

# Longitudinal experience with Studer neobladders: Outcomes and complications

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## Abstract

**Introduction:** This study aims to assess the longer-term functional, anatomical, and metabolic outcomes of patients who underwent Studer neobladder (SNB) urinary diversion.

**Methods:** A retrospective review of patients who underwent SNB at a single center from 1995–2017 (n=116) was performed. Demographics, comorbidities, pathological data, and longer-term functional, anatomical, and metabolic outcomes were collected from hospital records. The primary outcome was voiding function of patients at most recent followup. Secondary outcomes included postoperative complications, renal function, nephrolithiasis, infections, and metabolic outcomes.

**Results:** Excluding those with incomplete followup data, 72 patients with a minimum followup of one year were included for analysis. Median followup was 70±11 months, with 52.8% of patients having ≥5 years of followup. Clean intermittent catheterization (CIC) was used by 22.2% of patient at most recent followup, which was mostly necessitated by bladder overdistension, deteriorating renal function, or recurrent urosepsis despite timed voiding. Patients experienced more daytime and nighttime urinary incontinence in the early postoperative setting, which improved over time. Generally, renal function declined over time; poorer long-term renal function was predicted by hydronephrosis within one year (p=0.002).

**Conclusions:** Longer-term followup of SNB reveals significant but manageable complications. Gradual decline in renal function was common. Strict adherence to bladder emptying protocols (e.g., timed voiding or CIC) may reduce incidence of renal deterioration, metabolic disorders, and urinary dysfunction. Early onset (<1 year) of hydronephrosis may indicate a need for intervention to preserve long-term renal function.

## Introduction

Neobladder, as described by Studer, offers the advantages of superior cosmesis and potentially near-normal voiding function and continence for patients undergoing radical cystectomy.<sup>1</sup> Creation of a Studer neobladder (SNB), however, may not be suitable for some patients due to metabolic, anatomical, oncological, or demographic reasons.<sup>2,3</sup> Neobladders using autologous bowel segments are also associated with a risk of long-term complications, such as ureteral obstruction, urosepsis, metabolic derangements, urinary stone disease, fistula formation, and functional urinary impairment.<sup>4-6</sup> Reports of SNB functional outcomes and management, renal function, and need for surgical correction of anatomical complications beyond five years have been limited.<sup>4,7-10</sup>

This study aims to assess the functional, anatomical, and metabolic outcomes of patients who have undergone SNB urinary diversion, with median followup beyond five years, at a Canadian tertiary care center.

## Methods

### Study design

We conducted a retrospective study of patients who underwent SNB between January 1995 and May 2017 (n=116) performed by three surgeons. Standard surgical technique for SNB and postoperative care have been previously described by Studer et al.<sup>11</sup> Extended pelvic lymphadenectomy was performed at the discretion of the surgeon.

Data collection was performed by retrospective review of electronic and paper charts. Patients who had less than one year of followup or incomplete followup were excluded. All patients were followed regularly in clinic with physical examination, basic laboratory assessment, postvoid residual, and surveillance imaging as per the AUA/ASCO/ASTRO/SUO guideline on followup of non-metastatic muscle-invasive bladder cancer.<sup>12</sup> Followup data was collected until

the most recent encounter with their operative surgeon at our center. Institutional ethics approval was received from Western University (REB#: 109687).

## Outcome measures

Basic demographic and tumor-specific variables were obtained from review of the electronic records. Urinary outcomes, including daytime urinary incontinence (DUI), nighttime urinary incontinence (NUI), urinary frequency, nocturia, clean intermittent catheterization (CIC) and/or indwelling catheterization, and postvoid residual (PVR), were collected based on surgeon-reported outcomes derived from their most recent clinical documentation. DUI and NUI were defined as need for use of at least one incontinence pad during the daytime and nighttime, respectively.<sup>13-15</sup> Use of prophylactic pads was not included. Continence was defined as no need for incontinence pads. PVRs were obtained by Bladder Scan BVI 3000 clinic ultrasonography (Verathon Inc, Bothell, WA, U.S.).

