



# Continent cutaneous urinary diversion with an ileal pouch with the Mitrofanoff principle versus a Miami pouch in patients undergoing cystectomy for bladder cancer: results of a comparative study

Maxime Pattou<sup>1</sup> · Michael Baboudjian<sup>2</sup> · Ugo Pinar<sup>1</sup> · Jérôme Parra<sup>1</sup> · Morgan Rouprêt<sup>1,3</sup> · Gilles Karsenty<sup>2</sup> · Véronique Phe<sup>3,4</sup>

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## Abstract

**Purpose** Radical cystectomy (RC) is currently the standard of care for non-metastatic muscle invasive bladder cancer. Few studies compare methods of cutaneous continent urinary diversion (CCUD) following RC. The objective was to compare perioperative morbidity and functional outcomes of CCUD using an ileal pouch with a Mitrofanoff efferent versus a Miami ileocolic pouch in patients undergoing cystectomy of pelvic exenteration for bladder cancer.

**Methods** This retrospective two-centre study included all consecutive patients who underwent radical cystectomy or pelvic exenteration with CCUD for bladder cancer between 2001 and 2020 in two academic French hospitals with a median follow-up time of 5.4 years. Patients were divided into two groups according to the type of urinary diversion: Miami ileocolonic pouch (group A) and ileal pouch with Mitrofanoff/Monti principle (group B). Continence rate, ability to perform intermittent self-catheterisation, complications and health-related quality of life (HRQoL) measured by the bladder cancer index were evaluated.

**Results** Thirty-one patients were included. Continence was achieved in 11 out of 14 patients (79%) in group A versus 12 out of 17 patients (71%) in group B ( $P=0.3$ ). A significantly higher rate of cutaneous tube stenosis was reported in group B compared to group A (eight (47%) vs. one (7%) patient, respectively;  $P=0.02$ ). HRQoL outcomes were similar in both groups except less digestive discomfort observed in group A.

**Conclusions** When comparing the ileal pouch with Mitrofanoff/Monti's principle with a Miami pouch, no significant differences were found regarding continence rate, ability to self-catheterise, long-term complication rate and overall patient satisfaction.

**Keywords** Complications · Continent cutaneous urinary diversion · Indiana pouch · Miami pouch · Mitrofanoff/Monti principle · Quality of life · Radical cystectomy

✉ Véronique Phe  
veronique.phe@aphp.fr

<sup>1</sup> Department of Urology, Assistance Publique-Hôpitaux de Paris, Pitié-Salpêtrière Academic Hospital, Sorbonne University, Paris, France

<sup>2</sup> Department of Urology and Kidney Transplantation, Assistance Publique-Hôpitaux de Marseille, La Conception Hospital, Aix Marseille University, Marseille, France

<sup>3</sup> GRC5 Predictive Onco-urology, Sorbonne University, Paris, France

<sup>4</sup> Department of Urology, Assistance-Publique-Hôpitaux de Paris, Tenon Academic Hospital, Sorbonne University, 4 rue de la Chine, 75020 Paris, France

## Introduction

Bladder cancer is a major health problem worldwide, ranking ninth in annual incidence and thirteenth as a cause of death [1]. While radical cystectomy (RC) is currently the standard of care for non-metastatic muscle invasive bladder cancer, the method of urinary diversion following RC is shifting. Non-continent urinary diversion using an ileal conduit is widely performed [2] but is associated with problems of acceptance of a stoma by patients. In other patients, an orthotopic neobladder is not always possible, particularly

in cases of urethral invasion or high risk of urinary incontinence, especially in women [3].

Some groups have suggested offering selected patients cutaneous continent urinary diversion (CCUD) if they are willing to self-catheterise in long term [3]. Different types of CCUD can be considered, including a Miami ileocolic pouch [4] and a heterotopic ileal pouch with an efferent tube using Mitrofanoff's principle. The choice of CCUD is determined on a case-by-case basis depending on the patient's history and previous abdominal surgery. The largest Miami pouch study series of 90 cases of gynaecological tumours found a continence rate of 93% and a revision surgery rate of 23.3% [5]. Revision surgeries were due to difficulty to self-catheterise, incontinence, ureteral strictures and urinary stones. Studies based on neuro-urological patients reported a continence rate of 96% and a revision surgery rate of 24.1% [6]. Revision surgeries were due to incontinence, enterocutaneous fistula and urinary stones.

However, data are scarce regarding the long-term functional outcomes of CCUD after RC [7].

The aim of this study was to compare perioperative morbidity and functional outcomes of CCUD using a Miami ileocolic pouch versus a heterotopic ileal pouch with an efferent tube based on Mitrofanoff's principle in patients undergoing cystectomy or pelvic exenteration for bladder cancer.

## Methods

### Study design and patients

This retrospective study included all consecutive patients who underwent RC and CCUD for bladder cancer between 2001 and 2020 in two academic urology departments. All patients gave their written informed consent and this study was approved by the local ethics committees.

