3 (7.3%) were superficial wound infections, 2 (4.9%) were drained abscesses, and 1 (2.4%) had sepsis. Of infectious complications 90+ days, 4 (9.8%) had sepsis, 4 (9.8%) had drained abscesses, 3 (7.3%) had pyelonephritis, and 3 (7.3%) had treated UTIs.Wound dehiscence occurred in 3 patients (7.3%) within 30 days postoperatively, 2 patients (4.9%) at 31-89 days, and 2 patients (4.9%) at 90+ days.

Readmission related to the operation was 10 (24.4%), 13 (31.7%), 16 (39.0%) at ≤30 days, 31-89 days and 90+ days, respectively. For ≤30 days, 4 (40%) readmissions were due to GI complications, 5 (50%) infectious causes, and 1 (10%) wound complication. For 31-89 days, 2 (15.4%) of readmissions were due to significant conduit related complications, 2 (15.4%) metabolic abnormalities, 4 (30.8%) infectious complications, and 4 (30.8%) wound complications. For 90+ days, 2

Table 2. Conduit-related complications and surgical morbidity

	<30 days, *n* (%)	31-89 days, *n* (%)	90+ days, *n* (%)
Significant-conduit related, *n* (%)	1 (2.4)	1 (2.4)	5 (12.2)
Conduit leak	0	1 (2.4)	0
Ureteral anastomotic leak	0	0	0
Ureteral stricture	0	0	4 (9.8)
Conduit obstruction	0	0	0
Conduit hemorrhage	1 (2.4)	0	0
Parastomal hernia	0	0	1 (2.4)
Gastrointestinal complications, *n* (%)	11 (26.8)	0	2 (4.9)
Ileus	8 (19.5)	0	0
TPN	6 (14.6)	0	0
NG tube	5 (12.2)	0	0
Small bowel obstruction	2 (4.9)	0	2 (4.9)
TPN	2 (4.9)	0	0
NG tube	2 (4.9)	0	2 (4.9)
Enterocutaneous fistula	1 (2.4)	0	0
Infectious, *n* (%)	21 (51)	9 (22)	14 (34)
Drained abscess	3 (7.3)	2 (4.9)	4 (9.8)
Wound infection	1 (2.4)	3 (7.3)	0
Pyelonephritis	1 (2.4)	0	3 (7.3)
Treated UTI	10 (24.4)	3 (7.3)	3 (7.3)
Sepsis	7 (17.1)	1 (2.4)	4 (9.8)
Wound dehiscence	3 (7.3)	2 (4.9)	2 (4.9)
Readmission related to operation	10 (24.4)	13 (31.7)	16 (39)
Metabolic abnormalities, *n* (%)	31 (75.6)	14 (34.1)	19 (46.3)
Hyperchloremia	17 (41.5)	4 (9.8)	10 (24.4)
Metabolic acidosis	19 (46.3)	11 (26.8)	14 (34.1)
Hypokalemia	25 (61)	10 (24.4)	16 (39)
Clavien-Dindo Classification, *n* (%)			
Class I	4 (9.8)	0	3 (7.3)
Class II	31 (75.6)	8 (19.5)	12 (29.3)
Class IIIA	3 (7.3)	1 (2.4)	6 (14.6)
Class IIIB	1 (2.4)	2 (4.8)	5 (12.2)
Class IV	0	0	0
Class V	1 (2.4)	0	0

(12.5%) readmissions were due to significant conduit related complications, 4 (25%) GI complications, and 10 (62.5%) infectious complications.

The complications classified by Clavien-Dindo are reported in Table 2. Within 30 days postoperatively, 4 (9.8%) had Class I, 31 (75.6%) had Class II, 3 (7.3%) had Class IIIa, 1 (2.4%) had Class IIIb, and 1 (2.4%) had Class V complications. From 31-89 days, 8 (19.5%) had Class II, 1 (2.4%) had Class IIIa, and 2 (4.8%) had Class IIIb complications. For 90+ days, 3 (7.3%) had Class I, 12 (29.3%) had Class II, 6 (14.6%) had Class IIIa, and 5 (12.2%) had Class IIIb complications.

Metabolic Abnormalities

Within 30 days, 17 (41.5%) had hyperchloremia, 19 (46.3%) had metabolic acidosis, 25 (61.0%) had hypokalemia (Table 2). From 31-89 days, 4 (9.8%) had hyperchloremia, 11 (26.8%) had metabolic acidosis, 10 (24.4%) had hypokalemia. For 90+ days, 10 (24.4%) had hyperchloremia, 14 (34.1%) had metabolic acidosis, and 16 (39.0%) had hypokalemia. From a selection of 15 patients whose data were in electronic medical record, 7 (46.7%) were treated medically and 8 (53.3%) were not treated.