Postoperative complications were documented, including the development of anastomotic leaks, fistulae, uretero-ileal stenosis, and neobladder neck contractures (i.e., fibrotic stenosis of the ileourethral anastomosis). Functional and metabolic outcomes were also documented, including recurrent urinary tract infections (UTI; defined as  $\geq 3$  occurrences of symptomatic UTI per year requiring antibiotic treatment), urinary stone formation, electrolyte disorders (requiring supplementation), and vitamin B12 deficiencies (requiring supplementation).

For patients with less than five-year followup, renal function was documented preoperatively (up to six months before surgery), at 6–12 months, and 1–5 years postoperatively (most recent). Postoperative renal function was documented at 10 years and 15 years for patients with longer followup ( $\geq 5$  years). Presence or absence of hydronephrosis was obtained from radiographic reports (computed tomography or ultrasound) and documented preoperatively, at 6–12-month followup, and most recent followup. Estimated glomerular filtration rate (eGFR) was calculated using the Modification of Diet in Renal Disease formula,<sup>16</sup> and categorized according to chronic kidney disease (CKD) stage.

## Data analysis

Descriptive analysis of patient demographics, pathological stage, postoperative complications, functional outcomes, and metabolic outcomes was performed. Patient outcomes were compared based on followup duration ( $< 5$  vs.  $\geq 5$  years) and gender. Between-group differences were calculated using Mann-Whitney U test for continuous variables and Fisher exact test for categorical variables based on nonparametric data. Univariate logistic regression was performed for predictors of renal function and functional outcomes.

Statistical significance was set as  $p < 0.05$ . Statistical analysis was performed using SPSS (IBM SPSS Statistics for Windows, Version 21.0. Released 2012. Armonk, NY, U.S.: IBM Corp.).

## Results

Of the 116 patients who underwent radical cystectomy and SNB for bladder cancer, 72 met our inclusion criteria. Five patients (4.3%) had early ( $< 12$  months) postoperative followup with their local urologist and were excluded from analysis due to lack of long-term data. Patient demographics and tumor characteristics are outlined in Table 1. Surgeries were performed at a single institution by three urologic oncologists, accounting for 75%, 16.7%, and 8.3% of our sample, respectively.

Mean  $\pm$  standard deviation (SD) patient age at surgery was  $54.8 \pm 8.6$  years, with a median  $\pm$  interquartile range (IQR) preoperative Charlson comorbidity index (CCI) of  $4 \pm 2$ . A majority of patients had muscle-invasive disease ( $n=44$ ; 61.1%). Median  $\pm$  IQR followup time was  $70 \pm 11$  months. More than half ( $n=38$ ; 52.8%) of our sample had  $\geq 5$  years of followup. Baseline characteristics for comparison groups ( $< 5$  vs.  $\geq 5$  years, and male vs. female) were compared and similar in all categories except for histological type, with a higher proportion of squamous cell carcinoma in females in this series ( $p=0.007$ ). Patients in the  $\geq 5$  years subgroup had a longer duration of followup ( $p < 0.001$ ).

## Functional outcomes

Functional voiding outcomes are shown in Table 2 and Fig. 1. All patients were advised and encouraged adherence to a timed voiding schedule. Despite this, approximately one-quarter of patients required catheterization (three indwelling and 16 CIC). CIC was initiated at our institution when risk of SNB overdistension was identified through elevated PVR ( $n=9$ ), recurrent urinary retention ( $n=3$ ), deteriorating renal function ( $n=1$ ), increasing hydronephrosis ( $n=1$ ), or recurrent urosepsis ( $n=2$ ). Elevated PVR was defined as greater than 500 mL on bladder scan after best void (e.g., double voiding, Credé maneuver), as this was a threshold deemed acceptable to patients to initiate self-catheterization. Patients who used CIC had mean PVR of 206.7 mL compared to those who did not (mean PVR: 78.1 mL,  $p=0.024$ ). PVR was not associated with other functional voiding outcomes on linear regression. Need for CIC was not associated with age or followup duration on linear regression. Indications for permanent catheterization included incontinence, fistula, and patient preference.

