Use of Bowel in Reconstructive Urology: What a Colorectal Surgeon Should Know

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Abstract

Urologists routinely use bowel in the reconstruction of the urinary tract. With an increasing prevalence of urinary diversions, it is important for surgeons to have a basic understanding of varied use and configuration of bowel segments in urinary tract reconstruction that may be encountered during abdominal surgery. The aim of this review article is to provide an overview of the various reconstructive urological surgeries requiring bowel and to guide physicians on how to manage these patients with urinary diversions.

Keywords
- incontinent urostomy
- continent urostomy
- neobladder
- electrolyte disturbances
- chronic bacteriuria

For over a century and a half, urologists have been using bowel for urinary tract reconstruction or diversion. The most common indications for urinary tract reconstruction with bowel include malignancy and underlying neurologic conditions (e.g., spinal cord injury, spina bifida). Just as the management of these underlying diseases and conditions has evolved over time, so has the use of bowel in the reconstruction of the urinary tract in these patients. Now, for any given disease process, there may be many different reconstructive options available to these patients.

Urinary diversions can be either incontinent or continent. In an incontinent urostomy, urine freely drains out of a stoma and into an appliance attached to the patient's skin. A continent urostomy relies on intermittent catheterization through a stoma to drain the urine. We will describe the various urinary diversions that result in either an incontinent or a continent urinary diversion. We will also discuss other relevant urological reconstructive surgeries that involve bowel but do not result in a urostomy. Finally, we will discuss various topics in the medical management of urinary diversions including electrolyte disturbances, drainage, and interpretation of urinalyses and cultures.

Incontinent Urostomy

Ileal Conduit

First described in 1950 by Dr. Eugene Bricker, the ileal conduit is the most common urinary diversion in patients undergoing radical cystectomy for bladder cancer.[1] In a 2009 study that reviewed 35,370 patients with bladder cancer undergoing radical cystectomy in the United States, 30,295 (85.7%) had an ileal conduit constructed for urinary diversion, while the remaining patients had a continent urinary diversion such as a neobladder or a catheterizable urinary reservoir.[2]

For construction of an ileal conduit, a 10- to 15-cm segment of terminal ileum approximately 10 to 15 cm proximal to the ileocecal valve is selected. The harvested ileal segment is identified by its corresponding vascular arcade, and the segment to be used for the conduit is isolated. The remaining bowel is anastomosed to reestablish continuity. The conduit is oriented caudal to the reanastomosed bowel and usually positioned in the right lower quadrant. The right and left ureters are mobilized while making all efforts to preserve their tenuous blood supply. The left ureter is brought over the great vessels and tunneled through the sigmoid mesentery toward the right lower quadrant conduit. If oncological purposes require a resection of a significant length left ureter resulting in insufficient length to reach a right lower quadrant conduit, a longer ileal segment can be selected and the ileal segment can be tunneled through the sigmoid mesentery to meet the truncated left ureter. The ureters are typically anastomosed to the ileal conduit in a refluxing end-to-side or conjoined end-to-end configuration. The distal end of the conduit is brought up to the abdominal wall. Often, a classic end stoma, or "rosebud" stoma, is fashioned to protrude from the skin level. However, in obese patients or

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patients with a short mesentery, a Turnbull loop-end stoma can be used to maximize outward reach and protrusion from the abdominal wall.[3]

Ileal conduits are easier to construct intraoperatively and historically have been thought to have fewer intraoperative and early postoperative complications as compared with other urinary diversions such as an orthotopic neobladder or a catheterizable urinary reservoir (described later in this article). However, a 2008 study that retrospectively reviewed 281 cystectomies at a single institution between 1990 and 2005 found no significant difference in early complications between patients who received an ileal conduit versus a continent urinary diversion.[4] Despite these findings, an ileal conduit may be the optimal urinary diversion for patients with significant comorbidities or decreased functional status. An ileal conduit is easier to manage than catheterizable stomas or neobladders and has a lower risk of electrolyte disturbances caused by urine absorption by bowel segments.