Patients were divided into two groups according to the type of urinary diversion: Miami pouch (group A) and Mitrofanoff/Monti (group B). Exclusion criteria included metastasis, history of colorectal cancer or chronic diarrhoea, local control of the disease not possible, inability to perform intermittent self-catheterisation due to upper limb or cognitive impairment and stage 4 chronic kidney disease (glomerular filtration rate < 30 ml/min). In both groups, one senior surgeon was involved, assisted by chief residents.

### Data collection

Preoperative data were collected including sex, body mass index (BMI), American Society of Anesthesiologists (ASA) score, date of bladder cancer diagnosis, histological type of neoplasia, TNM classification, neoadjuvant treatment (if

performed), preoperative renal function and imaging of the upper urinary tract.

### Surgical procedures

Centre 1 used the Miami pouch procedure (group A), where an ileocolonic segment was cut with a stapler and the colonic reservoir made by folding the caecocolon on itself and suturing both lumina together. The last 15 cm of the ileum was used as a continence mechanism. Appendectomy was always performed [8].

In centre 2 (group B), a heterotopic ileal pouch was obtained from a 40-cm vascularised ileal segment, taken 30 cm from the ileocecal valve and detubulated according to the technique of Hautmann et al. [9]. The reservoir was hand sewn in a W shape. The efferent "continent" portion of the reservoir was created either from the appendix according to Mitrofanoff's technique [10] or from a segment of the small intestine if absent, according to the technique of Monti et al. [11] or Casale [12]. An antireflux system for the tube was created using the Le Duc-Camey's technique [13].

In both groups, ureters were implanted with a serous lined antireflux mechanism, protected by two ureteral stents removed after 12 days. Additionally, a 22-Fr Foley catheter was placed in the neobladder wall and a 16-Fr catheter in the efferent conduit (14-Fr in the Miami group) was inserted and removed after 20 and 21 days, respectively, in order to allow the patients to start intermittent self-catheterisation.

### Follow-up

Patients were first seen 1 month after discharge to evaluate their self-catheterisation technique and to communicate their histology results. Follow-up was then performed at 3, 6 and 12 months with a bladder diary and renal function assessment. Patients also underwent a bi-annual thoraco-abdominopelvic computed tomography scan in accordance with international recommendations [14] and an annual pouch endoscopy to look for stones or reservoir abnormalities. A urodynamic test was justified in the event of stoma leakage, urinary tract infection or upper urinary tract abnormalities.

### Outcomes

Primary outcomes were the ability to perform self-catheterisation and urinary continence rate after surgery. Continence was defined as the absence of any leakage.

Secondary outcomes included the incidence of early postoperative complications, reported according to Clavien–Dindo's classification [15] and health-related quality of life (HRQoL) assessed using items of the bladder cancer index (BCI). The BCI is a validated questionnaire specific to bladder cancer [16] and translated into French [17],

including urinary, digestive and sexual function (ranked as none, moderate or important discomfort), as well as body image perception (0 = best perception to 30 = worst perception) and overall patient satisfaction (Likert scale of 0–10). Questionnaires were collected in June 2018 and December 2021.

## Statistical analysis

Quantitative variables are described as mean and standard deviation (SD) and qualitative variables as number and percentage. Length of follow-up is described as median and interquartile range (IQR). Patients were divided in two groups according to the type of diversion (group A vs. group B). The Mann–Whitney test was used to compare quantitative variables and Fischer’s exact test for qualitative variables.  $P < 0.05$  was considered statistically significant for all analyses. Statistical analyses were performed using R software.

## Results

### Study population

A total of 31 patients (23 women and 8 men) were included during the study period. Mean ( $\pm$  SD) age and BMI were

$56.2 \pm 8.6$  years and  $23.5 \pm 3.2$  kg/m<sup>2</sup>, respectively. There were 14 patients (45%) in group A and 17 patients in group B (55%). In group B, Monti’s technique was used in nine patients (53%) and Mitrofanoff’s technique in eight (47%). ASA score was significantly lower in group B compared to group A (Table 1).

The perioperative data are summarised in Table 2. Overall,  $n = 13$  early complications were observed in group A (84.6% minor grades, including acute pyelonephritis ( $n = 7$ ), urinary fistula ( $n = 1$ ), ileo-ileal anastomosis fistula ( $n = 1$ ), ileus ( $n = 2$ ), and 15.4% major grade including peritonitis due to ileocolic anastomosis leak ( $n = 1$ ) and prolonged ileus ( $n = 1$ )). In group B,  $n = 12$  complications occurred (66.7% minor grade, including functional renal insufficiency ( $n = 2$ ), septicaemia ( $n = 2$ ), acute pyelonephritis ( $n = 4$ ), and 33.3% major grade including parietal abscess ( $n = 1$ ), cutaneous stenosis ( $n = 1$ ), obstructed ureteral stent ( $n = 1$ )).

