Bladder Reconstruction and Diversion during Colorectal Surgery

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ABSTRACT

Extirpative procedures for advanced colorectal cancers can involve multivisceral pelvic resections. In patients without evidence of distant metastatic disease, a reasonable therapeutic effect can be expected when negative surgical margins are obtained. For patients with bladder involvement, the decision to perform a bladder-sparing procedure or a total pelvic exenteration will be based on the extent of the primary lesion as well as patient characteristics. In this article, the authors describe bladder-sparing techniques with and without enterocystoplasty as well as options for urinary diversion in patients requiring total pelvic exenteration. Contraindications and clinical decision making regarding bladder reconstruction or replacement are discussed.

KEYWORDS: Bladder replacement, reconstruction, exenteration, rectal cancer

Objectives: Upon completion of this article the reader should understand the indications for bladder-sparing surgery as well as the indications for enterocystoplasty. The reader should also have an overview of the options for urinary diversion in patients requiring complete cystectomy for advanced carcinoma of the colon or rectum.

During extirpative procedures for neoplasms of the colon and rectum, involvement of adjacent organs including the bladder, prostate, ureters, or vagina occurs in 3 to 10% of cases.¹⁻³ In the absence of distant unresectable disease, aggressive surgical resection can provide a reasonable therapeutic benefit. With regards to bladder involvement, options include total pelvic exenteration (TPE) with urinary diversion or wide local excision with bladder-sparing procedures in select cases.^{4,5} Numerous retrospective series examining the oncologic efficacy of TPE versus bladder-sparing procedures are discordant in their conclusions. One consistent finding is that obtaining negative microscopic margins remains key to preventing local recurrences.^{6,7} The single best predictor of overall survival in patients under-

going aggressive surgical resection is lymph node status (5-year overall survival 70% R0N0 vs 35% R0N+) followed by margin status of specimen (5-year overall survival 61% R0 vs 17% R1).^{6,8,9}

The most common locations for colorectal cancer to involve the urinary bladder is the distal sigmoid followed by the rectum. Determination of the extent of locoregional extension with the use of pelvic computerized tomography (CT), magnetic resonance imaging (MRI), and endorectal ultrasound remains an area of active debate and research.⁷ Sensitivity for pathologic stage with pelvic CT approaches 80% in some series.² In one series, the overall accuracy of MRI and (18)F-fluorodeoxyglucose-positron emission tomography/computed tomography [(18)F-FDG PET/CT] for

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tumor stage was 67% and 60%.¹⁰ The addition of cystoscopy and examination under anesthesia may aid in preoperative planning and can be used in conjunction with the above modalities. Even with a combination of these diagnostic modalities, some patients will have multivisceral involvement suspected only at the time of surgery. When the primary tumor is adherent with another pelvic organ, accurate delineation of inflammatory adhesions versus neoplastic invasion is not always possible intraoperatively. Biopsy and frozen section analysis of interposing tissues is fraught with sampling errors and the risk of tumor spillage. Although two thirds of these attachments will be due to inflammatory adhesions, blunt mobilization or lysis of adhesions between the primary tumor and surrounding organs (i.e., bladder or vagina) can lead to an increased risk of the development of local recurrences and subsequent need for further treatment.^{2,6}

Individual patient selection, preoperative counseling, and the availability of a multidisciplinary surgical team are vital to providing an oncologically sound operation with curative intent.¹¹ Urologic, plastic, and gynecologic surgeons can aid in reducing the morbidity associated with multivisceral pelvic extirpative procedures. Due to the complexity of these cases, a standard surgical treatment for all patients cannot be proposed. The decision to perform TPE versus bladder-sparing surgery (partial cystectomy with reconstruction) must be made within the operating room. When possible, the possibility of urinary reconstruction or diversion should be discussed in great detail preoperatively. Once thought

to be inferior, meticulous bladder-sparing techniques have been shown to have equivalent oncologic outcomes with possibly less morbidity.^{4,5,12,13} Of course, complete resection of involved tissues remains paramount in achieving these desired results. An overview of surgical options and complications is provided herein.

