ORIGINAL PAPER

Technique selection of ureteroileal anastomosis in hautmann ileal neobladder with chimney modification: Reliability of patient-based selection strategy and its impact on ureteroentric stricture rate

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Summary
Objective: We aimed to establish the reliability of technique selection strategy for ureteroileal anastomosis (Bricker vs. Wallace) by comparing perioperative outcomes, complications, and anastomotic stricture rate in a contemporary series of patients who underwent open radical cystectomy followed by reconstruction of modified Hautmann neobladder.
Materials and methods: A total of 60 patients underwent radical cystectomy and modified Hautmann neobladder, of whom 30 patients (group I) with Bricker anastomotic technique were compared to 30 matched paired patients with end-to-end ureteroileal anastomosis (group II). Long-term results, including ureteroileal stricture (UIS) and postoperative complication rate at two year follow up were available. The choice of anastomosis type was successively based on chimney size, ureteral length after retro-sigmoidal tunneling and diameter of distal ureter. Postoperative complications were graded according to the Clavien-Dindo system.
Results: Ureteroileal stricture rate was 6.6% in group I vs. 0% in group II, after three months (p < 0.05), while anastomotic leakage rate was 6.6% vs. 3.3% (group I vs group II) between the two groups for the same follow up period (p > 0.05). High-grade complications (Clavien III-V) were more in Bricker group as compared to Wallace group and the difference was significant (20% vs 10.3%, p = 0.03).
Conclusion: Our preliminary outcomes demonstrate that this selection strategy seems to be clinically reliable, with lower incidence of postoperative complications in Wallace group.

KEY WORDS: Orthotopic bladder substitution; Urinary diversion; Reconstructive urology; Selection strategy; Surgical technique.

INTRODUCTION

In both male and female patients, orthotopic bladder substitution has become the preferred method of urinary diversion post *radical cystectomy* (RC) for malignant disease (1). Among different reconstructive modalities, ileal neobladder with Hautmann or Studer reservoir is a frequent orthotopic diversion and several modified techniques have been described (2-6).
The standard technique for uretero-enteric anastomosis is

the Bricker ureteral implantation in an end-to-side fashion using running sutures (7). According to the literature, the ureteroileal stricture (UIS) rate using this technique ranges between 3%-20% (7-10). A frequently used anastomotic technique in urinary diversions is that described by *Wallace*, in which the end of the intestine is sutured to the end of the ureter (11). It is already known that this technique has the lowest complication rate comparing to other ureterointestinal anastomosis (12), including its usage in orthotopic bladder reservoirs (13, 14).
Nevertheless, only a few studies favour this technique in orthotopic neobladder (5, 6, 15).
The objective of this study was to establish the reliability of technique selection strategy for ureteroileal anastomosis, based upon patients characteristics; additionally, we aimed to compare perioperative outcomes and ureteroileal anastomotic stricture rate in a contemporary series of patients who underwent open RC followed by reconstruction of modified Hautmann neobladder.
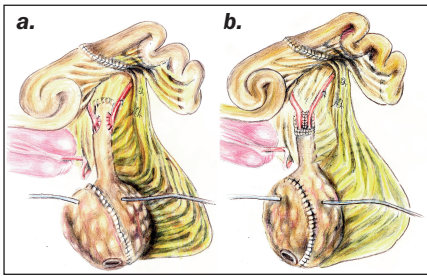
MATERIALS AND METHODS

Study design and patients

We compared 30 matched paired patients who underwent Hautmann neobladder with single chimney and Bricker anastomotic technique (2, 3) with 30 matched paired patients who underwent Hautmann neobladder with chimney modification consisting of a longer ureteral spatulation (3-4 cm) combined with end-to-end ureteroileal anastomosis (*Wallace* type I) and 6-8 cm long isoperistaltic tubularised chimney (16).
Long-term results, including *uretero-ileal stenosis* (UIS) and postoperative complications rate (graded according to Clavien-Dindo system) at 2-year follow-up, were available for analysis.
The main differences between techniques were the length of the ureteral spatulation, the chimney size and the end-to-end running suture ureteroileal anastomosis (Figure 1). Patient characteristics included three aspects: ureteral length after retro-sigmoidal tunneling, chimney size and diameter of distal ureter after dissection and preparation for anastomosis. When the ureteral length was similar on