The prevalence of NUI and DUI was similar between followup durations and patient sex (Table 2). Patients with longer followup reported a lower proportion of DUI (Fig. 1). Pathological stage, age, and chemotherapy were not predictive of DUI or NUI.

**Table 1. Patient demographics, chemotherapy status, postoperative complications, and tumor characteristics**

Patient demographics	All (n=72)	<5 years (n=34)	≥5 years (n=38)	p	Male (n=61)	Female (n=11)	p
Age at surgery, mean years (SD)	54.6 (8.6)	56.6 (7.2)	53.29 (9.5)	0.122	55.08 (7.6)	53.45 (13.2)	0.994
Female sex, n (%)	11 (15.3%)	6 (18%)	5 (13%)	0.746	–	–	–
CCI, median (IQR)	4 (2–6)	4 (2–6)	4 (1–7)	0.789	4 (2–6)	4 (1–7)	0.785
Prior pelvic radiotherapy, n (%)	0	0	0	–	0	0	–
Chemotherapy,* n (%)	27 (37.5%)	26 (76.5%)	11 (28.9%)	0.150	23 (37.7%)	4 (36.4%)	0.999
Followup duration, median years (IQR)	5 (0–13)	2 (0–4)	11 (5–16)	<0.001	6 (1–11)	3 (0–7.5)	0.374
<b>Postoperative complications</b>							
Clavien-Dindo classification**							
0	29 (40.3%)	12 (35.3%)	17 (44.7%)	0.223	25 (49%)	4 (36.4%)	0.172
I	21 (29.2%)	10 (29.4%)	11 (28.9%)		19 (37.2%)	2 (22.2%)	
II	6 (8.3%)	4 (11.8%)	2 (5.3%)		5 (9.8%)	1 (9.1%)	
III	3 (4.2%)	3 (8.8%)	0		2 (3.9%)	1 (9.1%)	
IV	1 (1.4%)	1 (2.9%)	0		0	1 (9.1%)	
Missing	12 (16.7%)	4 (11.8%)	9 (21.1%)		10 (19.6%)	2 (18.2%)	
Readmission within 90 days							
Yes	15 (20.8%)	8 (23.5%)	7 (18.4%)	0.773	8 (14.2%)	2 (13.3%)	0.999
<b>Tumor characteristics</b>							
Pathological stage	No. (%)						
T0	4 (5.6%)	1 (2.9%)	3 (7.9%)	0.109	4 (2.0%)	0	0.625
Ta	1 (1.4%)	1 (2.9%)	0		1 (1.6%)	0	
Tis	12 (16.7%)	3 (8.8%)	9 (23.7%)		11 (18.0%)	1 (9.1%)	
T1	9 (12.5%)	2 (5.9%)	7 (18.4%)		9 (14.8%)	0	
T2	21 (29.2%)	13 (38.2%)	8 (21.1%)		16 (26.2%)	5 (45.5%)	
T3	17 (23.6%)	10 (29.4%)	7 (18.4%)		13 (21.3%)	4 (36.4%)	
T4	6 (8.3%)	4 (11.8%)	2 (5.3%)		5 (8.2%)	1 (9.1%)	
Missing	2 (2.8%)	0	2 (5.3%)		2 (3.3%)	0	
Histopathological type							
Urothelial cell carcinoma	60 (83.3%)	30 (88.2%)	30 (78.9%)	0.615	54 (88.5%)	6 (54.5%)	0.007
Squamous cell carcinoma	4 (5.6%)	1 (2.9%)	3 (7.9%)		1 (1.6%)	3 (27.3%)	
Adenocarcinoma	1 (1.4%)	0	1 (2.6%)		1 (1.6%)	0	
Missing	7 (9.7%)	3 (8.8%)	4 (10.5%)		5 (8.2%)	2 (18.2%)	