OPERATIVE PLANNING

In a patient undergoing surgery with curative intent, obtaining adequate negative margins is paramount in the surgical plan. In the absence of distant metastasis, combining primary resection with multivisceral resection can aid in providing a prolonged disease-free interval. With regards to the urinary bladder, the location and extent of involvement will determine whether a partial or complete cystectomy with urinary diversion is necessary. If complete cystectomy is necessary, the choice of urinary diversion is dependent on a multitude of factors including patient age, comorbidities, neurologic function, manual dexterity, baseline renal function, and the need for adjuvant radiation therapy. In very select cases of rectal cancer involving only the prostate or seminal vesicals, isolated prostatectomy with urethrovesical anastomosis has been performed with encouraging results.^{4,13} Figure 1 outlines common surgical options in patients with colorectal neoplasms involving the bladder.

PARTIAL CYSTECTOMY

When removing a portion of the bladder for malignant infiltration, the bladder either can be closed primarily or

Figure 1 Proposed treatment algorithm for colorectal carcinomas involving the bladder. ¹With or without local tissue or omental flaps in patients at high risk for fistula formation (near coloanal anastomosis or radiation field). Ureteral reimplantation is also option if involved. ²Can be performed with concomitant ureteral reimplantation. Complete cystectomy is also an option. ³In select cases where separate conduits are not technically possible.

with the use of a bowel augmentation (enterocystoplasty). When closed primarily, local tissue (peritoneum) or omental interposition flaps can be used in patients at high risk for fistula formation.

The goal of the native bladder is (1) to store urine in a compliant, low-pressure reservoir; and (2) to contract with significant magnitude to achieve sufficient emptying. With decreased compliance (due to radiation side effects¹⁴ or significant resection), the bladder will store urine at higher pressures. High storage pressures can have chronic deleterious effects on renal function as well as presenting with symptomatic overactive bladder symptoms (detrusor overactivity). Enterocystoplasty may be considered in patients with preoperative compliance abnormalities or symptomatic bladder overactivity due to radiation therapy, as well as in patients with significant volume reduction after resection. Volume of bladder resected is a subjective indication and is difficult to quantitate at the time of surgery. There will be some patients who are closed primarily (without augmentation) who will develop symptomatic storage abnormalities and may require subsequent augmentation.

Due to the complications associated with augmentation and the feasibility of secondary augmentation (at a later date), we recommend an initial conservative approach. Obtaining negative oncologic margins are paramount, and the bladder may be reduced to a capacity of 50 to 100 milliliters after partial cystectomy to achieve these margins. In extreme cases, only the bladder neck and trigone are left intact (supratrigonal cystectomy) and may hardly close over a Foley balloon if primary closure was attempted. Enterocystoplasty may be a reasonable alternative to urinary diversion in these cases. Patients should be warned of this possibility before surgery and demonstrate a willingness and dexterity to self-catheterize. Also, it is important to be certain urethral sphincteric function is adequate to ensure dryness. Although augmentation can increase bladder compliance and functional volume (positive storage parameters), it can cause voiding dysfunction necessitating self-catheterization for adequate emptying. In patients requiring self-catheterization to void as a result of their enterocystoplasty, noncompliance with catheterization can result in bladder rupture with significant morbidity. Augmentation is contraindicated in patients with regional enteritis (Crohn disease). In patients with contraindications to augmentation, compromised surgical margins, or minimal residual bladder intact after resection, urinary diversion is indicated. Also, if sphincteric function is severely compromised and there is significant urinary incontinence present preoperatively, diversion should be considered. The standard enterocystoplasty involves anastomosis of a 10- to 20-cm well-vascularized segment of bowel to the bladder. Complications can

depend on the bowel segment utilized and include harvest-site specific metabolic abnormalities, infection, stone formation, small bowel obstruction, fistula formation, catheter-dependent bladder emptying, bladder perforation, and de novo malignant transformation (rare).

For primary closure of a partial cystectomy defect, the principles of primary repair of the bladder are used and are discussed in a separate article in this issue of *Clinics in Colon and Rectal Surgery*.