Colon Conduit

Although ileum is the most commonly used bowel segment for an incontinent urinary diversion, there are instances where the use of ileum may not be the best choice. Historically, a history of pelvic radiation has been the most common indication for a colon conduit. The transverse, sigmoid, or ileocecal colon can be used in the construction of a colon conduit. The transverse colon is most commonly used in patients with pelvic radiation given its distance from the radiated field. Approximately 15 cm of transverse colon is isolated and the remaining colon is reanastomosed. The stoma is usually placed in the right or left upper quadrant. If after radical cystectomy one of the ureters is longer than the other, the conduit should be placed on the ipsilateral side of the shorter ureter. The ureters are attached to the proximal conduit, and the distal end of the conduit is brought up as the stoma.[5]

There remains debate about whether ileal conduits should be completely avoided in patients with a history of pelvic radiation due to concern for ureteroenteric anastomotic leak or stricture. A 2004 retrospective analysis of 36 patients with a history of radiation undergoing radical cystectomy with ileal conduit diversion demonstrated that only one patient developed an anastomotic leak, which was managed conservatively and did not require reoperation. The authors of this study concluded that the creation of an ileal conduit in patients with a history of pelvic radiation is a safe option.[6] There are limited studies that compare the outcomes of ileal conduit verses colon conduit in patients undergoing radical cystectomy. A 2008 study reviewed the intraoperative, short-term, and long-term complications between ileal conduit and colon conduit urinary diversions. The authors did not find a significant difference in early complications between the groups. However, there was a significant increase in the rate of long-term complications in ileal conduit (74.5%) versus colon conduit (26.5%). In the ileal conduit group, small bowel obstruction and ureteroenteric strictures were more frequently encountered, which the authors postulate may be a result of increased anatomic variability of the arterial blood supply as well as the smaller lumen of the terminal ileum.[7] Despite these potential benefits, ileal conduit remains the mainstay incontinent urinary diversion following radical cystectomy.

Incontinent Ileovesicostomy

In patients with spinal cord injuries or neurogenic bladders, maintaining a low intravesical pressure is essential for the protection and preservation of the upper urinary tract.[8] For many patients, anticholinergic medications, botulinum toxin injections, and diligent clean intermittent catheterization (CIC) are sufficient to maintain a low bladder pressure. However, for some patients, these conservative measures are inadequate and surgical intervention is required.

An incontinent ileovesicostomy, which was first described in the 1950s and popularized in the 1990s, is a surgical intervention that allows for continuous drainage of the native bladder without requiring a chronic indwelling catheter. In this procedure, a segment of distal ileum is isolated and its proximal end is spatulated. A large cystotomy is made, and the spatulated ileum is then anastomosed to the bladder. The distal end of the ileum is then brought up to the abdominal wall, and an incontinent urostomy is created. The benefit of an ileovesicostomy, as compared with a cystectomy with ileal conduit, is that preservation of the bladder maintains the native ureterovesical junctions and eliminates the risk of ureteroenteric anastomotic strictures. In patients with a completely atonic bladder, there is some concern that an ileovesicostomy would be insufficient to allow for complete emptying, and thus an ileovesicostomy would not be optimal for these patients.[9]

Leng et al reviewed the long-term outcomes of ileovesicostomy in patients with severe lower urinary tract dysfunction.[10] In this series of 38 patients, 28 had spinal cord injuries, 9 had multiple sclerosis, 1 had cerebral palsy, and 3 had significant urethral injury/destruction. At 3 years following surgery, 94.1% had sufficiently low intravesical pressures. In addition, only three patients developed a febrile urinary tract infection (UTI), and there were no reported cases of urosepsis. Thus, an ileovesicostomy is a suitable option for patients with neurogenic bladders who fail initial conservative management.