Figure 1.
Differences between two techniques:
a) modified Hautmann neobladder with long chimney and Bricker ureteroileal anastomosis (group I);

b) our modified technique with short afferent limb, similar ureteral length on both sides and Wallace anastomotic type (group II).

both sides, *Wallace* was preferred; when disparate, Bricker was performed (12, 17). Moreover, if the ureters were transected at the level of common iliac vessels [diffuse *carcinoma in situ* (CIS)], chimney length was 10-12 cm and Bricker anastomosis was performed (2, 3); if ureters were divided more distally, as close to the bladder as possible, *Wallace* anastomosis on 6-8 cm long chimney was preferred (16). The third decision was based on the diameter of distal ureteral end, after the ureter has been divided and prepared for anastomosis. When distal ureteral end was more than double size of normal diameter (long-standing hydronephrosis), *Wallace* was preferred. If distal end was of a normal caliber, the choice of anastomotic technique was based upon other two variables. The inclusion and exclusion criteria are presented in the patient flowchart (Figure 2).
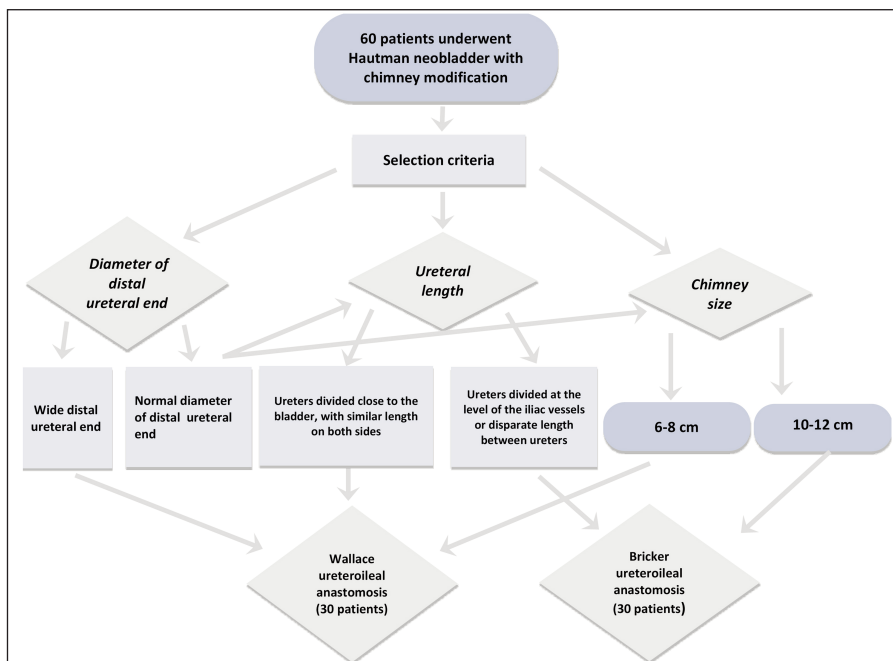*Bladder cancer* (BCa) patients scheduled for definitive treatment were recruited from the *Urology Clinic at the Clinical Centre of Serbia*. The surgical protocol had been approved by the *University of Belgrade Institutional* review board and registered with the Ethical committee of

