Orthotopic Ileal Neobladder: Past, Present, Future

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I. Past
The goals of urinary diversion have evolved from simple diversion of the upper tract to functional and anatomical restoration as close as possible to the natural state. This evolution of urinary diversion has developed along three distinct paths of incontinent cutaneous diversion (conduit); continent, cutaneous diversion (pouch); and, most recently, continent urinary diversion to the intact native urethra (neobladder, orthotopic reconstruction). During the last 15 years, orthotopic reconstruction has evolved from "experimental surgery" to "standard of care at larger medical centers" to the "preferred method of urinary diversion" in both sexes. During the last decade, the time-honored conduit has given way to the increasingly frequent use of orthotopic reconstruction.

II. Present
Substantial change in paradigm.
The goal of patient counseling about urinary diversion should be to determine the method that is the safest for cancer control, has the fewest complications in both the short- and long-term, and provides the easiest adjustment for the patients' lifestyle, supporting the best quality of life. The paradigm for choosing a urinary diversion has changed substantially. In 2005 all cystectomy patients are candidates for a neobladder, and we should identify patients in whom orthotopic reconstruction may be less ideal. The proportion of cystectomy patients receiving a neobladder has increased at medical centers to 50-80%.

Patient selection criteria: Absolute and relative contraindications.
Absolute contraindications to continent diversion of any type are compromised renal function as a result of long-standing obstruction or chronic renal failure with serum creatinine above 150-200 μmol/L. Severe hepatic dysfunction in also a contraindication to continent diversion. Patients with compromised intestinal function, particularly inflammatory bowel disease, may be better served by an conduit. Absolute contraindications to orthotopic reconstruction are all patients in whom simultaneous urethrectomy is indicated based on their primary tumor. The role of relative contraindications and comorbidities is steadily decreasing. However, some of them, such as mental impairment, external sphincter dysfunction, or recurrent urethral strictures, deserve serious consideration.

Patient factors: Pro
The primary patient factor is the "patient's desire for a neobladder." The patient needs a certain motivation to cope with the initial and sometimes lasting inconveniences of nocturnal incontinence associated with a neobladder. Most patients readily accept some degree of nocturnal incontinence for the benefit of avoiding an external stoma and pouch, but not all patients do, and realistic expectations of the functional outcome are essential for both the surgeon and the patient. The psychologically-damaging stigma to the patient who enters surgery expecting a neobladder but awakens with a stoma plays an increasing role. It should always be remembered that in many parts of the world, a bag may either be socially unacceptable or economically unrealistic as a long-term solution. These pressures drive the urologist toward some form of continent urinary diversion, and although rectal pouches have been used widely as alternatives to conduits, continent catheterizable reservoirs or orthotopic bladder substitutes in particular represent attractive options.

Patient factors: Against
There are still patients who are better served with a conduit. Patient factors against a neobladder are:
- If the patient's main motivation is to "get out of the hospital as soon as possible" and resume normal, rather sedentary activities. Many frail patients undergoing cystectomy will have less disruption of normal activities with a well-functioning conduit than an orthotopic reservoir associated with less than ideal continence.
- The "little old lady" living in social isolation.
No concern about body image. Most older patients do not have the same cosmetic concerns that a younger patient might have, and their main goal is returning to their previous lifestyle, which is often quite sedentary.

**Patient selection criteria: oncologic factors**

Following cystectomy, the rhabdosphincter must remain intact. Nevertheless, the cancer operation must not be compromised. This concern applies to two aspects of selection: Urethral tumor recurrence in men and the use of orthotopic replacement in women:

First: One of the initial deterrents to orthotopic diversion is the risk for urethral recurrence of cancer. See below.

Second: Orthotopic bladder substitution for women with invasive bladder cancer has been popularized recently. For oncological justification see below.

Increasing experience with orthotopic reconstruction has fostered less restrictions for patient selection based on tumor stage. Should extensive pelvic disease, a palpable mass, or positive but resectable lymph nodes preclude a neobladder because of the high propensity for a pelvic recurrence or distant relapse? There is no convincing evidence that a patient with an orthotopic diversion tolerates adjuvant chemotherapy less well or that a pelvic recurrence is any more difficult to manage with a neobladder than after an ileal conduit. Patients can anticipate normal neobladder function until the time of death.

However, adjuvant chemotherapy may substantially weaken the patient and prolong the time for neobladder maturation. Nevertheless, our philosophy respects the patient’s desire for a neobladder; if the patient is strongly motivated he or she can get a neobladder. Even though the patient has a poor prognosis and relapse is likely to occur, we still try to construct the diversion they want. Preoperative radiation therapy, especially with an advanced cancer, usually mitigates against an orthotopic diversion but does not absolutely preclude it. However, all patients should be informed that diversion to the skin either by a continent reservoir or ileal conduit may be necessary due to unexpected tumor extent and an appropriate stoma site should be marked on the abdominal wall beforehand.

