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How to Obtain Good Results with Orthotopic Bladder Substitution: The 10 Commandments

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Article info

Keywords:

Bladder cancer
Cystectomy
Neobladder
Orthotopic reconstruction
Urinary diversion



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Abstract

Context: The orthotopic neobladder has not only withstood the test of time but is increasingly becoming a more desirable method of urinary diversion. Complementing orthotopic neobladder features with adequate training allows patients to return to a urinary routine that is close to, if not completely, normal.

Objective: The preconditions, indications, and contraindications as well as the key points of the surgical technique will be presented by researchers who pioneered this operation.

Evidence acquisition: Experience with and long-term follow-up of orthotopic reconstruction is presented by surgeons at institutions that pioneered orthotopic reconstruction during the last 25 yr with a high surgical volume of radical cystectomy (RCX) and any form of urinary diversion (particularly orthotopic reconstruction).

Evidence synthesis: Ten commandments were developed for achieving good results with orthotopic bladder substitution: (1) The procedure should be performed by a high-volume surgeon; (2) do not overextend the indication; (3) experience with nerve-sparing radical prostatectomy and bowel surgery is mandatory; (4) use ileum whenever possible; (5) maximum detubularisation is a must; (6) use a stented, freely refluxive ileoureterostomy; (7) the low-pressure, compliant, freely refluxive reservoir is standard; (8) be aware of myriad potential complications; (9) a full armamentarium of diversion techniques must be available; and (10) meticulous follow-up must be guaranteed.

Conclusions: Continence and voiding function following orthotopic bladder substitution are determined primarily by characteristics of the reservoir and by a preserved, innervated outlet mechanism. The reservoir should be detubularised and compliant with a low end filling pressure. Ileum seems to be superior to sigmoid or stomach, which can be used when necessary but with higher incontinence rates. Reflux prevention is not a major concern and does not justify the use of an antireflux mechanism with a high complication rate.

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1. Introduction

The orthotopic neobladder has not only withstood the test of time but is increasingly becoming a more desirable method of urinary diversion [1,2]. Complementing orthotopic neobladder features with adequate training allows patients to return to a urinary routine that is close to, if not completely, normal. Ten points, however, must be followed carefully.

2. Evidence acquisition

Experience with and long-term follow-up of orthotopic reconstruction is presented by surgeons at institutions that pioneered orthotopic reconstruction during the last 25 yr with a high surgical volume of radical cystectomy (RCX) and any form of urinary diversion (particularly orthotopic reconstruction).

3. Evidence synthesis

3.1. *Commandment 1: The procedure should be performed by a high-volume surgeon*

RCX has been assessed the highest values in terms of difficulty of surgery for any procedure in urology [3]. RCX also is the most difficult robotic procedure and is even more difficult if the diversion is performed totally intracorporeally [4]. Mortality from RCX at low-volume hospitals is 3.1% versus 0.7% at high-volume hospitals. Negative surgical margins and ≥ 10 lymph nodes removed were associated with better overall survival independent of patient age, pathologic stage, nodal status, and whether or not patients actually received neoadjuvant chemotherapy [5,6]. A local recurrence developed in 68% of margin-positive patients compared to 6% in margin-negative patients. High-volume urologists had a margin-positive rate of 4% versus 14% for low-volume urologists. The quality of the RCX, the pelvic lymph node dissection, and the urinary diversion directly affects the patient's chances of survival and is surgeon dependent. The likelihood of receiving a neobladder after RCX varies and depends on geographic, social, ethnic, and religious factors. Health care systems and referral patterns play an important role: for example, in the United States, 50% of RCX patients received a neobladder at medical centres as opposed to 15% in the Medicare population [7].