Clinical Centre of Serbia and conducted in accordance with the principles of the Declaration of Helsinki from the *World Medical Association*. The surgery comprised RC with standard *pelvic lymph node dissection* (PLND), which was followed by reconstruction of Hautmann neobladder with chimney modification. Eligible patients were aged ≥ 30 yr and had BCa clinical stage T2-T3/N0/M0. Patients were excluded if they had previous pelvic radiation, clinical stage T4 or N1-N3/M1, positive frozen-section urethral biopsy, extensive prior abdominal surgery, serum creatinine level of > 2.0 ng/mL and any history of upper urinary tract malignancy (4). Complications were reported according to the modified Clavien-Dindo classification system (18). Reservoir-related complications included obstructive or non-obstructive hydronephrosis, UIS, pyelonephritis, anastomotic leakage, metabolic acidosis and *vesicoureteral reflux* (VUR). UIS was diagnosed when there was evidence of obstruction on imaging (symptomatic hydronephrosis), worsening renal function or infection (18). Non-obstructive hydronephrosis was defined as a distended intrarenal collecting system on imaging without evidence of UIS or other mechanical obstruction and was confirmed by *intravenous urography* (IVU) or *computed tomography* (CT).
Of note, pyelonephritis was designated as a positive urine culture in association with foul smelling urine and fever (19). Perioperative outcomes were systematically and prospectively collected at surgery and during hospitalization and each complication classified as early (< 3 months) or late (> 3 months after surgery). Patient interviews were conducted by medical doctors and according to *European Association of Urology* (EAU) guidelines on reporting and grading of complications (20).
In this study we aimed to establish an optimal technique selection strategy for ureteroenteric anastomosis (*Bricker* vs. *Wallace*) based on patient characteristics and evaluated according to difference in early and late perioperative complications and postoperative *health-related quality of life* (HRQOL).

Outcomes measures and follow up
Postoperatively, all patients were placed on the identical treatment pathway and follow-ups were scheduled every 3-4 months during the first year and semi-annually in the second (19). Renal function was measured by serum creatinine, hydronephrosis was examined by abdominal ultrasound or computed tomography, and VUR was assessed by voiding cystography (6). Diagnostic imaging (kidney ultrasound, CT abdomen/pelvis and chest radiography) was performed annually or when clinically indicated. Abdominal *ultrasound* (US) was performed immediately before discharge of patients to deter-

Figure 2.
Patient flowchart describes selection criteria for surgical approach.

Table 1.

Clinicopathological features and perioperative outcomes between group I and II.

Clinicopathological characteristics	Mean (SD)/Percentage (%)		
	Group I (n = 30)	Group II (n = 30)	P value
Age (years)	63 (7.2)	68 (6.6)	0.6
BMI, kg/m², mean (SD)	27.2 (2.6)	26.1 (3.2)	0.8
Male, n (%)	22 (73.3)	24 (80.0)	0.2
Female, n (%)	8 (26.6)	6 (20)	0.1
ASA score, n (%)			
2	17 (56.6)	18 (62)	0.3
≥ 3	13 (43.3)	11 (38)	0.09
Pathologic stage, n (%)			
T2	23 (76.6)	25 (83.3)	0.1
T3	7 (23.4) *	4 (13.3)	0.03
LNP patients, n (%)	4 (13.3)	5 (16.6)	0.7
Operative time (min), SD	270 (42.3)	240 (33.6)	0.3
Estimated blood loss (ml), SD	340 (150)	400 (210)	0.06
Hospital stay (days), SD	18 (4.6)	19 (3.4)	0.6
Transfusion rate, n (%)	7 (23.3)	5 (16.6)	0.08

* Statistically significant difference between two groups (p < 0.05).
BMI: Body mass index; ASA: American Society of Anaesthesiologists; LPN: Lymph node positive.

mine the pouch capacity and *post voiding residue* (PVR). The acidosis was monitored using the base excess by venous blood gas analysis, initially every three days followed by weekly, depending on the blood gas values.

The *European Organization for the Research and Treatment of Cancer* (EORTC) *Quality-of-Life Core Questionnaire* (QLQ-C30) version 3 was used to measure HRQOL (21, 22).

Continence rates and time intervals between *clear intermittent catheterizations* (CICs) obtained at the end of 2-year follow up were recorded. CIC was recommended for patients with a *postvoid residual volume* (PVR) of >150 mL.

Statistical analysis

Statistical analysis was performed with SPPS v16.0 (*SPPS, Chicago, IL, USA*). Blood loss, operative time, and time to discharge (hospital stay) were assessed as continuous variables and tested for normality using the Kolmogorov test. The Student T test and Mann Whitney U test were used to determine statistical significance. The difference between obtained values was considered significant when p < 0.05. Descriptive statistics such as mean (SD) values and percentages, generated with SPSS, were also included.