Continent Urostomy

Appendicovesicostomy (Mitrofanoff) and Ileovesicostomy (Yang–Monti)

Originally described by Dr. Paul Mitrofanoff in 1980, the appendicovesicostomy has become a mainstay for the treatment of neurogenic bladders in the pediatric population.[11,12] Most often, spina bifida is the underlying pathology for a neurogenic bladder in pediatric patients. However, the use of a Mitrofanoff has also been used in patients with exstrophy–epispadias, cloacal anomalies, or posterior urethral valves.[13] Patients in this population often have other physical disabilities or anatomic variations that limit their ability to perform standard urethral catheterization. The goal of this surgery is to provide a life-long, easily accessible, continent urinary diversion.

In the construction of an appendicovesicostomy, the appendix is detached from the cecum while preserving the appendiceal artery pedicle to ensure adequate blood supply. The ideal length of the appendix for this procedure is at least 2.5 cm. If the length is too short, a portion of the cecum can be excised along with the appendix and then the cecal segment can be tubularized to gain additional length. The terminal end of the appendix is opened and tunneled submucosally into the bladder. To reduce redundancy in the appendiceal channel and to ease catheterization, the bladder may be secured to the posterior abdominal fascia. The proximal end of the appendix is then brought up to the skin surface for the creation of the stoma. The stoma is typically placed in the right lower quadrant or at the umbilicus to better conceal the stoma.[12,13]

For patients who do not have an appendix, ileum can be used to form a continent catheterizable channel. First described in 1997 by Dr. Paulo Monti, a 2.5- to 3.5-cm segment of terminal ileum is selected. The ileum is incised along its antimesenteric border and then retubularized transversely. The ends of the retubularized segment are then used in a similar fashion to the appendix in an appendicovesicostomy. If the length of a single retubularized segment is insufficient to extend from the bladder to the abdominal wall, two tubes can be sequentially connected to form a "double Monti." However, a double Monti tends to have higher rates of diverticula formation (particularly at the anastomotic junction), angulation of the channel, and perforation at the anastomosis with catheterization.[13,14]

In general, there are similar long-term success rates between Mitrofanoff and Monti catheterizable channels with continence rates approaching 98%.[15,16] A 2015 study of 510 patients reviewed the long-term outcomes and complications of Mitrofanoff and Monti catheterizable channels at a single institution between 1990 and 2013. There was no significant difference in stomal stenosis requiring revision (11.7 vs. 9.9%). However, subfascial revision due to difficulty catheterizing or channel stenosis/stricture was more common in Monti channels than in Mitrofanoff channels (6.5 vs. 16.6%).[17] Overall, both Mitrofanoff and Monti catheterizable channels are excellent surgical options for patients with neurogenic bladders who require intermittent catheterization. Often such channels are created in conjunction with an augmentation cystoplasty, which will be described later in this article.

Catheterizable Reservoirs Constructed from Ileum and/or Colon

For patients undergoing cystectomy who do not want an incontinent urostomy, there are, in general, two reconstructive options frequently used. One option is the creation of a urinary intestinal reservoir that requires catheterization from a small stoma located in the right lower quadrant or the umbilicus. A second option is the creation of an orthotopic intestinal neobladder that is anastomosed to the patient's urethra and relies on the patient's native urinary sphincter muscles for continence and drainage. The selection of urinary diversion following radical cystectomy depends on several factors including patient and surgeon preference, patient's ability to manage the urinary diversion, oncological variables, and renal function. Based on SEER (Surveillance, Epidemiology, and End Results) data from the United States between 1998 and 2005, the creation of a continent urinary diversion was used in <15% of patients undergoing radical cystectomy. However, the frequency of continent urinary diversion has been increasing in recent years, particularly at academic teaching hospitals.[2] A 2013 study that reviewed publications from 11 high-volume global institutions between 1970 and 2012 included 15,867 radical cystectomies with urinary diversions and demonstrated the frequency of continent cutaneous diversion at 10.4% and orthotopic neobladders at 38%.[18] The main indication for the selection of a continent cutaneous diversion rather than a neobladder is urethral involvement of the tumor requiring resection.

