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Orthotopic Bladder Substitution (Neobladder)

Part II: Postoperative Complications, Management, and Long-term Follow-up

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ABSTRACT

Bladder replacement following radical cystectomy is widely practiced and in some centers has become the standard method of urinary diversion when possible, rather than the traditional ileal conduit. To minimize the impact of cystectomy and bladder replacement on quality of life and to obtain optimal functional results, postoperative care must be comprehensive and multidisciplinary. Critical team members include the surgeon, urologic nurses, WOC nurses, and allied health care providers such as physiotherapists. This article highlights postoperative considerations for patients undergoing radical cystectomy with orthotopic neobladder construction. The common issues and complications that arise are discussed with a focus on strategies to optimize outcomes.

KEY WORDS: bladder cancer, bladder replacement, neobladder, orthotopic bladder substitution,radical cystectomy

Introduction

Bladder cancer (BC), a form of urothelial cancer, is the fourth most common urologic malignancy in men and ninth most common in women.[1] The incidence of BC increases with age; 80% of patients are between 50 and 80 years of age. In Western countries, more than 90% of BCs are transitional-cell carcinoma (TCC); most of the remaining tumors are squamous cell carcinomas.[2-4] Definitive diagnosis of BC requires surgery to obtain bladder tissue, which is closely examined to determine tumor grade (degree of cell differentiation) and tumor stage (degree of spread). The stage of the tumor is the most important prognostic indicator and predictor of survival for patients with invasive tumors. Urothelial cancers are typically staged and graded using the tumor node and metastasis system.[5,6] The tumor node and metastasis system for urothelial tumors is based on how deeply the tumor has grown into the bladder (T), whether there is cancer in the lymph nodes (N), and whether cancer has spread to other parts of the body (M).

Depending on tumor grade and stage, the "gold standard" treatment for BC is radical cystectomy with lymphadenectomy and urinary diversion.[7,8] Indications for radical cystectomy include tumor invasion into the muscle or prostate; high-grade invasive tumor associated with carcinoma in situ, including those refractory to intravesical chemotherapy or immunotherapy; recurrent multifocal superficial disease refractory to transurethral resection with or without intravesical therapy; and palliation for patients with persistent pain, frequency, and hematuria. Options for urinary diversion include ileal conduit, continent urinary reservoir, and orthotopic neobladder.[8] Choosing a diversion technique reflects a balance between the morbidity associated with the surgery and its anticipated impact on health-related quality of life.[7,9,10] Other malignancies or even benign conditions may necessitate cystectomy and would also be valid reasons for considering creation of an orthotopic neobladder.

The purpose of this article was to review orthotopic bladder substitution following cystectomy, focusing on the role of specialty practice nurses in preventing and responding to potential complications. This article is the second in a series of articles describing how our team

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manages patients undergoing radical cystectomy and orthotopic neobladder construction.

Orthotopic Bladder Substitution (Neobladder)

The term orthotopic neobladder is defined as a new bladder that is created as a substitute for the patient's native bladder. This "new bladder" is constructed from a segment of bowel that has been reconfigured to serve as a urinary reservoir (Figure 1). Because it is a bladder substitute, there are a number of ways in which it fails to perform as effectively as the original bladder. Nevertheless, this form of urinary system reconstruction most closely replicates the function of the original bladder and it is gaining popularity in some centers. Various surgical techniques have been described for construction of the neobladder. It often involves isolation of a 50- to 70-cm segment of ileum, colon, or a combination of ileum and colon from the fecal stream. The bowel segment is detubularized and shaped into a spherical reservoir for urine storage.[11] The ureters are implanted into the reservoir, which is then anastomosed to the patient's native urethra. The striated sphincter mechanism of the urethra (rhabdosphincter) is left intact, and continence is preserved in most patients. The neobladder is designed to be a large-capacity, low-pressure reservoir; its average capacity is 400 to 500 mL of urine.

Selection Criteria

Indications for constructing an orthotopic neobladder were discussed in detail in the first article in this 2-part series, as were relative contraindications.[8,12-16] When counseling the patient preoperatively, it is essential for the multidisciplinary team to answer all questions as clearly and fully as possible so that the patient gains a clear understanding of the potential advantages, disadvantages, and functional outcomes of each urinary diversion option (ileal conduit, continent urinary diversion, and orthotopic neobladder). Studies suggest that patients who are thoroughly educated and encouraged to select the diversion that seems best are generally satisfied with their decision over time.[12,13] Ideally this education and counseling are completed over multiple preoperative visits.