RESULTS

Clinicopathological features and perioperative outcomes are summarized in Table 1.

The two groups were similar for gender, age, ASA class and BMI. All patients had transitional cell carcinoma and the tumor stage ranged from T2 to T3 N0-3/M0. The follow-up time for the entire cohort was 2 years.

The mean operative time was 270 ± 42.3 min and 240 ± 33.6 min in the first and second group respectively (p = 0.3). The distribution of postoperative complications is shown in table 2. A total of 135 complications were recorded in 40/60 (66.6%) patients. 105 complications (77.7%) occurred in the first 90 days, with the remaining 30 complications (22.2%) occurring between 90 days and one year postoperatively. The majority of complications (44/60, 73.3%) were classified as low-grade with 41.6% in Grade I and 31.6% in Grade II. High-grade (Clavien-Dindo Grade III-V) complications were seen in 10/60 (16.6%) patients. Grade III, IV and V complications were observed in 11.6%, 1.6% and 3.3% of the patients, respectively (Table 3). The overall mortality rate was 3.3% (2/60). High-grade complications were less in *Wallace* group as compared to Bricker group, and the difference was significant (3/30, 10% *vs.* 6/30, 20%, p = 0.03).

Following 3 months, hydronephrosis was observed in eight patients (26.6%) in group I and six (20%) in group II, (p = 0.2) (grade I-III Clavien). Consequent to hydronephrosis, UIS was seen in two ureters (6.6%) in group I but none in group II (grade III Clavien). Moreover, one out of two patients with UIS required surgical treatment (grade IIIb Clavien). These differences were statistically significant (p = 0.0063).

Additionally, the anastomotic leakage rate was higher in the first group, although not significantly (6.6% *vs.* 3.3%, p = 0.06) (grade I/IIIa Clavien).

Table 2.

Postoperative complications of 60 patients with muscle invasive bladder cancer who underwent radical cystectomy and modified Hautmann neobladder with Bricker (group I) or Wallace (group II) ureteroileal anastomosis.

Clinicopathological characteristics	Mean (SD)/Percentage (%)				
	Group I (n = 30)		Group II (n = 30)		P value
	Early	Late	Early	Late	
Paralitic ileus, n (%)	8 (26.6)	0	9 (30)	0	0.7
Wound infections, n (%)	2 (6.6)	1 (3.3)	1 (3.3)	3 (10)	0.4
Blood transfusions for anemia, n (%)	9 (30)	0	10 (33.3)	0	0.5
Pelvic hematoma, n (%)	2 (6.6)	0	1 (3.3)	0	0.1
Lymphorrhea, n (%)	6 (20)	1 (3.3)	4 (13.3)	2 (6.6)	0.08
Pneumonia, n (%)	0	4 (13.3)	1 (3.3)	3 (10)	0.1
Reservoir related complications	Early	Late	Early	Late	
Renal insufficiency, n (%)	0	1 (3.3)	0	0	0.07
Vesicoureteral reflux (VUR), n (%)	4 (13.3)	3 (10) *	3 (10)	1 (3.3)	0.03
- Grade I	2	2	2	1	
- Grade II	1	1	1	0	
- Grade III	1	0	0	0	
- Grade IV	0	0	0	0	
Hydronephrosis, n (%)	8 (26.6)	1 (3.3)	6 (20)	3 (10) *	0.02
- Unilateral	8	1	0	2	
- Bilateral	0	0	6	2	
Pyelonephritis, n (%)	4 (13.3)	0	5 (16.6)	0	0.4
- i.v antibiotics only	1	0	2	0	
- Oral antibiotics only	3	0	3	0	
Anastomotic leakage rate, n (%)	2 (6.6)	0	1 (3.3)	0	0.09
Anastomotic stricture rate (UIS), n (%)	2 (6.6) *	1 (3.3)	0	0	0.04
Metabolic acidosis, n (%)	6 (20)	1 (3.3)	5 (16.6)	2 (6.6) *	0.04

* Statistically significant difference between two groups (p < 0.05).