\*Neoadjuvant or adjuvant chemotherapy. \*\*Complications within 90 days. Data collected for patients with ≥1-year followup. <1-year followup included one Clavien V and three Clavien IV complications. CCI: Charlson comorbidity index; IQR: interquartile range; SD: standard deviation.

## Renal function outcomes

Mean eGFR prior to SNB was 88.27 mL/min/1.73 m<sup>2</sup>. At 6–12 months postoperative, mean eGFR decreased to 71.92 mL/min/1.73 m<sup>2</sup>. At 1–5 years, 10 years, and 15 years followup, mean eGFR was 76.23 mL/min/1.73 m<sup>2</sup>, 66.06 mL/min/1.73 m<sup>2</sup>, and 68.33 mL/min/1.73 m<sup>2</sup>, respectively. Mean eGFR change per year from preoperative eGFR was -7.19 mL/min/1.73 m<sup>2</sup> in the first year. Between postoperative years 1–5, mean eGFR change per year was +0.862 mL/min/1.73 m<sup>2</sup>. Between years 6–10, mean eGFR change per year was -2.034 mL/min/1.73 m<sup>2</sup>. Between 10–15 years, mean eGFR change was 0.454 mL/min/1.73 m<sup>2</sup>.

With longer followup beyond one year, an increasing proportion of patients develop stage III (moderate) to IV (severe) CKD (41.7% at 10 years) (Fig. 2). Few patients remain at

CKD stage I with long-term followup (39.7% preoperative to 12.5% at 10 years). A greater proportion of hydronephrosis was identified over time, as 26 (36.1%) patients had hydronephrosis at most recent followup, compared with 12 (16.7%) of patients with preoperative hydronephrosis. Presence of hydronephrosis at 6–12 months followup was associated with decreased eGFR at 6–12 months ( $p<0.001$ ), 1–5 years ( $p=0.020$ ), 10 years ( $p=0.016$ ), and 15 years ( $p=0.009$ ).

## Urolithiasis and metabolic outcomes

Ten (13.9%) patients had documented electrolyte disorders (Table 2). A minority of patients ( $n=13$ ; 18.1%) developed urinary stone disease. All stones required operative intervention through percutaneous nephrolithotomy, antegrade ureteroscopy, or transurethral cystolitholapaxy. Patients

**Table 2. Functional, anatomical, and metabolic outcomes following Studer neobladder urinary diversion by followup duration (<5 years vs. ≥5 years) and patient gender**