The construction of a catheterizable reservoir can use ileum, colon, or both. For a reservoir construction solely from ileum, approximately 60 to 70 cm of terminal ileum approximately 15 to 20 cm from the ileocecal valve is selected. The middle 40 to 50 cm of the excised ileum is used to construct the pouch. The proximal 10 cm of ileum is used to create an antirefluxing in-flow channel to which the ureters are anastomosed. The pouch is typically located in the right lower quadrant. As such, the left ureter is tunneled through a mesenteric hole in the left mesocolon while the right ureter is brought across the common iliac artery and to the pouch. The distal 10 cm of ileum is used to form the catheterizable channel. The intestinal reservoir is sutured to the posterior abdominal fascia to reduce redundancy in the efferent limb and allow for easier catheterization. For patients with a sufficiently long appendix, less ileum can be used and instead the efferent limb can be created from the appendix in a similar fashion to a Mitrofanoff.[19]

There are multiple variations of a catheterizable urinary reservoirs constructed from colon and ileum. The Indiana pouch, first described in 1987, is one of the most commonly used continent urinary reservoirs. Approximately 15 to 18 cm of the terminal ileum and 20 cm of the cecum and ascending colon are used in the construction of an Indiana pouch. The right colon is incised along its antimesenteric border and the distal end of the colon is folded caudally to form a pouch. The ureters are aligned and anastomosed to the colon at the taenia coli. The continence mechanism is created by tapering the efferent ileal segment around a 12-French Foley catheter using a stapler to remove excess ileum. The ileal cecal valve is reinforced with sutures and serves as the main continence mechanism. The proximal end of the terminal ileum is brought up to the skin as the stoma.[20,21] Daytime and nighttime continence rates with a catheterizable urinary reservoir are reported around 80 to 96% and 73 to 80%, respectively.[4,22] Routine CIC is required to empty the reservoir and prevent complications such as UTIs, stone formation, upper tract injury, or reservoir perforations.

Other Uses of Bowel in Urological Reconstruction

Orthotopic Neobladder

The development of the orthotopic neobladder has perhaps been one of the greatest advancements in urinary diversion for patients undergoing radical cystectomy for bladder cancer. For some patients, the stigma of having a urostomy can profoundly impact the patient and may actually deter the patient from undergoing a curative oncological surgery. Historically, ureterosigmoidostomy was the only option for patients refused a urostomy. However, as discussed in the following, this surgery is associated with a high rate of secondary malignancy. The development of the neobladder in 1988 was instrumental in providing an alternative urinary diversion for patients refusing a continent or incontinent urostomy.

Two of the most commonly constructed neobladders is the Studer neobladder and the Hautmann ileal neobladder. For the construction of the Studer neobladder, a 55-cm segment of ileal approximately 25 cm proximal to the ileocecal valve is selected. Both the proximal and distal ends of the ileal segment are closed. The proximal 10 to 12 cm of bowel is used as the afferent limb of the neobladder to which the ureters are anastomosed. The remainder of the ileum is opened along its antimesenteric border. The bowel is arranged in a U-shape, and the medial borders are sutured together. The bottom of the "U" is then folded cranially to form a spherical reservoir. A small hole is incised at the base of the reservoir and then anastomosed to the remaining urethral stump.[23,24]

For the construction of the Hautmann ileal neobladder, 60 to 70 cm of distal ileum approximately 10 to 20 cm proximal to the ileocecal valve is selected. The ileum is folded into a W-shape. The length of ileum is incised along its antimesenteric border except for the most proximal and distal 3- to 5-cm "chimney" segments. The adjacent edges of the opened ileal segment are sutured together and then folded to form a spherical reservoir. The ureters are anastomosed to their ipsilateral ileal "chimney" above the common iliac vessels. A buttonhole is created at the base of the neobladder and anastomosed to the urethral stump. For both the Studer and Hautmann neobladders, the initial urine capacity will be low. Over time, the neobladder will distend and reach a goal volume of approximately 500 mL.[25,26] Most patients are able to void volitionally with sphincteric relaxation and mild abdominal straining. It is estimated that 88 to 93% of patients can void spontaneously; however, some require some degree of intermittent catheterization to fully drain their neobladders.[4,27] Chronic overdistention of the neobladder can make it "floppy," and patients may have difficulty fully emptying their neobladder. The rate of urinary continence with neobladders is 90 to 92% during the day and 67 to 79% at night.[4,27]