**Current practice**

Despite the fact that orthotopic bladder replacement provides the ideal method of urinary diversion after cystectomy, many patients treated outside of centers are dedicated to neobladder reconstruction receive an ileal conduit. Why? These patients often have adverse clinical factors such as increased age, more comorbidities, and more previous therapy, including patients with previously deemed unresectable cancers undergoing desperation cystectomy or after failed combined radiation therapy and chemotherapy regimens.

Thus, despite a strong desire to offer orthotopic diversion whenever possible, some patients do not qualify on the basis of current clinical judgment. An ileal conduit remains an expedient, safe, and appropriate method of diversion in these patients. Many factors go into the decision to perform a urinary diversion and must be kept paramount in discussing the pros and cons of each method with the patient and his or her family.

**Is reflux prevention necessary?**

A simple end-to-side freely refluxing anastomosis into an afferent limb of a low pressure orthotopic reservoir, in combination with regular voiding and close follow-up, is the procedure with the lowest overall complication rate. Continued peristalsis in the afferent ileal limb reduces but does not eliminate reflux. The potential benefit of "conventional" antireflux procedures in combination with orthotopic reconstruction seems outweighed by the higher complication and associated re-operation rates.

**Upper tract safety (long term)**

Renal deterioration following orthotopic reconstruction with an afferent ileal limb is minimal at 10 years follow-up. Close follow-up is required in order to identify correctable causes early, particularly stenosis. Those with pre-existing renal pathology seem to be at greatest risk of postoperative renal deterioration. Orthotopic reconstruction produces a safe long-term metabolic outcome for patients with normal bowel and renal function who undergo close follow-up. Many patients will develop mild compensated acidosis with few clinical symptoms but require bicarbonate supplementation. If the terminal ileum has been resected, some will require vitamin B12 supplements once body stores have been depleted.

**Are nipples dead?**

Most reconstructive surgeons have abandoned the continent Kock ileal reservoir with the intussuscepted nipple valve largely due to the technical difficulties in construction and the significant complication rate associated with
the intussuscepted nipple. Alternative and effective techniques for the creation of a continent cutaneous catheterizable mechanism have been developed. This evolution in urinary diversion must not be viewed as a condemnation of the brilliant and pioneering work of Kock and his associates. Rather, these are the natural improvements and refinement of reconstructive surgical techniques that occur over time.

Quality of life
The published literature on quality of life after radical cystectomy is rather extensive. However, the scientific quality is rather low and flaws in patient selection and methodology are common. There is no randomized controlled study. Such study is desirable, but probably difficult to conduct. Published evidence does not support advantage of one type of reconstruction over the others with regard to quality of life. An important reason is probably that patients are subjected to method-to-patient matching preoperatively and thus prepared for disadvantages and advantages with the different methods.

III. Future
a) Sexual preservation in both sexes
There is good data and evidence to suggest that preservation of sexuality with anterior vaginal wall-sparing radical cystectomy in women is appropriate from an oncologic perspective in most women undergoing cystectomy for bladder cancer. In addition, preserving the anterior vaginal wall may improve functional voiding and decrease the risk of pouch vaginal fistulae. In men, prostate-sparing cystectomy should not routinely be performed due to the oncologic risks of prostate cancer and bladder cancer involving the prostate in men with urothelial carcinoma of the bladder. Excellent continence results are seen with radical cystectomy and orthotopic reconstruction to the urethra. Nerve-sparing radical cystectomy is a safer option, but a significant number of patients may require adjuvant treatment for erectile dysfunction. Sexuality-preserving cystectomy may be performed in highly selected young men with good functional results for nonurothelial malignancies.

b) The artificial bladder
Prosthetic organs have been successful in many regions of the body. If a complex organ like the heart can be replaced by a mechanical pump, one can suppose that a simple biological reservoir such as the urinary bladder could also be easily replaced mechanically. However, despite numerous attempts this goal has still not been achieved over the last 50 years.
An artificial bladder should provide adequate urine storage, allow volitional complete evacuation of urine, and preserve the renal function. Moreover, its structure has to be biocompatible, resistant to urinary encrustation, and tolerant to bacterial infection.
Various solutions have been proposed over the years to achieve these multiple requirements. However, most of these solutions and their corresponding prototypes did not advance beyond the stage of a preliminary report of experimental data. Failures were either related to the alloplast used or to the design concept of the prosthetic bladder itself. Recent advances in biomaterials, including advances in alloplasts and in tissue engineering, open the door for new hopes in artificial bladder. My purpose is to review selected historical initiatives and selected evolving new technologies which may contribute to the development of an artificial bladder.

c) De novo cellular and functional reconstruction of a mammalian bladder in vivo will be presented and discussed.

d) Bladder transplant in dogs will also be discussed.