	Followup duration			p	Gender		p
	Total (n=72)	<5 years (n=34)	≥5 years (n=38)		Male (n=61)	Female (n=11)	
Need for catheterization							
Permanent indwelling catheter, n (%)	3 (4.3%)	1 (2.9%)	2 (5.3%)	0.999	3 (9.8%)	0	0.999
Clean intermittent catheterization, n (%)	16 (22.2%)	6 (17.6%)	10 (26.3%)	0.276	11 (18.0%)	5 (45.5%)	0.059
Lower urinary tract symptoms							
Frequency, n (%)	6 (8.3%)	4 (11.8%)	2 (5.3%)	0.412	6 (9.8%)	0	0.581
Nocturia, n (%)	9 (12.5%)	4 (11.8%)	5 (13.2%)	0.999	8 (13.1%)	1 (9.1%)	0.999
Urinary incontinence							
Daytime urinary incontinence,* n (%)	12 (16.7%)	9 (26.5%)	3 (7.9%)	0.056	8 (13.1%)	4 (36.3%)	0.078
Nighttime urinary incontinence, n (%)	32 (44.4%)	18 (52.9%)	14 (36.8%)	0.235	26 (42.6%)	6 (54.5%)	0.522
Postvoid residual							
Postvoid residual, mean, mL (SD)	110.9 (180.7)	125.94 (207.0)	101.59 (165.5)	0.886	254.6 (295.3)	93.81 (159.1)	0.242
Infection							
Recurrent UTI, n (%)	25 (34.7%)	10 (29.4%)	15 (39.5%)	0.460	19 (31.1%)	6 (54.5%)	0.173
Urolithiasis							
Any stones,** n (%)	13 (18.1%)	2 (5.9%)	11 (28.9%)	0.013	12 (19.7%)	1 (9.1%)	0.676
Upper urinary tract, n (%)	8 (11.1%)	1 (2.9%)	7 (18.4%)	0.059	7 (11.4%)	1 (9.1%)	0.999
Neobladder, n (%)	6 (8.3%)	1 (2.9%)	5 (13.2%)	0.203	6 (9.8%)	0	0.581
Metabolic disorders							
Electrolyte disorder, n (%)	10 (13.9%)	6 (17.6%)	4 (10.5%)	0.504	9 (14.8%)	1 (9.1%)	0.999
Bicarbonate use,*** n (%)	3 (4.2%)	1 (2.9%)	2 (5.3%)	0.999	3 (4.9%)	0	0.999
Vitamin B12 deficiency, n (%)	4 (5.6%)	0	4 (10.5%)	0.116	4 (6.6%)	0	0.999

\*Defined as requiring use of a daily pad for urinary incontinence. \*\*One patient developed both upper urinary tract calculi and neobladder calculi requiring intervention. \*\*\*Oral bicarbonate therapy due to hyperchloremic metabolic acidosis secondary to ileal urinary diversion. SD: standard deviation; UTI: urinary tract infection.

with longer duration of SNB (≥5 years) were more likely to develop urolithiasis ( $p=0.013$ ). Development of neobladder calculi was not associated with followup duration, sex, PVR, or need for CIC. Development of upper urinary tract calculi was associated with decreased eGFR at most recent followup (46.16 vs. 77.23 mL/min/1.73 m<sup>2</sup>,  $p=0.042$ ) and presence of hydronephrosis at 6–12 months (80% vs. 31%;  $p=0.047$ ). There was no association between electrolyte disorders or bicarbonate use with upper or lower urinary tract calculi. There were no significant differences between groups in other functional or metabolic complications over time (Table 2).

### Postoperative complications

Fourteen anastomotic urinary leaks were documented; nine (64.2%) occurred within the early postoperative period (<30 days) (Supplementary Table 1; available at [cuaj.ca](#)). Anastomotic leaks were identified clinically (elevated surgical drain output) or on postoperative retrograde ureterogram. Details on management of postoperative leaks is described in Supplementary Table 1 (available at [cuaj.ca](#)). Of the six uretero-ileal anastomotic leaks, five (83.3%) were on the left side.

Thirty-three occurrences of urinary obstruction were documented, including 17 uretero-ileal stenoses in 14 (19.4%)