3.2. *Commandment 2: Do not overextend the indication*

During patient selection, it is essential for realistic expectations to be discussed by the patient and the surgeon. There are several contraindications for an orthotopic neobladder:

- Urinary stress incontinence
- Damaged rhabdosphincter or incompetent urethra
- Tumour infiltration of the distal prostatica urethra in men or the bladder neck in women

- Impaired renal function (serum creatinine >150 mmol/l)
- Severely impaired liver function
- Severe intestinal disease (eg, Crohn's disease)
- Inadequate intellectual capacity, dexterity, or mobility
- Incompliant patients for active postoperative reeducation and regular follow-up
- Impossibility of nerve-sparing surgery at least on one side.

Patients aged >80 yr should not be excluded but should be very restrictively selected for an orthotopic neobladder. Achieving urinary continence for these patients might take longer than in younger patients, due to a possibly weaker rhabdosphincter muscle [8].

3.3. *Commandment 3: Experience with nerve-sparing radical prostatectomy and bowel surgery is mandatory*

For nerve-sparing surgical technique, the oncologic outcomes must be considered. First, the radical cancer resection must not be compromised by nerve-sparing surgery. Nerve sparing should only be attempted on the non-tumour-bearing side. Neurovascular bundles are preserved along the prostate dorsolaterally and in the angle between prostate and bladder along the seminal vesicles. This technique improves sexual function [9] and continence, especially during the day [10]. The prostatic capsule and seminal-sparing cystectomy goes one step further than the nerve-sparing technique. It has been proposed to improve the postoperative sexual function. It succeeded for that purpose but does not really improve the continence rate [11,12]. Moreover, the oncologic results are clearly worse, with a 10–15% higher failure rate [11]. Thus, this technique seems like a step in the wrong direction [11] until we understand the oncologic failures better.

Experience with bowel surgery and, more generally, with intestinal surgery is mandatory. Ileus and entero-enteral, enteropouch, or enterocutaneous fistula are among the most serious complications and could be life threatening [13]. Consequently, prevention and management are of great importance. It is also necessary to have experience in gynaecological surgery. The preservation of the anterior vaginal wall with orthotopic bladder is indicated in unifocal organ-confined tumours above the bladder base, using preoperative computed tomography scan to exclude uterine infiltration by the bladder cancer [14]. This preservation maintains vaginal length and support, has excellent functional results and acceptable complication rates, and can achieve negative margins with a low incidence of hypercontinence [15,16].

In summary, orthotopic bladder replacement after RCX could involve several surgical specialists, but all of them are part of a single team. Only one team leader is responsible for the surgery and its follow-up, and that is the urologist.

3.4. *Commandment 4: Use ileum whenever possible*

A comparison of gastric, ileal, ileocolic, right colic, and sigmoid segments shows an advantage for ileum over any

other segment with regard to function/urodynamics, transformation after exposure to urine, change in absorptive capacity, adaptation of mucosa absorptive to storage, incidence of metabolic disorders, late-volume increase, capacity at first and at maximum contraction, involuntary contractions, motor activity, distensibility, and suitability for patients with decreased kidney function [2].

Advantages were shown for ileocolic and sigmoid segments with regard to initial volume, accessibility and anastomosis, saving the ileocecal valve, and lack of vitamin B12 deficiency [2].

Comparison of gastric, ileal, ileocolic, right colic, and sigmoid segments shows that continence rates and urodynamic data were remarkably different for ileal, ileocolic, sigmoid, and gastric segments. Clear differences also appeared with regard to metabolic consequences in ileal, gastric, and colonic segments. Patient and surgeon issues were different with regard to surgeon's preference, length and ease of surgery, body image, and lowest possible complication rate.