Enterocystoplasty with Partial Cystectomy

As described by Rackley et al, the surgical technique of enterocystoplasty has several prerequisites: (1) selection of an optimal segment of bowel based on a broad, well-vascularized mesenteric pedicle; (2) isolation of the bowel segment; (3) reestablishment of bowel continuity and closure of the mesenteric defect; (4) detubularization and reconfiguration of the bowel segment without peritoneal soiling of bowel contents; (5) creation of a tension-free, watertight, full-thickness, circumferential anastomosis of the bowel to the bladder; and (6) confirmation of adequate postoperative urinary drainage.¹⁵

In the setting of combined colorectal resection, the segment of bowel used for enterocystoplasty depends on multiple intraoperative factors including a desire to minimize the number of anastomoses, avoidance of bowel with prior radiation injury, and ensuring a tension-free mesentery with the length capable of reaching the deep pelvis.

Ileocystoplasty and sigmoidocystoplasty are two common variations of enterocystoplasty. Other variations not discussed here allow cutaneous catheterization (ileocecostoplasty) and are options in very select and properly informed patients. Ileocystoplasty uses a 15- to 60-cm portion of ileum isolated at least 15 cm proximal to the ileocecal junction. Sigmoidocystoplasty involves isolating a 10- to 20-cm loop of sigmoid colon. For a patient undergoing concomitant APR with end colostomy, use of the sigmoid can eliminate the need and risks of a separate enteral anastomosis.

After isolating the desired bowel segment, the ileum or colon is incised along the antimesenteric border. A large flat plate of mucosa is created using a 2-0 running SAS suture and suturing the bowel into a U-shaped configuration. The enteric flap is then anastomosed using running full thickness 2-0 SAS to the bladder margin (Fig. 2). A large urethral catheter is left in place. A suprapubic tube, either through the bowel segment or the native bladder, is placed for maximal drainage and for postoperative irrigation of mucus. A closed drainage system is left in place in the area of the augmentation. Gentle irrigation is started on postoperative day one to clear mucous and ensure adequate drainage during the recovery period. In the absence of

Figure 2 U-Shaped reconfigured plate with anastomosis during ileocystoplasty. Adapted and modified from Rackley et al.¹⁵

a urine leak, the pelvic drain can be removed prior to discharge. The Foley catheter is removed after 3 weeks and the remaining suprapubic tube is capped while the patient “learns” to void. The suprapubic tube allows for bladder training and monitoring of residuals and can be removed as soon as normal voiding resumes. In patients requiring intermittent self-catheterization, the suprapubic tube aids in ensuring the patient is properly performing intermittent catheterization. The tube is removed once the patient is comfortable and able to perform self-catheterization.

TOTAL PELVIC EXENTERATION

Exenteration in the setting of advanced (T3-T4) colorectal malignancy will require urinary diversion. Diversion techniques can be classified as continent or noncontinent. The former class is then comprised of cutaneous and orthotopic diversions (Fig. 1). Numerous factors are considered when determining the type of urinary diversion. Patient expectations, comorbidities, surgical history, as well as surgeon experience with the numerous diversion techniques are some of the factors that are considered when choosing a specific urinary diversion. Quality of life studies are inconsistent with respect to choosing a superior urinary diversion.¹⁶ Each diversion technique has its own unique complications.

Although the techniques of continent cutaneous^{17,18} and orthotopic neobladders¹⁹ have been popularized in the setting of radical cystectomy for bladder cancer, the noncontinent urinary diversions (ileal or colon conduits) are still more commonly performed. This is especially true in complex patients such as those with advanced nonurologic cancers requiring pelvic exenteration and possible radiation. Even at many tertiary high volume referral centers, the ileal conduit is performed on greater than 75% of patients undergoing radical cystectomy.²⁰ The technical points of noncontinent diversion will be discussed.