While improvements in patient selection and perioperative care have reduced morbidity and mortality following radical cystectomy, the functional consequences associated with urinary diversion remain challenging. Some researchers argue that health-related quality of life for patients undergoing orthotopic neobladder procedure may be superior to that experienced by patients undergoing other types of urinary diversion; however, this point remains controversial.[12-16] Complications following orthotopic neobladder may be classified as early or late. Early complications are typically defined as occurring within 30 days of surgery, although some authors consider

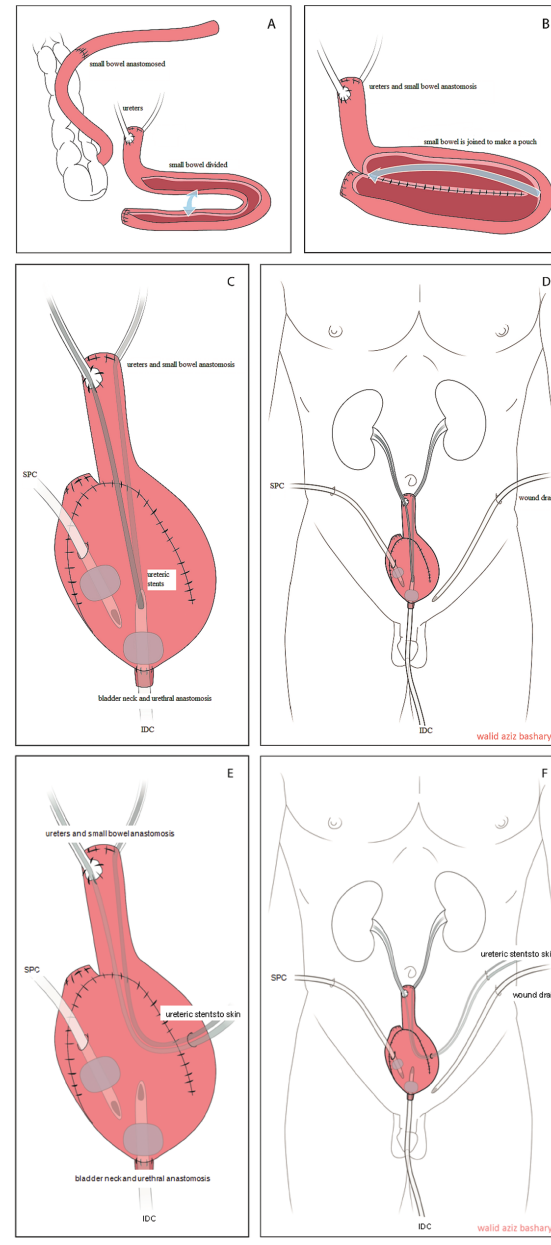

FIGURE 1. Orthotopic bladder substitution ("neobladder"). (A) An ileal segment of approximately 50 to 70 cm is isolated proximal to the ileocecal valve and bowel continuity is restored. (B) The distal ileal segment is divided along the antimesenteric border and the ureters are anastomosed in an end-to-side fashion to the unopened part of the tubular segment. (C) Closure of the 2 distal antimesenteric borders of the opened ileum is performed, and the bladder substitute is anastomosed to the native urethra. Ureteric stents are internalized by suturing them to the tip of the indwelling catheter (IDC). (D) Suprapubic catheter (SPC), indwelling Foley urinary catheter (IDC), and wound drain postoperatively. (E) Ureteric stents are more often brought out to the skin. (F) An SPC or equivalent is optional but generally used while an indwelling Foley catheter (IDC) and wound drain are always used. Figure illustrated by Walid Aziz. Copyright Nathan Lawrentschuk. Reproduced with permission.

the "early postoperative period" to be 60 or even 90 days following surgery. Early complications include anastomotic leakage, acute renal failure, urinary tract infection (UTI), wound infection/dehiscence, prolonged ileus, and complications that may occur following any major surgery, such as hemorrhage, sepsis, cerebrovascular accident, acute myocardial infarction, deep vein thrombosis, pneumonia, and lymphedema of the lower limbs. Late complications include ureteral obstruction, acute pyelonephritis and urosepsis, metabolic changes including hyperchloremic metabolic acidosis and bone demineralization, bladder stones, urethral stricture, rupture of the neobladder, incisional hernia, and fistula formation.[11,14,15,17-26] Studies indicate that approximately 15% to 30% of patients experience complications following neobladder construction.[14-16]

Postoperative Management

The management of patients undergoing orthotopic neobladder construction begins preoperatively and continues postoperatively, with the goals of preventing complications and optimizing functional outcomes. Postoperative neobladder management can be divided into 3 phases: (1) immediate postoperative period; (2) period following catheter removal; and (3) long-term management and surveillance. Seamless coordinated care and education are essential to reduce patient anxiety and assure optimal outcomes; such care is dependent in large part on urologic and WOC specialty practice nurses. In addition to providing critical education, the nurses and nurse specialist must monitor for possible complications and must intervene promptly should complications occur.