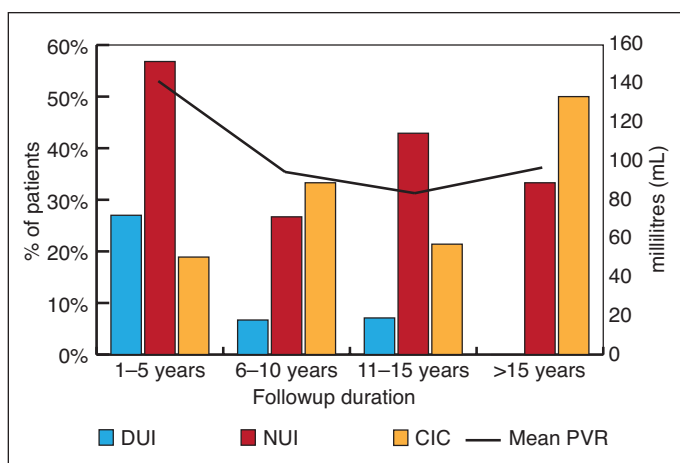
patients. Left uretero-ileal stenoses comprised the majority ( $n=10$ , 58.8%), followed by right ( $n=4$ , 23.6%) and bilateral ( $n=3$ , 17.6%). All patients who developed uretero-ileal stenosis underwent initial decompression with percutaneous nephrostomy tube to preserve renal function, with 10 requiring corrective surgical intervention at a later date (Supplementary Table 1 for surgical details; available at [cuaj.ca](#)). The remaining patients were left with nephrostomy tubes or ureteral stents with regular changes. Fifteen occurrences of neobladder neck contracture were documented in 12 (16.7%) patients, all of whom required some form of surgical intervention (e.g., urethral dilation, transurethral incision of bladder neck, etc). Three (4.2%) patients with neobladder neck contracture required two or more interventions. One (1.4%) case of urethral stricture occurred, requiring dilation.

Ten patients (13.9%) developed urinary fistulae with or without bowel involvement, of which five required surgical correction. Anatomic and management details are shown in Supplementary Table 1 (available at [cuaj.ca](#)).

### Discussion

SNB is an established form of continent urinary diversion and is a viable option for some patients who would prefer to optimize external appearance and avoid need for uros-





**Fig. 1.** Most recent functional voiding outcomes by duration of followup. Patients with longer followup duration report lower rates of daytime urinary incontinence (DUI) and nighttime urinary incontinence (NUI) than those with less than 5 years of followup. This may be explained by higher clean intermittent catheterization (CIC) rates in patients with longer followup as a part of bladder emptying protocols. Postvoid residual (PVR) rates remain relatively stable over longer-term followup.

tomy. In this study, we assessed functional, anatomical, and metabolic outcomes in patients who underwent SNB with longer-term followup.

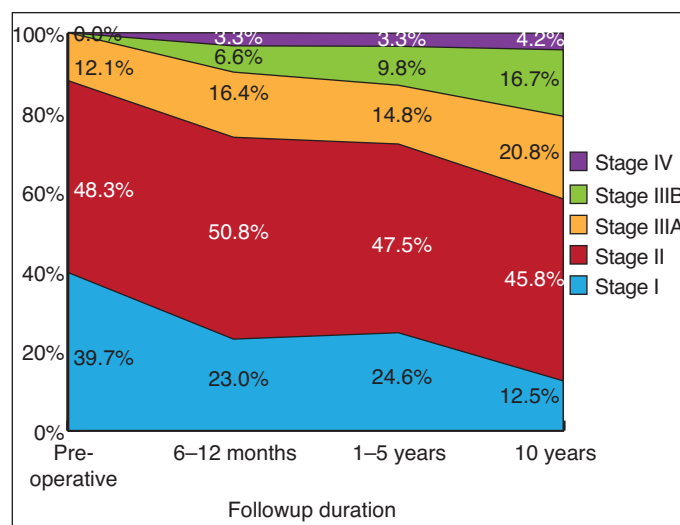
### Urinary continence function

A minority of patients in our series experienced DUI (16.7%), with lower DUI rates reported by patients with longer followup (Table 2, Fig. 1). This is in contrast with long-term series of SNB, which have reported DUI rates of 25–61%,<sup>15,17</sup> that plateau at 12 months with stability and subsequent deterioration.<sup>17</sup> Our cohort also showed lower NUI rates than other long-term series (44.4% vs. 75–79%).<sup>4,15,17</sup> This may be partly explained by the younger average age of our sample compared with those evaluated in other long-term series (average age: 54.6 vs. 65–70 years),<sup>15,17</sup> which is advantageous in terms of postoperative pelvic floor rehabilitation.