DISCUSSION

Pelvic exenteration is associated with high rate of perioperative morbidity and mortality.[6-8] Several techniques of urinary and fecal diversions have been reported, with use of ileal conduit as the standard. To our knowledge, this cohort of 41 patients is the largest retrospective analysis of short, intermediate, and long term complications in patients undergoing distal colon urinary conduit secondary to various indications such as cancer, neurogenic bladder, and fistula. Current literature looking at short and intermediate complications, are largely based in gynecologic oncology or for patients undergoing wet colostomy, and not distal colon diversion. Compared to previous studies, we observed a lower significant conduit-related complication rate: 2.4%, 2.4%, and 12.2% within 30 days, 31-89 days, and 90+ days respectively.[4,10] This difference was largely driven by the low incidence of urinary and bowel conduit leak. The rate of parastomal hernia in our cohort was similar to the 2% rate found in ileal conduit literature.[11] Our cohort had a 63% rate of prior pelvic radiation with neoadjuvant radiation in only 32% of cases, compared to 77%-92% in the other series.[4,10]

The greatest benefit of a colon conduit is in patients requiring concomitant end colostomies during pelvic exenteration or those with previous colostomies, since one can utilize the remaining distal colon for urinary diversion and avoid a small or large bowel anastomosis.[12] El-Hefnawy et al found a prevalence of 2.8% intestinal

obstruction within 30 days postoperatively after radical cystectomy and urinary diversion.[13] The benefit of avoiding a bowel anastomosis was supported by our data, as SBO and enterocutaneous fistulas (1, 2.4%) were rare. This is in accordance with Backes et al, who found that enteric fistula occurred in 1% of patients diverted with a sigmoid conduit, but occurred in 6.5% of patients diverted with an ileal conduit.[6,14] Backes et al also found patients with bowel leak of 9.5% in their ileal conduit with colostomy cohort, whereas there were none in our cohort.[6] Avoiding potential anastomotic leak is an important advantage of colon conduit since they are associated with a highmorbidity, and have been shown to double the patients length of stay (17 vs 30 days, $P = .03$).[6] Avoiding resection and reanastomosis of the ileum also expedites surgery. While our study was not designed to compare operative time, previous research shows diversion with sigmoid colon vs ileum can cut operating time of urinary and fecal diversion in half (32 vs 64 minutes, $P < .0001$).[15]

Another previously cited advantage of colon conduits is that the thicker musculature of the colon may lead to a more robust ureteroenteric anastomosis and improved ureteral drainage.[16-18] No patients in our cohort developed a ureteral anastomotic leak. 9.8% of patients developed a ureteral stricture long-term, which is consistent with Tabaa et al, who reported a 10% stricture rate in the ileal conduit group.[4] Additionally, colon conduit has a larger and more trouble free cutaneous stoma, which is less likely to require revision for stomal stenosis compared to ileal conduits.[11,19] No patients in our cohort developed conduit obstruction. Lastly, colon conduits are more mobile, especially in patients who have a redundant sigmoid colon and are suitable for high and low diversion stoma placement without being limited by the mesentery.[18]

Urinary diversion, both colonic and ileal, have been associated with metabolic abnormalities, especially in patients with impaired renal function. Past studies have found mixed results in improvement or worsening of renal function in long-term follow-up.[12,20] While more proximal segments have a stronger association with electrolyte abnormalities, both ileal and colonic segments have been associated with hyperchloremic acidosis and hypokalemia.[21,18] Long-term metabolic abnormalities have been associated with morbidity ranging from osteomalacia to fatigue, anorexia, and weakness.[11,21,22] In previous literature, the rates of hyperchloremic metabolic acidosis associated with ileal conduits have ranged from 25%-70% compared to 10%-15% of cases in colonic conduits[11,21,22]. In our cohort, we have found a high incidence of hyperchloremic metabolic acidosis with hypokalemia at short, intermediate, and long-term time points. This number could be an overestimate because we have defined the metabolic abnormalities as any laboratory value outside the normal range. Therefore, it is difficult to assess the clinical significance of the incidence of such metabolic abnormalities.

Several recent studies have looked at readmission rates after radical cystectomy, open and robotic, with overall readmission rates of approximately 25%.[23-27] It is difficult to make a direct comparison since these studies have exclusively looked at patients undergoing radical cystectomy for bladder cancer and none of these studies looked at readmission rates beyond 90 days. Readmission rates following pelvic exenteration is not routinely measured as a surgical outcome, however, roughly 45% of patients require at least 1 readmission following pelvic exenteration.[28,29] The readmission indications for our cohort was mainly secondary to infectious or gastrointestinal complications. The 39% readmission rate beyond 90 days is likely an underestimate given the retrospective nature of the study. Given the high readmission rate beyond 90 days, extended postoperative follow-up is imperative for these patients.

The major limitations of this study are the retrospective review of data and the potentially incomplete data from long-term follow up. A selection bias exists with our patient population given the referral pattern of patients for our tertiary care clinics. This limits long term follow-up of these patients at our institution, since many follow up with their local urologist following acute postoperative period.

CONCLUSION

This study suggests that colon conduit is a relatively safe and feasible alternative to ileal conduit diversion in patients undergoing total pelvic exenteration. In line with previously purported benefits of colon conduit, our rate of significant conduit-related complications, such as ureteral stricture, ureteral anastomotic leak, and conduit obstruction was low. By obviating the need for bowel anastomosis, there was a very low rate of bowel related complications such as SBO and enterocutaneous fistula with no bowel conduit leak. Given the high rates of long-term metabolic disturbances and readmission, extended postoperative follow-up is imperative. The acceptable rate of such complications, coupled with shorter operative time may make colon conduit the preferred option for urinary diversion in the setting of pelvic exenteration.

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