General postoperative complications are described in detail in other publications[27-29] and are not the focus of this article. Tables 1 and 2 provide a brief summary of these complications and their management. The discussion in this article focuses complications and issues most relevant to the orthotopic neobladder procedure.

Immediate Postoperative Nursing Management

The patient must be closely monitored in the postanesthesia care unit and postsurgical unit. Maintenance of fluid balance is of critical importance; thus, all administered fluids and all output must be accurately measured and recorded, and daily weights are recommended (Figure 1). Crystalloid and plasma expanders used during surgery may lead to serum hyperosmolarity and edema and can delay healing of the abdominal incision and intestinal anastomosis. Therefore, intravenous therapy with 5% glucose solution and furosemide 10 to 20 mg/d is standard practice in our setting for mobilization and excretion of retained fluids in our setting. Postoperative pain is anticipated; we use an epidural catheter for analgesia, whenever possible.

Radical cystectomy is associated with a high rate of prolonged postoperative ileus, reported incidence rates are as high as 17%.[27] The pathogenesis of ileus is multifactorial; contributing factors include activation of inhibitory reflexes, production of inflammatory mediators, and the effects of exogenous and endogenous opioids.[28] Clinical manifestations of prolonged postoperative ileus include failure to tolerate solid foods, failure to pass flatus and stool, decreased or absent bowel sounds, abdominal distention, and nausea and vomiting.[29-31]

Strategies for reducing postoperative ileus include early removal of the nasogastric tube, early feeding, administration of total parenteral nutrition, increased ambulation, and use of chewing gum.[32] To date, studies provide no evidence that nasogastric drainage prevents or reduces the incidence of ileus following intestinal procedures, and there is a trend to minimize the use of nasogastric tubes as a result.[32] We have observed that some surgeons avoid the use of nasogastric or gastrostomy tubes or remove them shortly after surgery, while other surgeons leave the tube to free (gravity) drainage with manual irrigation and aspiration at routine intervals until bowel activity returns. Recent studies in the colorectal literature advocate the use of chewing gum to reduce postoperative ileus; it has been postulated that gum chewing acts as a sham feeding and stimulates the cephalic-vagal reflex, thus causing increased hormonal secretion and mechanical stimulation of the gastrointestinal tract.[32] We advocate early feeding or the use of total parenteral nurtrition to stimulate peristaltic activity and to minimize the catabolic state commonly associated with major surgery. One other strategy advocated by some clinicians and authors is the combined use of nasogastric drainage and prokinetic agents such as metoclopramide; these authors state that combined therapy reduces the incidence of nausea and vomiting, promotes early return of bowel activity, and reduces the incidence of atelectasis.[33,34]

Catheter and Drain Management

The most important aspect of management during the immediate postoperative period is routine irrigation and aspiration of the neobladder to prevent catheter blockage (Figure 1). In some centers, irrigation is avoided during the first 48 to 72 hours following surgery to avoid the possibility of forcing suture lines open and encouraging a leak; once this period has passed, routine irrigation is initiated and is typically performed every 6 to 8 hours and "as needed." The neobladder is irrigated with 50 to 100 mL of normal saline. Postoperative drains are removed when their output is less than 50 mL/d or when the serum creatinine level of the fluid from the drain confirms that absence of urine. The amount of fluid output from the surgical drains is affected by the extent of lymph node dissection as well as the volume of fluid that

TABLE 1.

Management of Early Complications After Cystectomy and Continent Orthotopic Urinary Diversion

Complications	Signs/Symptoms	Managements
Anastomotic leak	Increase output from drains/decrease urinary output, abdominal fullness, bloating, nausea, lower abdominal pain	CT/cystogram followed by percutaneous nephrostomy. Surgical management if needed.
Urinary tract infection	LUTS, malodorous urine, fever	Antibiotics
Prolonged ileus	Abdominal distension/bloating, reduced/absent bowel sounds, nausea, vomiting	Early removal of NGT, early feeding, TPN, ambulation, chewing gum
Metabolic complication (salt loss syndrome and metabolic acidosis)	Lethargy, nausea, vomiting, dehydration, anorexia, epigastric burning, diarrhea	Recatheterize bladder, increase salt intake, $NaHCO_3$ 2 to 6 g/d, B_{12} and vitamin D supplement, cease PPI
Bladder stone	Intermittent pain	Prevention via regular bladder irrigation and emptying, endoscopic removal
Ureteral/urethral stricture	Increasing creatinine, hydronephrosis, acute renal failure	Endoscopic dilatation and stent insertion
Spontaneous neobladder rupture	High suspicion of rupture	Prevention via regular emptying of bladder
Hernia and fistula	Abdominal lump	Prevention by avoiding straining during bladder retraining, PFE, use of stool softeners to prevent constipation