Functional outcomes described in this series may also be explained by our pre-emptive approach to implementation of CIC. Indications for initiating CIC included elevated PVR, deteriorating renal function, increasing hydronephrosis, urinary retention, or recurrent urosepsis despite timed voiding. Patients also started CIC to prevent functional symptoms (i.e., once nightly to prevent NUI). Accordingly, our rates of CIC (22.2%) are greater than reported in other series of SNB (6–9.5%).<sup>10,15</sup>

### Postoperative renal function

Renal deterioration is common following SNB, as an increasing proportion of patients developed moderate to severe CKD over time (Fig. 2). As well, the prevalence of hydronephrosis



**Fig. 2.** Chronic kidney disease (CKD) stage over time. Increasing proportion of patients develop stage III-IV CKD with longer followup.

identified 6–12 months postoperative (27.8%) was increased compared to preoperative hydronephrosis (16.7%). Lantz et al<sup>18</sup> similarly identified that 19.3% of patients had hydronephrosis at 12 months postoperatively. At most recent followup, the rate of hydronephrosis in our series increased to 36.1%, though this was not associated with a decrease in mean eGFR. Higher rates of hydronephrosis with longer followup may be explained by refluxing ureteric anastomoses in some cases.

There have been few reports on long-term renal function in patients with orthotopic ileal neobladder. Jin et al<sup>19</sup> compared ileal conduit to ileal neobladders at 10-year followup and identified that 21% of patients with ileal neobladders had deterioration of renal function with minimal change in eGFR (difference in median eGFR: -2 mL/min/1.73 m<sup>2</sup>). This finding is similar to the 10-year and 15-year eGFR change reported in this study (+1.14 mL/min/1.73 m<sup>2</sup> and -1.53 mL/min/1.73 m<sup>2</sup>, at 10 years and 15 years, respectively), which may be due to selection bias for healthier patients with longer survival following SNB.

Moreover, Jin et al identified that obstruction was the leading and independent risk factor for renal deterioration.<sup>19</sup> This finding is supported by our data that indicates that hydronephrosis at 6–12 months followup was associated with renal function deterioration across 5–15-year followup periods. Eisenberg et al<sup>20</sup> similarly noted that postoperative hydronephrosis was predictive of renal function decrease, even after controlling for uretero-ileal anastomotic stenosis. Reflux nephropathy, therefore, may be a potential cause for renal deterioration; early intervention (e.g., timed voiding, CIC, indwelling catheter) should be recommended for patients with SNB with overdilation and non-obstructive hydronephrosis in order to preserve renal function. Despite pre-emptive intervention with CIC, only a minority of patients

will have preserved renal function (CKD stage I) at 10 years (12.5%) (Fig. 2).

### Urolithiasis and metabolic outcomes

Patients treated for metabolic acidosis with bicarbonate supplementation was similar between our series and others (4.2% vs. 1.1–4.4%).<sup>4</sup> It is noteworthy that metabolic derangements occurred early in the postoperative course, as well as with longer-term followup. Rates of vitamin B12 deficiency in this study were similar to other series (5.6% vs. 4.8–13.6%)<sup>16,17</sup> and only necessary in those with at least five years of diversion.

Urolithiasis (renal and ileal pouch) affected 28.9% of patients, primarily occurring after five years of followup. Rates of urolithiasis in our series was similar to that of other forms of intestinal urinary diversion (2–43%);<sup>18</sup> however, long-term rates of urolithiasis in SNB have not been well-documented. There were no risk factors associated with the development of neobladder calculi in this series. The association between upper urinary tract calculi following SNB and poorer renal function is unclear, but may be related to the presence of postoperative hydronephrosis secondary to obstruction or ureteral reflux.<sup>21</sup> Stone composition was not available for evaluation in this study, but stone formation following urinary diversion is commonly struvite due to bacterial colonization and diversion-related metabolic derangements.<sup>22,23</sup>

### Postoperative surgical intervention

In the early postoperative period, our data indicates that anastomotic urinary leaks following SNB can often be managed without need for percutaneous drains or nephrostomy tubes. Rates of intervention for early postoperative urinary leaks have previously been reported to be approximately 5%.<sup>24</sup> In our series, all early postoperative urinary leaks were managed successfully with conservative endourological means, as indicated in Supplementary Table 1 (available at [cuaj.ca](http://cuaj.ca)).