Ileal Conduit Diversion

As previously described, a 15-cm length of ileum (~10–15 cm proximal to the ileocolic sphincter) is removed from bowel continuity using a gastrointestinal anastomosis (GIA) stapler. The distal portion of the isolated ileum is marked with a 2-0 silk suture to allow identification for stoma formation and thus prevent creation of an ileal conduit with retrograde peristalsis. A hand-sewn technique may also be used. The ileal segment is maintained on a well-vascularized broad-based mesentery and placed *caudal* within the pelvis. Ileal-ileal anastomosis is then performed to restore bowel continuity. The left ureter is mobilized to the right side of the abdomen ventral to the great vessels and dorsal to the sigmoid mesentery. All stomas should be placed through the belly of the rectus muscles and should avoid skin creases or the base of redundant adipose flaps. A 2-cm diameter piece of skin is excised at the desired site (right for ileal conduit, either side for colon conduit). The subcutaneous fat is spread (not resected) to expose the rectus fascia. A vertical or cruciate incision is made in the fascia and the underlying muscle is spread and the peritoneum is incised. Care should be taken not to angulate the tract for the conduit. Two stay sutures of 2-0 SAS are placed through the corners of the rectus fascia and will be used to prevent retraction of the stoma. A Babcock is placed through the tract and used to grasp the ileal conduit. The conduit is pulled through the anterior abdominal wall with ~5 cm of ileum extending above the skin. This will allow for formation of a 2- to 3-cm rosebud stoma after maturation. The previously placed retraction sutures are placed through the seromuscular layer of the conduit at the level of the rectus fascia. The stoma is then matured in the standard rosebud fashion using 3-0 SAS. A 16-French red rubber catheter is placed into the stoma across the level of the fascia to prevent increase pressure due to edema in the early perioperative period.

Ureteroileal anastomosis is then performed along the intraabdominal portion of the conduit. The decision to perform a refluxing versus nonrefluxing anastomosis is based on surgeon preference as the evidence has not proven one superior to another.²¹ The Bricker

anastomosis is a simple, common, nonrefluxing end-to-side technique for ureteroenteric anastomosis.²² Anastomosis can be created using interrupted or running absorbable sutures. Principles include

- Use of absorbable suture (4-0)
- Mucosa to mucosa apposition
- Preservation of periureteral adventitia
- Tension-free watertight spatulated anastomosis
- Ureteral stent placement

The ureteral stents are brought out through the stoma. A close-suction pelvic drain is left in place. A urostomy appliance is placed to the skin. The red rubber catheter is removed when the patient is tolerating food. The pelvic drain is removed prior to discharge. We remove the ureteral stents at the first postoperative visit (2 weeks postop) or later in patients with marginal nutritional status or a history of radiation therapy.

Colon Conduit Diversion

Use of a colon conduit may be preferable in patients undergoing an end colostomy. Use of the colon in the urinary diversion will eliminate the need and risk of an intraabdominal enteric anastomosis to establish bowel continuity. Ureterocolonic anastomoses have historically been performed in a nonrefluxing fashion, although no clear data support this method over refluxing anastomoses. During construction of a nonrefluxing anastomosis, the anterior taenia is incised lengthwise for ~3 cm. The muscularis is dissected from the mucosa creating a submucosal trench. The mucosa is incised at the end of the trench and a spatulated ureterocolonic anastomosis (with stent) is created as previously described. The muscularis and serosa are very carefully reapproximated over the ureter thereby creating a nonrefluxing tunnel. Care must be taken not to constrict the ureter. Another simple option is to perform a Bricker style end-to-side anastomosis as previously described for ileal conduits. Again, the role of a refluxing versus nonrefluxing anastomosis has not been established and is decided based on surgeon preference.

Alternative Techniques

In select cases, a double-barrel combined urinary diversion and enteric diversion can be performed. Even though separate channels are created, this method will obviously create colonization of the urinary conduit and will place the urine flow in the opposite direction of bowel peristalsis. Double-barrel colostomies and ileostomies have been performed with "success," although long-term follow-up and significant numbers are limited.²³⁻²⁶ The double-barrel diversion is an option in

cases with a hostile abdomen, morbidly obese patients with a short mesentery and an inability to mobilize two stomas, an unstable patient necessitating an expedient double diversion, or in patients with limited life expectancy undergoing palliative exenteration.

CONCLUSION

Patients with advanced colorectal carcinoma who are candidates for radical extirpative surgery may require removal of genitourinary organs. Multidisciplinary and individualized management must be employed to minimize morbidity with these multivisceral resections and reconstructions.

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