Abbreviations: CT, computed topography; LUTS, lower urinary tract symptoms; NGT, nasogastric tube; PFE, Pelvic Floor Exercises; PPI, Proton Pump Inhibitor; TPN, Total Parenteral Nutrition.

is "third spacing" from the bowel to the peritoneal cavity. In some patients, the volume of fluid through the surgical drains is more than a liter a day during the first week following cystectomy; high-volume drain output raises concerns regarding a potential urine leak, although in our experience such a leak is extremely rare. When there are concerns regarding a potential anastomotic leak, the fluid should be tested for creatinine. Some advocate that prophylactic antibiotic therapy such as amoxicillin and clavulanic acid be given until the catheter is removed, although higher-level evidence is lacking.[29]

Wound Infection/Wound Dehiscence

The risk of wound infection or dehiscence is no greater with the orthotopic neobladder procedure than with any other abdominal procedure, and the use of nonabsorbable suture is associated with a lower incidence of dehiscence.[35] Infection is a risk factor for dehiscence, although dehiscence can also occur in noninfected wounds that fail to heal normally. The nursing staff must monitor the patient for fever and for incisional redness, pain, or drainage and the development of these indicators should be promptly reported to the physician. Infection and/or dehiscence can usually be managed effectively with conservative measures such as antibiotics and meticulous wound care; occasionally surgical intervention is required for debridement, mesh closure, or skin grafting.

Anastomotic Leak

Urinary extravasation due to anastomotic leaks can lead to significant postoperative issues; this is fortunately a fairly uncommon event in patients undergoing neobladder reconstruction.[9,36] Leaks may result from partial breakdown of the ureteral anastomoses or from breakdown of the anastomotic lines within the neobladder itself. Anastomotic breakdown is more likely when there is increased pressure in the neobladder due to dislodgement or blockage of the catheter draining the neobladder. Therefore, the catheter must be regularly monitored for patency and irrigated as needed. Indicators of anastomotic leakage include increased output from pelvic drains, often accompanied by decreased output from the catheters draining the neobladder. The fluid from the surgical drains should be assessed for creatinine content, and computed tomography or a cystogram may be undertaken to identify the site of urinary extravasation when indicated. Initial management of an anastomotic usually involves temporary urinary diversion (ie, percutaneous nephrostomy tube), continued nonvacuum drainage, and close monitoring. A new drain (either a pigtail catheter or other catheter, and preferably larger than 10 Fr) may be placed via radiologic guidance into any collection of urine if no other drain is present or working. Our clinical experience suggests that surgical intervention is rarely necessary. While anastomotic breakdown is less likely following discharge, patients must be instructed regarding signs and symptoms that require immediate notification of the surgeon or a visit to the emergency department; these include abdominal fullness, bloating, nausea, increasing lower abdominal pain, reduced urinary output, and difficulty with irrigation.[16]

Infection in the neobladder is most likely to occur in the early postoperative period, the infection may be afebrile and limited to the neobladder, or it may be associated with a fever indicating pyelonephritis or even urosepsis. Infections of the neobladder are typically managed with antimicrobials.[37,38] In our center, a urine sample is sent for

TABLE 2.

Management of Long-term Issues

Management Area	Signs/Symptoms	Managements
Psychological support	Disheveled appearance, anxiety/depressive symptoms (inability to sleep, focus, enjoy usual activities; feeling sad much of the time; suicidal thoughts); loss of weight	Provide reassurance and counseling Encourage support group participation Provide educational material Refer to psychology liaison nurse if needed Notify medical staff if suicidal
Social support	Complaints regarding equipment availability; financial stress	Provide access to equipment programs etc Educate family members and friends in availability of equipment/support Refer to social services
Urinary tract infection	Dipstick urine "+" for nitrites and leukocyte esterase; fever; malodorous urine; malaise	Assure appropriate hydration; antibiotics
	Arrange microscopy and urine culture	
Voiding patterns/ continence	Voiding diary assessed for voiding intervals, usual voided volume, postvoid residual urine Reassess pelvic floor muscle strength and endurance Assess for leakage	Retraining, timed voiding, pelvic floor exercises; rarely referral for a sling or sphincter if over 12 to 18 months since surgery and no improvement
Mucous production	Reports of need for self-catheterization/inability to empty effectively due to large clumps of mucus	Hydration, self-catheterization, pharmacologic agents (eg, *N*-acetylcysteine)
Bowel function/diet	Stool elimination patterns postoperatively (check for diarrhea or constipation); abdominal distension/bloating, nausea, vomiting	Encourage appropriate fluid and fiber intake to normalize bowel function; recommend stool softeners if needed
	If any abdominal complaints, assess for hernia or fistula.	Notify MD if any indicators of hernia, fistula or other concerns; vitamin B_{12} and vitamin D supplement
	Check B_{12} and folate levels at least annually	
Sexual function	Assessment of sexual function appropriate to stage of recovery	Education and counseling for patient and partner Consider penile rehabilitation and use of oral agents, injections, or pump therapy for men with erectile dysfunction Recommend dilators and modified positions for intercourse for women with shortened vagina
Renal function	Increasing creatinine, hydronephrosis, or acute renal failure may indicate ureteral or urethral stricture	Referral for further imaging Endoscopic dilatation and stent insertion
Metabolic function	Increasing lethargy, general malaise with no obvious reason	Recatheterize bladder if indicated Increase salt intake, $NaHCO_3$ replacement at 2 to 6 g/d in conjunction with medical team
	Check electrolytes and particularly examine for metabolic acidosis	
Oncology follow-up	Recent imaging and blood results, cytology	Communicate suspicious results or missed follow-up to the team Arrange follow-up if normal Endoscopy of neobladder as required