It remains controversial as to whether patients with an orthotopic neobladder have an improved quality of life compared with those with a urostomy. A 2012 study reviewed the results of validated EORTC (European Organisation for Research and Treatment of Cancer) quality-of-life questionnaires administered to 301 patients who underwent ileal conduit or orthotopic ileal neobladders. The authors reported that patients with a neobladder had a significantly higher quality of life and better physical functioning as compared with patients with an ileal conduit.[28] In contrast, a 2014 prospective study of 73 patients undergoing radical cystectomy with either a continent or an incontinent urinary diversion did not show any significant difference in health-related quality of life.[29] Ultimately, studies may identify the urinary diversion that will provide a better quality of life. However, until then, the selection of an incontinent or a continent urinary diversion following radical cystectomy should be based on the patient's preference, functional status, and associated comorbidities.

Ureterosigmoidostomy

First described in 1852, the ureterosigmoidostomy was previously the most common form of urinary diversion, particularly in cultures where a stoma is stigmatized. Its use has been widely replaced by orthotopic neobladders for patients refusing to have a stoma.[30] In a ureterosigmoidostomy (Mainz pouch II), 20 to 24 cm of sigmoid colon is incised proximal to the rectosigmoid junction. The sigmoid colon is reconfigured into an inverted "U" to form a pouchlike structure. The left ureter is tunneled behind the sigmoid mesentery to the right side of the pouch where it is anastomosed to the pouch along with the right ureter.[31]

The primary concerns associated with a ureterosigmoidostomy are secondary malignancy, infection, and urinary/fecal incontinence. In a 2011 study that reviewed 17,758 urinary diversions at 44 centers between 1970 and 2007, secondary malignancies developed in 2.58% of patients receiving a ureterosigmoidostomy. This incidence was 22 times more common than other continent urinary diversions.[32] Of note, 94% of these tumors developed at the ureterocolonic anastomosis. In terms of fecal/urinary incontinence, a 2010 study of 245 patients with over 10-year follow-up demonstrated that 92% of patients with a ureterosigmoidostomy had complete continence. This study also found that the rates of pyelonephritis were similar to those of patients with an ileal conduit.[30] However, most urologists still tend to shy away from a ureterosigmoidostomy given the concern for secondary malignancy and the availability of other options for urinary diversions.

Bladder Augmentation

As discussed earlier in this article, an ileovesicostomy can be used to maintain a low intravesical pressure for patients with neurogenic bladders. However, many patients prefer not to have an incontinent urostomy. For these patients, augmentation cystoplasty (bladder augmentation) with bowel is a frequently used surgical approach to increase the capacity of the bladder and lower the intravesical storage pressure. Patients undergoing augmentation cystoplasty must have adequate hand dexterity to perform CIC and routinely drain their bladder.

Ileum is the most commonly used bowel in augmentation cystoplasty; however, one can also use an ileocecal segment, a sigmoid segment, or even a part of the stomach. When using ileum, a 20- to 25-cm segment approximately 15 to 20 cm proximal to the ileocecal valve is selected. The bowel is opened along its antimesenteric border and reconfigured into a U-, S-, or W-shape. A sagittal incision is made in the bladder, and the reconstructed ileal plate is anastomosed to the bladder edges. If a catheterizable channel is also desired, using an ileocecal segment for the augmentation is an ideal option as the appendix can be used for the channel. In this instance, 15 to 30 cm of terminal ileum and the proximal right colon are detubularized and anastomosed to the open bladder.[33]