The most common indication for postoperative intervention in this series was for uretero-ileal stenosis (19.4%). All uretero-ileal stenoses were initially managed by percutaneous drainage, followed by endourological techniques (e.g., antegrade balloon dilation), with open revision as a backup strategy (1.4%). Rates of balloon dilation of uretero-ileal stenosis in our sample were higher compared to those of similar studies (19.4% vs. 2.7–11.1%), with similar rates of open revision (1.4% vs. 0.9–2.4%).<sup>9,17</sup> The higher rate of intervention for uretero-ileal stenosis may be attributed to pre-emptive treatment of uretero-ileal stenosis in asymptomatic patients to prevent long-term renal deterioration.

Neobladder outlet obstruction is relatively uncommon

and may be attributed to local tumor recurrence infiltrating pelvic floor and neobladder neck, neobladder neck contracture, urethral stricture, or excessive angulation of the pouch relative to the urethra.<sup>25,26</sup> The neobladder neck contracture rate in our series (16.7%) was higher than other long-term series (1–9%).<sup>25,27,28</sup> Most neobladder neck contractures occurred within the first year and all were treated endoscopically. Recurrence of neobladder neck contracture (n=5) generally occurred within one year of transurethral incision of bladder neck. Endoscopic management is recommended for neobladder neck contractures, with conversion to ileal conduit for recalcitrant cases.<sup>29</sup>

Although uncommon, incidence of neobladder fistulae may be higher than that of ileal conduit or Indiana pouch.<sup>30</sup> In our series, nine (12.5%) fistulae were identified; none were associated with previous radiotherapy. Identified causes of neobladder intestinal fistulae included recurrent malignancy, pelvic abscess, and diverticulitis. Rates of neobladder intestinal fistulae seen in this series are similar to other long-term series (1.5–4.4%).<sup>17,30</sup> All cases of neobladder cutaneous fistulae (2.8%) were successfully managed conservatively.

### Limitations

This study is limited by its retrospective design and smaller sample size based at a single center with strict inclusion criteria. Some patients were excluded due to surgery being performed in last 12 months, early (<12 months) transfer of care back to community urologist, or lack of robust followup data sufficient for analysis. A small proportion of females who underwent SNB limited comparison of functional outcomes between sexes. Documentation of functional urinary outcomes may also have been under-reported. Use of validated questionnaires to record patient-reported outcomes of urinary function was unfortunately not performed, nor were formal urodynamic evaluations or functional imaging generally conducted. Comprehensive long-term documentation of anatomical, functional, metabolic, and renal function outcomes should be considered through prospective data collection.

### Conclusions

We assessed the functional, anatomical, and metabolic outcomes of patients who underwent SNB over two decades. Preoperative counselling on carefully selected patients should include long-term chronic renal function deterioration, metabolic derangements, and urinary continence issues, including potential need for intermittent or long-term indwelling catheterization. Emphasis on conscientious avoidance of chronic bladder overdistention through fastidious timed voiding and early initiation of intermittent catheterization may help to prevent renal deterioration, recurrent urosepsis, and some urinary dysfunction problems. Standardized followup proto-

cols with monitoring of PVR, hydronephrosis, and metabolic and functional outcomes are essential for patients with SNB and may prevent long-term complications.

**Competing interests:** The authors do not report any competing personal or financial interests related to this work.

This paper has been peer-reviewed.

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