3.5. *Commandment 5: Maximum detubularisation is a must*

The difference in pressure between a tubularised and a detubularised ileal neobladder becomes obvious in the urodynamics studies (Fig. 1). The peristaltic contractions of the tubularised segment generate high peak pressures that lead to urine leakage when the bladder pressure exceeds the urethral pressure. In the detubularised reservoir, bladder pressure increases little and the bladder end filling pressure is <30 cm of water, which is less than the urethral pressure. Consider a tubular segment: Open it along the full length and fold it. By doing that, a new tubular segment is obtained with double the width, half the length, and a doubled volume. It is the same with a segment of bowel. Moreover, the body of the neobladder reservoir counteracts pressure peaks, and, thus, a large volume is obtained at low pressure. It is also possible to preserve a tubular segment for ureteral implantation, such as a short limb for a Hautmann-type neobladder or a longer tubular segment for the Studer technique. The peak pressures in connection with this tubular segment are lost in the low bladder pressure, with

no clinical impact. In special cases, it is also possible to replace the ureter with a tubular segment.

In conclusion, there is no reason left to use tubularised bladder.

3.6. *Commandment 6: Use a stented, freely refluxive ileoureterostomy*

Conventional wisdom suggests the need for an antireflux mechanism, as reflux nephropathy can develop with high-pressure neuropathic bladders. Reflux prevention in a low-pressure detubularised orthotopic reservoir, however, might not be as beneficial as anticipated. Several reasons for that exist. First, with detubularised bowel segments and the absence of any coordinated contractions, no appreciable pressure is generated. Second, an increase in intra-abdominal pressure results in identical pressure rises in both the neobladder and ureters, allowing no reflux [17]. The pressure in the reservoir cannot be higher than the peristaltic force of the ureters and afferent tubular segment. Additionally, the afferent tubular segment itself has certain dynamic antireflux properties due to its coordinated peristalsis [18]. With a major pressure peak within the reservoir that exceeds the urethral closure pressure, the external sphincter generally acts as a safety valve, allowing urinary leakage and thus preventing reflux. Urine usually remains sterile within the closed system of orthotopic substitutes, and therefore nephropathy is less likely. Finally, all published antireflux techniques have a higher anastomotic stricture and eventual renal damage rate than the Nesbit technique (direct ureterointestinal anastomosis).

3.7. *Commandment 7: The low-pressure, compliant, freely refluxive reservoir is standard*

It is mandatory to avoid ileal or colonic segments that are too long because they lead to neobladder volume that is too large and, thus, to overdistension. The larger the bladder volume, the higher the rate of postvoiding residual urine and, thus, of reflux; the higher the rate of leakage, the higher the risk of metabolic disorders [19]. No more than 45 cm of ileum seems safe to avoid metabolic disorders. The rate of bacteriuria is also increased with large bladder and residual postvoiding urine. An optimal volume of 450 ml for the bladder has been advocated [20].

Whatever the detubularised technique used, training and life-long follow-up are of great importance. Training is necessary to teach and explain to the patient how to be continent, how to empty the bladder, and how to avoid overdistension. Life-long follow-up, apart from oncologic surveillance, controls these data regularly and if needed, corrects them. And remember: Confidence does not exclude surveillance.

In ureteroileal anastomosis, the pressure in the lower part of the ureter is 20–30 cm of water [21]. The bladder end filling pressure is 20 cm for an optimal cytometric capacity of 450 cm³. This pressure difference is a safety margin. During the filling phase of bladder, the absence of coordinated contractions guarantees a low pressure

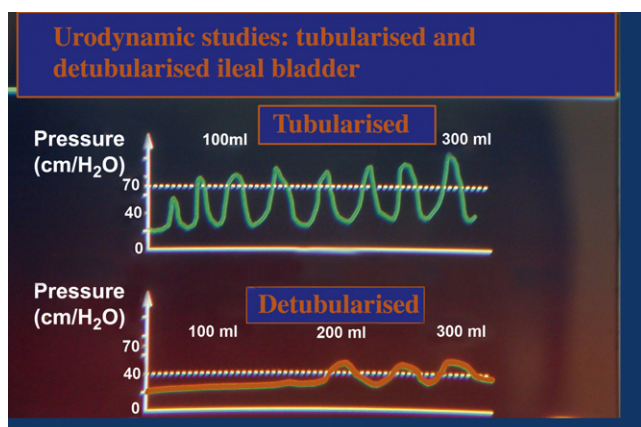


Fig. 1 – Typical urodynamic studies of tubularised versus detubularised good segment.