A segment of stomach, either from the antrum or body, can also be used for bladder augmentation. A 10- to 20-cm wedge-shaped segment of stomach is excised along the greater curvature of the body. It is important to preserve the vascular supply to the flap that arises from either the right or left gastroepiploic arteries. The stomach flap is tunneled through a window in the transverse mesocolon superiorly and then through the small bowel mesentery inferiorly to reach the bladder. The flap is anastomosed to the incised bladder.[33] Gastrocystoplasty, although infrequently used, has benefits compared with an ileovesicostomy. For patients with poor renal function or with chronic acidosis, the development of hyperchloremic metabolic acidosis (commonly seen with intestinal segments) with gastrocystoplasty is less likely. The stomach segment also secretes less mucous, which can hinder catheterization and successful bladder emptying. Finally, patients with gastrocystoplasty have a higher rate of sterile urine as compared with urine from patients with augmentations from small or large bowel, which typically have chronic bacteriuria. The downsides to gastrocystoplasty include hypochloremic metabolic alkalosis and hematuria–dysuria syndrome, which typically presents with perineal pain, hematuria, and dysuria or pain with catheterization.[34] Stomach conduits are rarely performed today and most have been reversed secondary to complications.

The most dreaded complication of an augmentation cystoplasty is perforation. If the bladder becomes overdistended, ischemia within the bowel wall may develop and can lead to perforation. If perforation is suspected, a computed tomography cystogram should be performed. Conservative management can be attempted with Foley drainage and intravenous antibiotics; however, if the patient's status deteriorates, he or she may need surgical exploration and repair.[33] Thus, it is imperative that the patient empties his/her bladder routinely to avoid overdistention. Although less catastrophic, other common complications seen with bladder augmentations include bladder stones and UTIs.

Ileal Ureter

Prolonged obstruction secondary to ureteral stricture disease, if untreated, can lead to progressively worsening renal function and potential loss of the renal unit. In the United States, ureteral stricture disease is most often iatrogenic and the result of previous surgery or radiation. Other etiologies include retroperitoneal fibrosis, malignancy, or trauma.[35] Outside of the United States, tuberculosis and schistosomiasis are common causes of ureteral stricture disease.[36] For short strictures, endoscopic management or surgical excision with reanastomosis of healthy adjacent ureteral ends can be performed. If the patient has a distal stricture, excision with ureteral reimplant with a bladder psoas hitch or Boari flap (tubularized segment of bladder) can be used. However, management of proximal- or midureteral strictures or long strictures may require more extensive reconstruction.

If one has to excise a significant portion of the ureter and the remaining ureter is not of adequate length to reach the bladder, ileum can be used to bridge the distance between the proximal ureteral end and the bladder. A segment of ileum long enough to extend from the renal pelvis or the proximal ureteral end is isolated and bowel continuity is reestablished. The segment of ileum is tunneled to the retroperitoneum through a window in the colonic mesentery. The segment of ileum is positioned in an isoperistaltic fashion. The proximal ureter is anastomosed to the proximal ileum in an end-to-side fashion. If the entire ureter has been excised, the ileal segment can be directly anastomosed to the renal pelvis in an end-to-end fashion. The distal ileal segment is then anastomosed to the bladder.[37] The Yang–Monti principle has also been applied for the formation of ileal ureters. One or more 2.5-cm segments of ileum are isolated and incised along its antimesenteric border. The bowel is retubularized along its longitudinal border to form a longer tube with a narrow diameter. One or more retubularized segments can be anastomosed in an end-to-end fashion and then used to bridge the distance between the proximal ureter and the bladder. In a 2009 study of 91 patients who underwent urological reconstruction with ileal ureters, 74.7% of patients had stable or improved renal function. However, in this series, the reported short- and long-term complications were 42.9 and 23%, respectively. While technically feasible, ileal ureters are usually reserved for patients who fail conservative or endoscopic management.[35]

Medical Management of Urinary Diversions

Electrolyte/Metabolic Disturbances

Metabolic disturbances are common in patients with intestinal urinary diversion due to the natural absorption of electrolytes by the bowel. The degree of metabolic disturbances and the clinical features can vary from patient to patient. Factors that influence the degree of electrolyte derangements and solute absorption include the segment of bowel used, the surface area of the segment, period that the urine is exposed to bowel, the patient's renal function, and the composition of the urine.[38]

