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Seminars in Oncology

Urinary Diversion: Options, Patient Selection, and Outcomes

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Improved survival following radical cystectomy for bladder cancer as a result of advancements in combination chemotherapy and surgical technique has resulted in a philosophical change in the surgeon's approach to urinary diversion selection. Aims have evolved from the mere diversion of urine to a functional bowel conduit such as an ileal conduit or ureterosigmoidostomy, to providing the optimal diversion for the patient's quality of life. While quality of life is important, one must also consider the stage of cancer and individual patient comorbidities. Which diversion provides the best local cancer control, the lowest potential for complications (short and long term), and the easiest emotional adjustment in lifestyle while still allowing the timely completion of chemotherapy and therapeutic goals? A multidisciplinary approach to diversion selection that includes the patient, the medical oncologist, radiation oncologist, internist, and surgeon is ideal. We describe the three most commonly used types of diversions today, including conduits, continent cutaneous reservoirs, and orthotopic urethral diversions, as well as issues relative to patient selection and functional outcomes in patients undergoing radical cystectomy for the treatment of bladder cancer.

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It is critical for urologists today to be adept at performing a variety of urinary diversions using different types of bowel segments based on an individual patient's need and desire. Since the first reported urinary diversion using a bowel segment in 1852 by Simon, there has been significant evolution in the principles and practice of urinary diversions with a greater emphasis on quality of life. Ureterosigmoidostomy was one of the earliest forms of a continent urinary diversion; however, the rate of complications, notably ascending pyelonephritis, renal deterioration, fluid and electrolyte alterations, and long-term incidence of adenocarcinoma in the diverted segment necessitated the development of less morbid techniques and is rarely used today. The ileal conduit, first described by Seifert in 1935 and popularized by Bricker in 1950, remains the most common form of noncontinent urinary diversion practiced worldwide today, and is the standard to which all other urinary diversions are compared.[1] Continent cutaneous diversions using detubularized colonic segments requiring timed intermittent self-catheterization obviated the need for external collection devices; these diversions gained popularity in the 1980s and are still applied today in patients for whom an orthotopic urethral diversion is not possible. Orthotopic bladder substitutes most closely approximate the native bladder, and therefore potentially offer the best quality of life. However, the hunt for an ideal bladder substitute continues. Advances in tissue engineering and stem cell research may result in the use of autologous biologic bladder substitutes, alleviating the common metabolic complications seen in the current form of urinary diversions.[2]

Choice of Bowel Segment

The most commonly used urinary diversions involve distal ileum and/or cecum along with ascending or sigmoid colon because they have the least affect in terms of metabolic consequences. Electrolyte and metabolic abnormalities differ based on the bowel segment used for urinary diversion. While most metabolic abnormalities are clinically subtle, they may assume significance in patients with renal insufficiency and in adolescents and young adults who are subjected to the metabolic abnormalities for a prolonged period. Table 1 demonstrates the primary indications for the use of various bowel segments and the associated metabolic consequences and symptomatology associated with each segment of bowel.[3-7]

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Table 1 Primary Indications and Metabolic Consequences for Use of Bowel Segments[7-24]

Bowel Segment	Primary Indication	Metabolic Consequences	Clinical Symptoms
Gastric	• Children requiring diversion (extrophy, pelvic radiation) • Renal insufficiency	Metabolic alkalosis (↓ K, Cl, hypergastrinemia)	• Hematuria-dysuria syndrome • Dehydration, lethargy, seizures, respiratory distress
Jejunum	• Pelvic radiation • Deficient ureteral length • Compromised viability of other small or large bowel	Metabolic acidosis (↓ Na, Cl, ↑ K, azotemia)	Dehydration, nausea/vomiting, weakness, lethargy, seizures
Ileum or ileal-colic reservoirs	• Malignancies requiring removal of the bladder • Severe hemorrhagic cystitis • Incontinence	Metabolic acidosis (↑ Cl, ↓ bicarbonate, azotemia)	• Fatigue, anorexia, weight loss, diarrhea, polydipsia • B_{12} and fat soluble vitamin deficiency • Diarrhea, urinary calculi, cholelithiasis
Colon (ureterosigmoidostomy)	• Children requiring diversion (extrophy, pelvic radiation) • No other bowel segment alternative	Metabolic acidosis (↑ Cl, ↓ bicarbonate, azotemia)	• Fatigue, anorexia, wt. loss, diarrhea, polydipsia • Pyelonephritis • Adenocarcinoma at anastomotic site
Transverse colon conduit	• Malignancies requiring removal of the bladder • Small bowel not practical	Metabolic acidosis (↑ Cl, ↓ bicarbonate, azotemia)	• Fatigue, anorexia, wt. loss, diarrhea, polydipsia • Pyelonephritis • Adenocarcinoma at anastomotic site

Ileal Conduit or Ileal-Colic Reservoirs

Hyperchloremic metabolic acidosis is the most common metabolic abnormality with the use of ileum and colon.[7] This derangement results from a net absorption of ammonium and chloride from the urine. The sodium in the Na^+/H^+ antiport is replaced by ammonium,[8,9] while a bicarbonate ion is excreted in exchange for a chloride ion. The net gain of chloride ions and loss of bicarbonate results in the acidosis. Hypokalemia is a common finding in these patients, especially those in whom a segment of colon is used because ileum has a better capability to absorb potassium.[10] The metabolic complications are accentuated in patients with compromised renal function because of decreased compensatory reserves for the increased acid load.

Patients with continent urinary diversions are more likely to develop metabolic sequelae because of the larger segment of bowel utilized and the increased contact time between the urine and the absorptive surface of the bowel mucosa.[11] Treatment of hyperchloremic metabolic acidosis includes correction of acidosis with concurrent potassium repletion. Alkalinization is usually achieved with sodium bicarbonate, sodium citrate, citric acid, or combined potassium and sodium citrate.[10] Chlorpromazine[12] or nicotinic acid[13] also have been used successfully in some patients in whom sodium or potassium overload is undesirable.

In addition, the terminal ileum and ileocecal valve are important sites for reabsorption of vitamin B_{12} and bile acids. Megaloblastic anemia and impaired myelin production are consequences of vitamin B_{12} deficiency. The body's main storage site of vitamin B_{12} is found in the liver, and it is estimated that 3 to 4 years would be required to completely deplete normal vitamin B_{12} stores. Extensive resection of ileum (>60 cm) is associated with an increased risk of B_{12} malabsorption[14,15]; it is therefore recommended that testing for vitamin B_{12} levels start 2 years after diversion. Nearly 95% of bile acids are reabsorbed in the terminal ileum. Removal of small segments of the ileum or colon rarely leads to significant changes in lipid absorption. Resection of larger segments of ileum (>100 cm) or the ileocecal valve has been associated with malabsorption of lipid with consequent steatorrhea and diarrhea. Lipid-soluble vitamins (A, D, E, and K) may subsequently become deficient.

Gastric Conduits or Reservoir

The metabolic derangement unique to the use of stomach for a reservoir is hypokalemic, hypochloremic metabolic alkalosis.[16] Another distressing complication limited to the use of stomach is the hematuria-dysuria syndrome that is caused by excess acid secretion and characterized by suprapubic pain, hematuria, and dysuria.[17,18] H2 blockers or proton pump inhibitors are usually effective for both of the above mentioned complications.