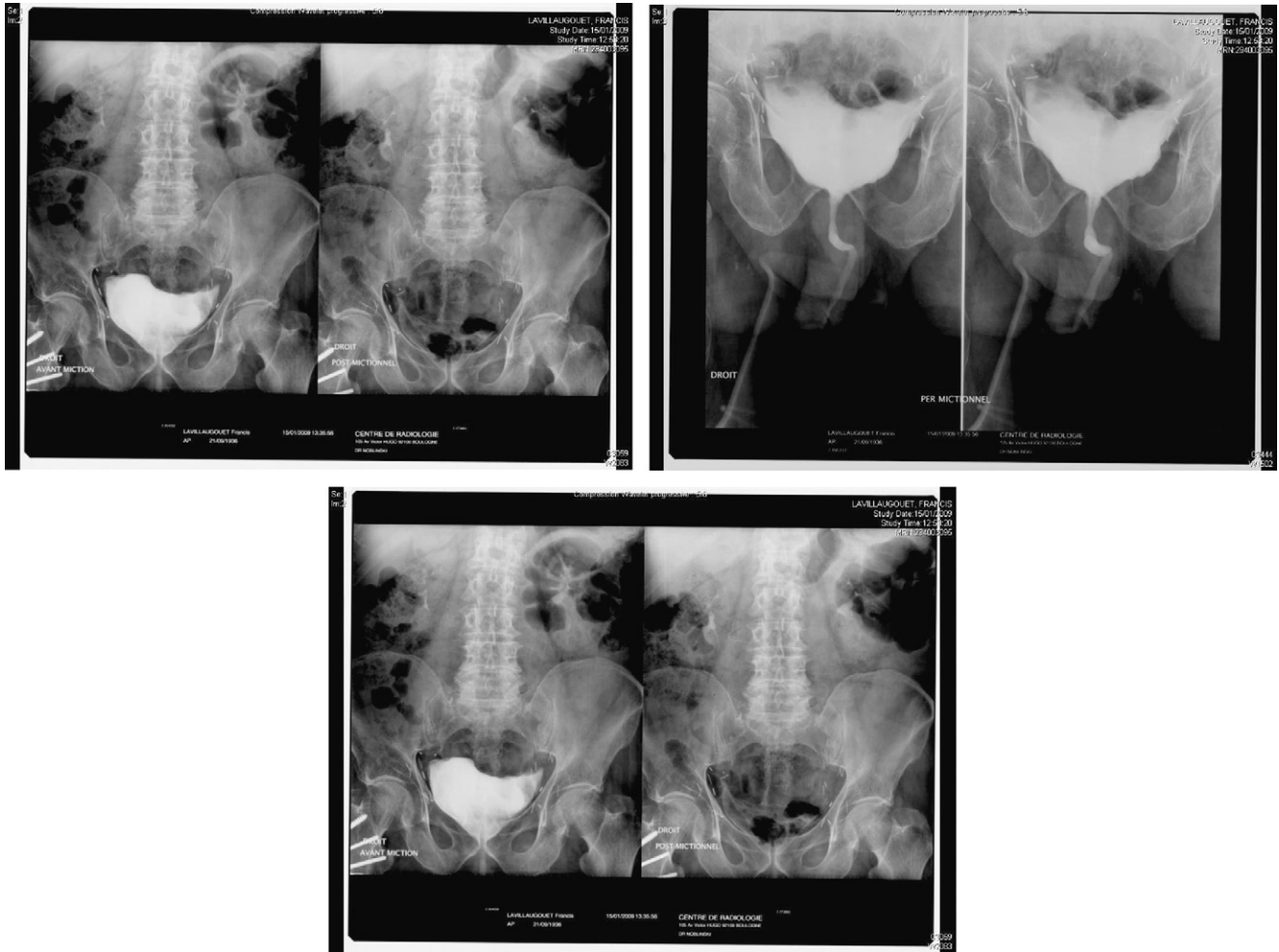


Fig. 2 – Patient with a Z-shaped ileal bladder done in 1994 with good urethral filling, no reflux, and no postvoiding residual urine. Reprinted with permission from Elsevier [22].