culture and sensitivity testing 24 to 48 hours following completion of prophylactic postoperative antibiotic coverage, and further treatment is based on results.

Catheter Removal and Long-term Management

Patient education is a critical element of care throughout the postoperative period and is focused on strategies for effectively emptying the bladder and for gradually increasing neobladder capacity, strategies for optimizing continence, and prompt recognition and appropriate management of any complications (Table 2). Patients are instructed to avoid driving, heavy lifting, and any sexual activity during the first 6 to 12 weeks; normal activities of daily living and light exercise are resumed as tolerated. Patients should be instructed to maintain a balanced diet and to ensure adequate intake of fiber and fluid in order to prevent constipation and straining at stool, which could possibly affect neobladder function and increase the risk of urinary leakage. If needed, stool softeners and mild laxatives may be added to ensure normal bowel function. Issues that should be covered in most postoperative visits are outlined in Table 2.

The urethral catheter is typically removed around postoperative day 10, and removal may be combined with a cystogram to rule out anastomotic leak.[37] If the cystogram confirms that the new reservoir is watertight, the suprapubic catheter can be removed or clamped and the patient can be taught how to void. We have observed that some surgeons clamp the suprapubic catheter but leave it in

place as a backup mechanism for emptying the neobladder if the patient has difficulty emptying through the urethra. Once the suprapubic catheter is removed or clamped and the neobladder allowed to fill, patients can begin to learn the sensations associated with filling. In our experience, patients typically report a sense of abdominal fullness as opposed to the sense of urgency and pressure associated with native bladder filling. Patients must also be taught how to void urine from the neobladder, since it lacks the contractility of a normal bladder. Patients are taught to void in the sitting position and to consciously and completely relax the sphincter and pelvic floor muscles (PFMs). The patient is then instructed to use the Valsalva maneuver to empty the reservoir. Many patients find it helpful to lean forward slightly while keeping the back straight, which further increases abdominal pressure. Patients who have difficulty emptying the neobladder completely may be instructed to exert gentle manual pressure over the lower abdomen and suprapubic area. Men are taught to "milk" the urethra to eliminate any residual urine.

Patients are taught to empty the neobladder on a scheduled basis, in order to gradually increase capacity while preventing excessive distention and the risk of rupture. In our experience, the newly created neobladder has a capacity of about 150 to 200 mL; our long-term goal is to attain a capacity of about 400 to 500 mL. During the first week, the patient is instructed to void every 2 hours during the day and every 3 hours at night; patients are encouraged to use an alarm clock to assure that they void on schedule. During the second week, voiding intervals are increased to every 3 hours during the day and every 4 hours at night. The schedule is usually adjusted to voiding every 5 to 6 hours during the day and once at night. The voiding schedule should be individualized based on individual patient concerns and issues; for example, the interval may need to be reduced for patients who experience leakage at capacity. Urinary pH is another factor to be considered when determining optimal voiding interval; patients whose urine becomes alkaline with longer voiding intervals should have their schedule adjusted to maintain an acidic urine. We check urinary pH once during the period of progressively lengthened voiding intervals; we also check serum markers of acid-base balance, such as bicarbonate levels. If the urine is acidic, serum bicarbonate levels are normal, and the patient remains asymptomatic, no further monitoring is indicated. If abnormalities of urine pH or serum markers of acid-base balance are noted, or if the patient becomes symptomatic, we monitor urinary pH for as long as needed.