Stomach: although uncommon, the use of stomach in the reconstruction of the urinary tract, as is in the case of gastrocystoplasty, can result in a hypochloremic metabolic alkalosis. Carbonic acid is broken down into hydrogen and bicarbonate ions. The hydrogen ion is secreted through the H^+/K^+ antiport, and the bicarbonate is released into the blood stream. In the absence of normal renal function, the excess bicarbonate cannot be excreted and the patient can develop a metabolic alkalosis. If the antrum of the stomach is used, patients are at risk for developing increased serum gastrin levels. Gastrin secretion by the antrum of the stomach is triggered by mechanical stretch and the presence of alkaline urine. Increased gastrin levels lead to increased hydrogen ion secretion by parietal cells, resulting in worsening metabolic alkalosis. Symptoms of a metabolic alkalosis include respiratory depression, lethargy, seizures, and arrhythmias. For patients with gastrocystoplasty, a proton-pump inhibitor or H2 blocker can be used to treat or prevent the development of metabolic alkalosis.[38] In a 1998 review of 47 children who underwent gastrocystoplasty at a single institution, 6% of patients developed a hypochloremic metabolic alkalosis that was managed with an H2 blocker or hydration.[39]

Jejunum: the jejunum is associated with the highest electrolyte disturbances; thus, it is not often used in urinary tract reconstruction. The jejunum secretes sodium chloride and reabsorbs potassium and hydrogen ions. The excessive loss of sodium chloride can result in significant dehydration. The jejunum also has a more water-permeable membrane that can lead to more significant fluid shifts and dehydration as compared with the stomach, ileum, or colon.[40] The patients can develop jejunal conduit syndrome, which is characterized by hyponatremia, hypochloremia, hyperkalemia, and acidosis. Patients often will present with symptoms of dehydration, nausea, vomiting, lethargy, and weakness and should be treated with aggressive fluid resuscitation and bicarbonate supplementation, as needed.[38]

Ileum and colon: as ileum and colon are the most commonly used bowel in urological reconstruction, it is imperative that physicians are familiar with the metabolic derangements that typically result. When urine comes in contact with the ileum or colon, ammonium and chloride are reabsorbed while bicarbonate is excreted.[41] This results in a hyperchloremic metabolic acidosis. Patients may also develop hypokalemia as a result of the chronic acidosis.[38] For patients with adequate renal function, the kidneys are typically able to adapt and correct the acidosis. However, in patients with renal insufficiency, bicarbonate and potassium repletion may be necessary. Patients with a continent urinary diversion or an orthotopic neobladder will have a larger surface area and increased duration in which urine is exposed to the intestinal wall. Thus, these patients may be at a higher risk for metabolic derangements, particularly if the patients have a baseline renal insufficiency. However, a 2008 study comparing ileal conduit, continent urinary diversion, and ileal neobladder found no significant difference in the frequency of hyperchloremic metabolic acidosis between the groups.[4] Of note, this study did not account for baseline renal insufficiency prior to surgery. In general, it is recommended that a continent urinary diversion be avoided in patients with glomerular filtration rate < 50 mL per minute.[18]

As the terminal ileum is largely responsible for absorption of bile acids and vitamin B12, there is concern that vitamin deficiency may develop in patients with urinary diversions that rely on ileum. Stein et al measured the serum levels of fat- and water-soluble vitamins of 137 patients following urinary diversion. This study did not find any significantly lower levels of fat-soluble vitamins; however, it did note a significantly decreased level of vitamin B12 levels in patients 4 years following surgery.[42] Patients with urinary diversions may ultimately need replacement of vitamins, particularly as the length of time since surgery increases.

Drainage and Management of Continent Urinary Diversions

For patients with continent urinary diversions or bladder augmentations, it is essential to adequately drain urine on a regular basis to reduce the risk of obstructive uropathy, pyelonephritis, and perforation. Depending on the patient and their reconstructive surgery, this may include a meticulous routine of intermittent catheterization or volitional voiding. However, when these patients are admitted to the hospital, it may be difficult or impossible to continue their normal routine. Thus, it is critical that medical providers be familiar with various urinary diversions and their management in an inpatient setting.