reservoir. During voiding, the use of Valsalva manoeuvre increases the pressure in the bladder, the abdomen, and the renal pelvis simultaneously, keeping the safety margin. Thus, a direct ureteral neobladder anastomosis can be performed, provided that the patient is well trained and controlled (Fig. 2).

Even if there is reflux during voiding, it is only transient and grade 1 without renal damage. But in the case of overdistension of the bladder, whatever the reason, reflux will occur.

In summary, the low-pressure, highly compliant, freely refluxive reservoir allows a good bladder capacity without renal reflux and postresidual urine, assuming training and surveillance are well done.

3.8. Commandment 8: Be aware of myriad potential complications

RCX is a morbid procedure, even in the most experienced hands, with contemporary single-institution series reporting postoperative complications in the range of 25–57%, in-hospital mortality of $\leq 3\%$, and reoperative rates in the range of 2.3–17% [23]. The disparity in the quality of surgical-

complication reporting in urologic oncology makes it impossible to compare the morbidity of surgical techniques and outcomes [24]. Between January 1986 and September 2008, the Department of Urology at Ulm, Germany, performed 1013 RCXs with orthotopic reconstruction. All complications within 90 d of surgery were defined, categorised into 11 categories, and classified with an established five-grade modification of the original Clavien system utilised at the Memorial Sloan-Kettering Cancer Centre (MSKCC): Grade 1 consisted of oral medication/bedside care; grade 2 consisted of intravenous therapy, hyperalimentation, enteral feedings, or transfusions; grade 3 consisted of intubation, interventional radiology, or reoperative intervention; grade 4 consisted of organ resection or chronic disability; and grade 5 consisted of death.

Results shows that only 42.4% of the patients had no early complications. Overall, 11.1% of complications were grade 1, 25.3% were grade 2, 16.7% were grade 3, 2.3% were grade 4, and 2.3% were grade 5 (Table 1) [25].

In summary, RCX and ileal neobladder formation represents major surgery with potential, relevant, early complications, even in the most experienced hands. The

Table 1 – Grading of early complications according the modified Clavien system at the Memorial Sloan-Kettering Cancer Centre [25]

	0	1	2	3	4	5
Gastrointestinal	85.0 %	0.7 %	8.1 %	3.9 %	1.8 %	0.5 %
Infection	75.4 %	3.8 %	15.6 %	3.6 %	0.4 %	1.3 %
Wound	93.5 %	1.9 %	1.1 %	3.5 %	0.1 %	0.0 %
Cardiac	97.6 %	1.2 %	0.9 %	0.1 %	0.0 %	0.2 %
Genitourinary	83.8 %	3.5 %	7.1 %	5.6 %	0.0 %	0.0 %
Pulmonary	95.3 %	0.3 %	1.8 %	1.7 %	0.2 %	0.8 %
Bleeding	98.1 %	0.1 %	0.2 %	1.5 %	0.1 %	0.0 %
Thromboembolic	97.2 %	0.7 %	1.4 %	0.2 %	0.0 %	0.5 %
Neurologic	97.5 %	1.9 %	0.5 %	0.0 %	0.0 %	0.1 %
Miscellaneous	90.5 %	3.0 %	1.6 %	4.9 %	0.0 %	0.0 %
Surgical	96.7 %	2.1 %	0.5 %	0.6 %	0.0 %	0.1 %
Total	42.4 %	11.1 %	25.3 %	16.7 %	2.3 %	2.3 %

rate of severe and lethal complications, however, is acceptably low.