The patient's ability to effectively empty the neobladder is monitored through postvoid residual urine measurements. For patients who remain in hospital during this phase, nursing staff measure postvoid residual urine volumes, using a bladder scanner. Patients who are at home and whose suprapubic catheter remains in place but clamped are taught to void and to record the volume and then to open the suprapubic catheter and to drain and record the residual volume. Patients whose suprapubic catheter has been removed must use clean intermittent self-catheterization (CISC) to assess postvoid residual volumes. Patients are instructed to maintain meticulous bladder logs detailing time and amount of each void and volume of postvoid urine following each void and to take those logs during each clinic visit for evaluation. The majority of patients quickly learn to effectively empty the neobladder with the voiding techniques described previously; those who are unable to empty effectively must use CISC to prevent stasis and the resulting complications. Although no precise definition of problematic retention exists, we teach patients to perform CISC when residual volumes are greater than 200 mL or the patient experiences recurring UTI.

Since the neobladder is constructed from loops of bowel, patients are counseled that it is normal for the urine to contain mucus. In many centers, patients are taught to routinely irrigate the neobladder with normal saline to eliminate retained mucus, beginning with 50 cc and repeating until mucous and debris clears. We advise patients to irrigate on a daily basis to avoid blockages. Patients are also encouraged to maintain adequate fluid intake (about 2-3 L of fluid per day) for general health maintenance, to reduce the risk of UTI and constipation, and to keep the mucus thin enough to pass during micturition or with CISC.

Strategies to Promote Continence

Incontinence is a common problem during the initial postoperative period, and restoration of continence is an important goal for most patients. Patients are taught PFM exercises preoperatively, and this instruction is reinforced continually during the postoperative period. The clinician assesses the patient's ability to perform a correct PFM contraction, baseline pelvic muscle strength and endurance, and the ability to brace and hold PFM contractions in situations resulting in increased intra-abdominal pressure, such as coughing, bending, and lifting. A baseline assessment is obtained using 2-channel electro-myographic; this assessment is used to individualize the home training program as indicated. In our center, strength training is done at a maximum frequency of 3 times a day, with a 6-second hold and 12 repetitions; endurance training is completed once daily with a 60-second hold as the goal, and dynamic functional bracing is incorporated into usual daily activities (contracting the PFMs before coughing, bending, etc).

Once the patient achieves continence, we encourage a maintenance exercise regimen that incorporates strength and endurance exercises once daily. Our practitioners use bladder charts and pad weight tests as an outcome measure. Patients are asked to do a pad weight test once a week until improvement plateaus. The long-term goal is a 90% daytime continence rate and 80% nighttime continence rate; we define 80% continence as 20 mL of leakage, and

90% continence as leakage limited to 10 mL. Most patients achieve continence 6 to 12 months following surgery. Our clinical experience suggests that the benefit of actively involving patients in their own recovery through monitoring leakage and performance of pelvic muscle exercises is substantial.

Metabolic Complications

The potential metabolic consequences of incorporating an ileal segment into the urinary tract are a result of both the preternatural exposure of intestinal mucosa to urine and the removal of the ileal segment required for the reconstructive procedure.[39] The negative consequences of urine exposure to the intestinal mucosa are affected by several factors, including the length and surface area of intestinal mucosa exposed to urine, contact time between the urine and intestinal mucosa, urinary ionic concentration and pH, and renal function. A completely detubularized (spherical-shaped) reservoir provides optimal capacity with the least amount of mucosal surface exposed to urine giving the largest volume of urine for the smallest mucosal surface area.[19,21,26,29,39,40]

Due to the exchange of ions across the intestinal mucosa between the urine and the blood, salt loss syndrome and metabolic acidosis are fairly common metabolic complications, occurring in up to 25% of patients. Fortunately, the majority of patients have only mild metabolic abnormalities, but 1% to 2% will experience clinically relevant metabolic complications that can become a chronic problem if not managed early.[19,21,26,29,40] These problems arise because of abnormalities in cation and anion exchange that occur as a result of urine exposure to intestinal mucosa. Because urine contains large amounts of ammonium ($NH4^+$), hydrogen (H^+), and chloride (Cl^-), these ions are absorbed into the blood stream, and there is parallel secretion of bicarbonate (HCO_3^-) and sodium (Na^+) into the urine. In short, Na^+ is secreted in exchange for H^+ and HCO_3^- for Cl^-, resulting in metabolic, hyperchloremic, and hyperkalemic acidosis.[39] Patients are at particular risk for developing salt loss syndrome and metabolic acidosis when the reservoir catheters are removed, because the hyperosmolar urine is then in prolonged contact with the bowel mucosa. Metabolic acidosis is worsened by UTI, which can lead to further dehydration. In our center, venous blood gas analysis is done routinely 2 to 3 days after removal of catheters to ensure positive base excess and to evaluate metabolic acidosis. Symptoms of metabolic acidosis include lethargy, nausea, vomiting, dehydration, anorexia, and epigastric burning; prompt workup is required for patients who develop these symptoms. In severe cases of urosepsis and acidosis, hospitalization for intravenous antibiotics and intravenous rehydration and electrolyte correction may be required. Early interventions for symptoms of metabolic acidosis include recatheterization of the neobladder, increased salt intake, correction of acidosis with 2 to 6 g of $NaHCO_3$ daily, discontinuation of any proton pump inhibitors, and treatment of UTI. Our experience suggests that prompt treatment may relieve chronic metabolic acidosis and resulting bone demineralization. Some patients will remain on bicarbonate supplementation for life while others gradually develop compensatory mechanisms that maintain acid-base balance; this usually occurs after 12 months. Regular monitoring of serum electrolytes and/or urinary pH is required for these patients.[39]