For patients who rely on intermittent catheterization, it is important to continue the patient's usual catheterization schedule (usually every 4 to 6 hours, depending on the size of the reservoir). If possible, self-catheterization is ideal as the patient is often most familiar as to how best to navigate the catheter through the channel. If the patient is incapable of performing intermittent catheterization, a nurse can assist. If significant difficulty or obstruction is noted with catheterization, it may be necessary to place a temporary indwelling Foley catheter. While an indwelling catheter may seem simple and most convenient, it has inherent risks. Most concerning is the potential for catheter obstruction. The intestine naturally secretes mucous that can clog the catheter and prevent adequate drainage. If unnoticed by the patient, nurse, or physician, over distention and perforation may occur. If an indwelling catheter is required, it is best to use a catheter with a larger lumen. It is also imperative that a nurse irrigates the catheter at least twice daily to remove excess mucous and to ensure the catheter is draining successfully. Periodic ultrasonographic bladder scans should be performed to ensure that the reservoir is adequately drained. If the catheter stops draining and cannot be irrigated or the patient develops symptoms of a perforation, immediate urology consultation is recommended.

Interpretation of Urinalysis/Urine Cultures

In the setting of urinary diversions that use bowel, urinalyses and urine cultures are often positive for bacteria. However, these patients often have chronic asymptomatic bacteriuria that does not require intervention or treatment. There are several factors that can affect the incidence of chronic bacteriuria in patients with urinary reconstruction. The type of bowel used and the type of reconstruction can influence the incidence of chronic bacteriuria. A 1987 study compared the frequency of bacteriuria between ileal and colon conduits. In this study, 73% of patients with ileal conduits had significant bacteriuria, typically consisting of mixed bacterial flora. Only 37.5% of patients with a colon conduit had significant bacterial growth, and, interestingly, all had growth of only a single organism.[43] Patients with gastrocystoplasty, who typically have aciduria, have also demonstrated lower rates of chronic bacteriuria compared with patients with urinary diversions that incorporate small or large bowel.[34] The need to perform intermittent catheterization or the ability of the urinary diversion to fully drain can also affect the incidence of chronic bacteriuria. A 2004 study demonstrated that more than 70% of tested urine samples from patients with an orthotopic neobladder who had incomplete emptying of their neobladder had bacteriuria. This was significantly higher compared with patients who were able to empty their neobladders completely, where the rate of bacteriuria was only 47%.[44]

Given the high rates of chronic bacteriuria, urinalyses and urine cultures should be interpreted with a critical mind and in conjunction with a thorough clinical evaluation. For patients with urinary diversions who present with generalized signs of infection such as fever, malaise, or leukocytosis, it is critical to exclude other sources of infection. The clinician should also evaluate the patient for symptoms of a UTI, such as hematuria, dysuria, or flank pain before empirically treating a presumed UTI. Unnecessary treatment of chronic bacteriuria with antibiotics leads to the development of resistant organisms that can make treatment of acute and symptomatic bacterial infections much more challenging.

Conclusion

Urologists use bowel in many different reconstructive urological surgeries. For colorectal and general surgeons who may operate in the abdomen for unrelated reasons, it is imperative to have a basic understanding of these urological surgeries and how the urinary tract and bowel are reconfigured, particularly with regard to vascular pedicles and ureteral tunneling. Physicians must also be aware of the medical complications that can develop in these patients. Metabolic derangements are commonly seen in these patients and should be corrected, particularly if the patient is symptomatic. While patients are admitted to the hospital, it is essential to closely monitor their urine output and continue home voiding or catheterization routines. Finally, as many of these patients will have asymptomatic chronic bacteriuria, judicious use of antibiotics and only treating patients with clear symptoms of a UTI will help limit inappropriate antibiotic usage.

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