Table 3.

Classification of postoperative complications and treatment options for reservoir-related complications after radical cystectomy and construction of modified Hautmann reservoir with Bricker (group I) or Wallace (group II) ureteroileal anastomosis.

Postoperative complications & treatment	Group I (n = 30) Early	Group I (n = 30) Late	Group II (n = 30) Early	Group II (n = 30) Late	P value
Clavien-Dindo classification	19 (63.3)*	9 (30)	16 (53.3)	10 (33.3)	0.03
Grade I	8 (26.6)	4 (13.3)	9 (30)	4 (13.3)	
Grade II	7 (23.3)	2 (6.6)	5 (16.6)	5 (16.6)*	
Grade III (IIIa/IIIb)	4 (13.3)*	1 (3.3)	2 (6.6)	0	
Grade IV (IVa/IVb)	0	1 (3.3)	0	0	
Grade V (death)	0	1 (3.3)	0	1 (3.3)	
Treatment, n (%)	15 (50)*	7 (23.3)*	6 (20)	4 (13.3)	0.01
Antegrade stent placement	1	0	0	0	
Percutaneus nephrostomy (PCN)	1	1	1	0	
Balloon dilatation of strictures	2	0	0	0	
Surgical repair of strictures	1	0	0	0	
Intraabdominal drainage	2	0	0	0	
Intermitent catheterization (CICs)	8	6	5	4	

* Statistically significant difference between two groups (p < 0.05).

Nine patients (15%) required interventions under general or local anesthesia for the management of high-grade (≥ III) complications. Four patients from the first group required invasive treatment of early reservoir-related complications (13.3%), which was significantly higher compared to the *Wallace* group (3.3%; p = 0.01). Three patients underwent percutaneous nephrostomy for ureteroileal anastomotic stricture or anastomotic leak in both groups, whereas two patients from the first group had percutaneous drainage for lymphocele or pelvic collection. Only one patient from the Bricker group developed local tumor recurrence (3.3%) (grade IIIa), which was treated endoscopically (Table 3). Neoadjuvant chemotherapy was performed in 16 patients (27.1%), while adjuvant treatment received only one examinee (1.7%).

At the end of the 2-year follow-up, two patients with VUR in group I had improved after CICs (grade I Clavien). In addition, five out of six patients with hydronephrosis had improved with or without treatment. However, one case with UIS - related unilateral hydronephrosis resulted in a non-functional kidney despite the treatment for the stricture (grade IV Clavien). Serum creatinine was less than 1.4 mg/dl preoperatively in all patients and it remained within the normal ranges, during the follow-up in both groups, except in the patient with kidney failure.

Complete daytime continence at one year was achieved in 28 patients (93.3%) in the first group and 26 patients (89.6%) in the second group, with no statistical differences however (p > 0.05). Complete night time continence was achieved in 24 (80%) and 25 patients (86.2%), respectively (p > 0.05). Patient self-rated emotional and social functional scales were similar between groups.