The second type of metabolic complication is due to the impact of ileal resection and loss of that absorptive surface. Loss of portions of the terminal ileum may result in altered reabsorption of bile acids with resulting fat malabsorption with impaired absorption of the fat-soluble vitamins A, D, E, K, and B_{12} (cyanocobalamin).[39] Extensive resection of the terminal ileum with removal of the ileocecal valve may result in severe B_{12} deficiency and compromised bile acid absorption[38]; clinical indicators include peripheral neuropathy, fatigue, and activity intolerance secondary to B_{12} deficiency. Additional manifestations include diarrhea, increased renal oxalate levels, and gallbladder stone formation secondary to bile acid loss. However, preservation of the ileocecal valve and most of the terminal ileum has greatly diminished the incidence of these complications.

Patients should be counseled that they may experience initial alterations in bowel function as a result of use of the bowel to create the reservoir; however, they also may be counseled that these alterations are rarely long-term. If diarrhea persists, treatment can be initiated with fat-binding agents, stool thickeners, and antidiarrheal agents. Consultation with a dietitian prior to hospital discharge is routinely conducted in our center to educate patients about diet and bowel management following neobladder construction.

Bladder stones are relatively common in patients with orthotopic neobladders affecting 10%-20%, and the incidence is higher in patients who are immobile and in patients whose neobladders were constructed using staples.[41] Stone formation is more likely in the presence of UTI and alkaline urine; the organisms most commonly cultured from patients with neobladder stones are the urea splitting organisms *Proteus mirabilis*, *Providencia*, and *Klebsiella*. Most of the stones that develop in the reservoir of a neobladder are struvite composed of triple phosphates.[42] The presence of stones increases the risk of UTI, which can precipitate a vicious cycle of infection leading to stone formation, which in turn increases the risk of recurrent infection. Neobladder calculi are managed endoscopically when the stone is small (<5 cm); larger stones may require open removal. Regular emptying of the neobladder, combined with routine irrigation, may reduce the incidence of stone formation.

Ureteroileal strictures are not uncommon, affecting around 5% to 15% of patients.[43,44] We treat ureteroileal

strictures with percutaneous nephrostomy to decompress the renal drainage system, followed by antegrade balloon dilatation of the strictured area and insertion of a stent. Endoscopic techniques such as laser therapy are typically successful in only a third of cases; additional options for long-term management include surgical revision or, rarely, long-term stents. When surgical revision is required for persistent stricture or when the stricture involves a significant length of the ureter, an open minimally invasive approach may be used. Urethral stricture occurs in around 5% of cases; clinical manifestations include reduced force of the urinary stream and difficulty emptying the neobladder.[37] Urethral strictures are typically managed by internal urethrotomy, although long-term self-dilatations may be required in selected cases.

Spontaneous bladder rupture is a rare (<1%) late complication caused by excessive distention, compromised perfusion, or blunt trauma; rupture ranges from a microscopic tear to major disruption of neobladder integrity.[37] The region where the radius of the reservoir is smallest, just proximal to the urethral anastomosis, is at highest risk for rupture. Effective management requires prompt detection and early surgical intervention to repair the neobladder.[45,46] Prevention focuses on emptying the reservoir on schedule and voiding promptly in response to the sensation of reservoir fullness. Patients are also taught to immediately report any signs/symptoms of rupture (abdominal distention, pain, and tenderness, and reduced urinary output despite no change in intake) to their surgeons. Patients who present with signs of possible rupture (poor urine output, tender abdomen, and signs of peritoneal inflammation) must be promptly evaluated with a computed tomographic scan with cystography; plain cystogram may miss a rupture and is therefore considered insufficient.