3.9. *Commandment 9: A full armamentarium of diversion techniques must be available*

Orthotopic bladder replacement may be infeasible for anatomical and oncologic reasons.

Anatomically, in the preoperative setting, it is necessary to select, together with the patient, the optimal position for a potential cutaneous urinary stoma. The position of the patient on the operating table is hyperextended to open the surgical field.

For the urethral neobladder anastomosis, this position can be altered and the lower limbs are pushed up. With this change in position, the urethral stump moves upwards by a mean of 3 cm, avoiding too much tension on the urethra-neobladder anastomosis. In an extreme and very uncommon situation, it could be necessary to free the right colonic junction and to move the ileum and the right colon downwards to make the urethra-neobladder anastomosis tension free or at least avoiding too much tension. When the urethral anastomosis is too tight, despite all of these manoeuvres, the goal of bladder replacement must be given up.

Oncologically, urethral frozen section is mandatory. In men, the use of frozen section is a matter of controversy, but it seems wise to use it whenever possible [26].

When a positive margin for carcinoma in situ or major dysplasia is found, it is necessary to carry out a urethrectomy ending in a cutaneous urinary diversion.

Cutaneous ureterostomy seems like the worst technique for the patient. Regarding the other techniques of cutaneous diversion, even when performed by a high-volume surgeon, some procedures are not used. Consequently, the urologist should select those techniques for which he or she is regularly trained, remembering that practice makes perfect.

3.10. *Commandment 10: Meticulous follow-up must be guaranteed*

Critical components for good long-term results require not only surgical finesse but also patient compliance and meticulous postoperative care [27,28]. Immediate postoperative management should include the following steps:

- Subcutaneous heparin prophylaxis into the arm instead of the thigh to prevent lymphoceles
- Bladder substitute rinsed every 6 h, with aspiration of mucus
- Bowel stimulation with parasympathomimetics from day 2 or 3 on
- Withdrawal of urethral stents at day 5–7 after resumed bowel activity
- First removal of the suprapubic tube on day 8–10 (cystogram)
- Withdrawal of urethral catheter on day 10–12

Following catheter withdrawal, patients are carefully instructed on how to void. Initially, they are taught to empty the neobladder in a sitting position every 2 h during the day by relaxing the pelvic floor and increasing the intra-abdominal pressure. The following points must be observed:

- Voiding without residual urine
- Sterile urine
- Alarm clock at night
- Venous blood gas analysis every second day
- Supplement of bicarbonate (2–6 g) and salt.

Increase fluid intake and check body weight. Increase reservoir capacity by adhering to regular voiding intervals: at first, 2 h; thereafter, 3 h; later, 4 h. The aim is a capacity of 500 ml.

Meticulous long-term follow-up is essential regarding metabolism (vitamin B12, electrolytes, base excess), continence, volume of voided urine (400–500 ml), sterile urine, residual urine (if yes, check regular voiding intervals), and bladder neck obstruction (if yes, perform incision or resection).

4. Conclusions

Continence and voiding function following orthotopic bladder substitution are determined primarily by the characteristics of the reservoir and by a preserved, innervated outlet mechanism. The reservoir should be detubularised and compliant, with a low end filling pressure. Ileum seems to be superior to sigmoid or stomach, which can be used when necessary but with higher

incontinence rates. Reflux prevention is not a major concern and does not justify the use of an antireflux mechanism with a high complication rate.

Orthotopic reconstruction has passed the test of time. In these patients, life is similar to that of individuals with a native lower urinary tract. Until a better solution is devised, orthotopic reconstruction remains the best option for patients requiring RCX.

Conflicts of interest

The authors have nothing to disclose.

Funding support

None.

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