DISCUSSION

The first description of Hautmann neobladder with chimney modification was published by *Lipper* and *Theodorescu* (2) consisting of a 5-10 cm isoperistaltic chimney with an end-to-side ureteroileal anastomosis. The study included three patients with short follow-up; no postoperative complications were reported, demonstrating that the technique employed was a promising modification to the original Hautmann neobladder. In 2000, a more comprehensive study was performed on 50 patients with invasive BCa (3), using 8-12 cm tubularised isoperistaltic ileal chimney. This technique proved to be safe and feasible, easy to perform and created a reliable ureterointestinal anastomosis (*Bricker*) without tension, which resulted in a relatively low UIS rate (6%). On the other hand, *Hautmann et al.* (23) reported that freely refluxing *Wallace* anastomosis to the afferent limb of the orthotopic reservoir has the lowest non-tumor related anastomotic stricture rate (5.4% compared to 16.3% using Bricker technique). Furthermore, *Kouba et al.* (12) revealed a statistically significant difference in UIS rate between *Bricker* and *Wallace* anastomotic techniques (3.7% *vs.* 0), in favour with the latter. Despite these results, the success and complications of two techniques are still debatable and no definite conclusion regarding the optimal anastomotic technique for orthotopic diversion has been made. The reason for this may be the lack of clear selection criteria for each anastomotic technique, instead of simple surgeon preference (12, 24). A recent study (17), suggesting an individualized selection strategy for deciding upon the type of uretero-ileal anastomosis (*Bricker vs. Wallace*), showed acceptable low rate of ureteral strictures (3.1%) and confirmed clinical reliability of research. The technique selection was based on several individual patient factors, including tumor characteristics, ureteral anomalies and ureteral length. In our study, however, chimney size and diameter of distal ureter, together with ureteral length after retro-sigmoidal tunneling were considered as selection criteria to decide upon the type of ureteroileal anastomosis. The results we reported here revealed higher incidence of UIS using Bricker technique (6.6%), after three months follow-up; on the other hand, this complication was not detected using *Wallace* anastomosis on shortened tubularised isoperistaltic chimney. Since this type of stricture remains the most challenging and difficult of all ureteral strictures to treat (25, 26), any technical modification that aims to decrease or prevent UIS is recommended (17). Our modified *Wallace* technique consisted of longer ureteral spatulation and short Chimney, seemed to be effective in reducing the occurrence of both UIS and anastomotic leakage during follow-up period. Moreover, a shorter chimney may also play a role in reflux prevention, due to the fact that a shorter limb allows the use of longer segments of the lower ureters that participate in reflux prevention (27).

All these findings together bolster the assertion that proper patient selection and meticulous ureteral handling of distal ureter, as well as a shorter intestinal chimney with end-to-end running suture ureteroileal anastomosis, may be essential to minimize the risk of postoperative reservoir-related complications.

Oncologic factors were an important consideration in our series. Although the *Wallace* technique has the lowest rate of UIS, it not recommended for patients with increased risk of recurrent tumors (bladder CIS) (4,11).

In our study, however, patients with multifocal bladder CIS were selected exclusively for Bricker anastomotic technique, after obtaining negative frozen-section urethral biopsy. Therefore, oncologic limitations of direct end-to-end ureteroileal anastomosis were clinically insignificant in our cohort with conclusion that *Wallace* technique may become the preferred anastomotic approach, in properly selected patients.

It is questionable, however, why the Bricker group was associated with high postoperative complications rate (Clavien-Dindo grade III-13.3%), where incidence of UIS was higher than expected (1, 3, 23). Since the obesity may impair the outcome of ureteroileal anastomosis after RC (17), we assumed that higher BMI of patients within Bricker group, associated with short mesentery and extensive dissection of the distal left ureter, led to significantly higher rate of UIS, comparing to *Wallace* group. Incidence of CICs after neobladder construction is generally 4-25% in males and up to 53% in females (28, 29). In our study, however, 16.9% of patients still required CICs at the end of first year. Nevertheless, during the initial three months post-surgery, hydronephrosis had improved after CICs in 50% of patients within the second group, whereas only one patient required an invasive procedure for the treatment of hydronephrosis (PCN).

The limitations of this study are the small size of groups of patients and the short follow-up periods. Despite that, we found an acceptable rate of ureteroenteric strictures, VUR and anastomotic leakage, lower than that found in the conventional technique. Furthermore, our research was conducted with no clear protocol for administration of neoadjuvant or adjuvant chemotherapy, as this was left to the discretion of the uro-oncologist board. In addition, the unusually high rate of anastomotic leakage in patients within the first group could lead to research bias regarding effectiveness of our modified Hautmann neobladder with *Wallace* anastomotic technique.

Single surgeon experience could be the major reason for this bias, which should be addressed by involving other highly trained surgeons.

Conclusions

Our preliminary outcomes demonstrated that this patient-based selection strategy for ureteroileal anastomosis in orthotopic urinary diversion after RC seems to be clinically reliable and favors *Wallace* anastomotic technique over the Bricker approach.

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