We have observed that incisional hernia may occur early due to wound dehiscence, and inguinal or abdominal hernia may present as a long-term complication due to chronic straining while voiding. Fistula formation in orthotopic neobladder is extremely low.[15] Fistulas may develop between the intestine and the reconstructed urinary tract or from either of these to the skin or adjacent organs. They are managed by conservative measures initially (low-residue diet or total parenteral nutrition); surgical intervention is indicated for patients who fail conservative therapy or who develop signs of sepsis.

Long-term Surveillance

Desirable outcomes for a neobladder patient include minimal or no postvoid residual volume, urinary continence, and absence of infection, metabolic complications, or upper tract obstruction. Our experience strongly suggests that achieving optimal long-term outcomes for neobladder patients depend not only on the surgeon's surgical skill and appropriate patient selection but also on good postoperative care, patient education, and patient compliance with voiding schedules and pelvic muscle exercise programs.

Routine follow-up for our neobladder patients includes an initial follow-up visit 3 to 6 weeks after surgery, at which time pathology results are reviewed and a treatment and surveillance plan is developed by a multidisciplinary team and the patient. Subsequent follow-up is typically provided at 3-month and then 6-month intervals; clinic visit are characterized by a focused physical examination, urine culture, body weight, blood tests, and measurement of a postvoid residual volume. We obtain an intravenous urogram (pyelogram) annually for the first 3 years, followed by intravenous urography at the fifth postoperative year. Renal ultrasound is done every 3 months for the first 6 months and yearly thereafter. Pelvic/abdominal computed tomography is performed 6 months after surgery, and bone scans are done at 6 and 18 months postoperatively. Chest x-ray and cytology of cells obtained by urethral lavage are completed every 6 months for the first 2 years and annually thereafter; this lavage may be done with a catheter or with a flexible cystoscope. Folic acid and vitamin B_{12} levels are checked 2 years after surgery and then annually thereafter.[29,47] Table 3 provides a recommended surveillance for neobladder patients that has been adapted from Varol and Studer.[47]

Recovery of sexual function depends on patient age and the specific surgical technique (nerve sparing vs standard). Erectile dysfunction in men and dyspareunia in women are common for the first 3 to 6 months after surgery.[30,31] We counsel patients to anticipate this outcome and reassure them that additional treatment options are available if sexual dysfunction persists following this time period.

Psychologic and Social Support

In most instances, the urologic or WOC nurse acts as a primary source for psychologic support and ongoing education throughout the rehabilitation period and during routine follow-up. Our clinical experience strongly suggests that the encouragement, reassurance, and counseling provided by these specialty practice nurses are essential for achieving successful outcomes. Connection with the various BC support networks and neobladder support groups should be made available and facilitated where requested. The specialty practice nurse should have access to printed, electronic, and online resources for patients with an orthotopic neobladder. We also find that specialty practice nurses act as an invaluable resource for patients seeking to gain access to cost-effective medical equipment and supplies such as catheter and continence pads. Patient or family members who do not show signs of positive adaptation to a neobladder may be referred for psychologic counseling in consultation with the physician. These patients also may benefit from referral to a social services professional.

TABLE 3.

Surveillance of Patients Postcystectomy and Continent Orthotopic Urinary Diversion

Months	3	6	12	18	24	30	36	42	48	54	60
Clinical examination	x	x	x	x	x	x	x	x	x	x	x
Urine MCS	x	x	x	x	x	x	x	x	x	x	x
Body weight	x	x	x	x	x	x	x	x	x	x	x
Blood tests[a]	x	x	x	x		x		x		x	x
PVR	x	x	x	x	x	x	x	x	x	x	x
IVU			x		x		x		x		x
Ultrasound scan	x	x		x		x		x	x	x	
Pelvic/Abdominal CT		x									
Bone scan		x		x							
CXR		x	x	x	x		x		x		x
Urethral lavage		x	x	x	x		x		x		x
Folic acid and vitamin B_{12}					x		x		x		x

Abbreviations: CT, computed tomography; CXR, chest x-ray; IVU, intravenous urogram; MCS, Microscopy, culture with sensitivities; PVR, postvoid residual.

[a]Serum electrolytes (including bicarbonate and some add a venous blood gas analysis); full blood examination and liver function tests. If the bicarbonate is abnormal, this may prompt a formal arterial blood gas analysis

Conclusions

Orthotopic neobladder has become the urinary diversion of choice in many settings; but achieving positive long-term outcomes for these patients requires the coordinated effort of a multidisciplinary team. Critical elements of effective management include prevention of early postoperative complications, patient instruction in voiding techniques and pelvic muscle exercises, and ongoing monitoring and prompt intervention for potential complications such as metabolic complications, UTI, and stone formation. Patients must also be counseled regarding postoperative sexual dysfunction.

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