Overall, 11 late postoperative complications were observed in group A (including abdominal pain ( $n = 1$ ), urinary infection ( $n = 1$ ), peri-umbilical eventration ( $n = 1$ ), acute pyelonephritis ( $n = 1$ ), uretero-colic anastomosis stenosis ( $n = 1$ ), neobladder stones ( $n = 3$ ), fleshy bud ( $n = 1$ ), peri-umbilical eventration ( $n = 2$ )) and 15 in group B (including cystitis ( $n = 2$ ), ureteroileal anastomosis stenosis ( $n = 2$ ), cutaneous stenosis ( $n = 8$ ), neobladder stone ( $n = 1$ ), acute urinary false passage ( $n = 1$ ) and urethral carcinoma relapse ( $n = 1$ )).

**Table 1** Characteristics of the study population at baseline ( $N = 31$ )

Characteristic	Group A (Miami/Indiana) ( $N = 14$ )	Group B (Mitrofanoff) ( $N = 17$ )	<i>P</i> value
Sex, <i>n</i> (%)			
Female	4 (29)	4 (24)	0.9
Male	10 (71)	13 (76)	
Age (years), mean ( $\pm$ SD)	56.9 ( $\pm 9$ )	55.7 ( $\pm 8.6$ )	0.8
BMI (kg/m <sup>2</sup> ), mean ( $\pm$ SD)	23.4 ( $\pm 3.1$ )	23.5 ( $\pm 3.3$ )	0.9
ASA score, <i>n</i> (%)			
2	5 (36)	17 (100)	<0.01
3	9 (64)	0 (0)	
Neoadjuvant chemotherapy, <i>n</i> (%)			
Yes	4 (29)	10 (59)	0.1
No	10 (71)	7 (41)	
Preoperative eGFR <sup>1</sup> (ml/min/1.73m <sup>2</sup> ), mean ( $\pm$ SD)	82.2 ( $\pm 18.8$ )	95.4 ( $\pm 29.9$ )	0.2
Histological type, <i>n</i> (%)			
Urothelial carcinoma	13 (92.9)	13 (76.4)	0.3
Epidermoid carcinoma	1 (7.1)	1 (5.9)	
Adenocarcinoma	0 (0)	2 (11.8)	
Melanoma	0 (0)	1 (5.9)	

SD standard deviation; BMI body mass index; ASA American Society of Anesthesiologists; eGFR estimated glomerular filtration rate

<sup>1</sup>Calculated using MDRD

**Table 2** Perioperative data

Variable	Group A (Miami/Indiana) ( <i>N</i> =14)	Group B (Mitrofanoff) ( <i>N</i> =17)	<i>P</i> value
Surgical approach for radical cystectomy, <i>n</i> (%)			
Open surgery	14 (100)	14 (82)	0.2
Robot-assisted laparoscopy	0 (0)	3 (18)	
Operative time (min), mean ( $\pm$ SD)	322 ( $\pm$ 58.3)	361 ( $\pm$ 66.7)	0.2
Blood loss (ml), mean ( $\pm$ SD) <sup>1</sup>	375 ( $\pm$ 155)	857 ( $\pm$ 535)	0.02
Duration to catheter removal (days), mean ( $\pm$ SD)	25.2 ( $\pm$ 11.5)	22.9 ( $\pm$ 3.7)	0.4
Length of stay (days), mean ( $\pm$ SD)	28.3 ( $\pm$ 15.1)	24.9 ( $\pm$ 4.5)	0.8
<30 day Clavien–Dindo score, <i>n</i> (%)			
No complication	1 (7)	5 (29)	
Clavien 1	0 (0)	2 (12) <sup>7</sup>	0.08
Clavien 2	11 (79) <sup>2</sup>	6 (35) <sup>8</sup>	
Clavien 3	2 (14) <sup>3</sup>	4 (24) <sup>9</sup>	
>30 day Clavien–Dindo Score, <i>n</i> (%)			
No complication	3 (21)	2 (12)	
Clavien 1	3 (21) <sup>4</sup>	0 (0)	0.2
Clavien 2	2 (15) <sup>5</sup>	3 (18) <sup>10</sup>	
Clavien 3	6 (43) <sup>6</sup>	12 (70) <sup>11</sup>	
Oncological recurrence, <i>n</i> (%)	2 (14)	4 (24)	0.7

*SD* standard deviation

<sup>1</sup>10 missing data (four in group A and six in group B)

<sup>2</sup>Acute pyelonephritis (*n*=7), urinary fistula (*n*=1), ileo-ileal anastomosis fistula (*n*=1), ileus (*n*=2)

<sup>3</sup>Peritonitis from ileocolic anastomosis leak (*n*=1), prolonged ileus (*n*=1)

<sup>4</sup>Abdominal pain (*n*=1), urinary infection (*n*=1), peri-umbilical eventration (*n*=1)

<sup>5</sup>Acute pyelonephritis (*n*=1), uretero-colic anastomosis stenosis (*n*=1)

<sup>6</sup>Neobladder stones (*n*=3), fleshy bud (*n*=1), peri-umbilical eventration (*n*=2)

<sup>7</sup>Functional renal insufficiency (*n*=2)

<sup>8</sup>Septicaemia (*n*=2), acute pyelonephritis (*n*=4)

<sup>9</sup>Parietal abscess (*n*=1), cutaneous stenosis (*n*=1), obstructed ureteral stent (*n*=1)

<sup>10</sup>Cutaneous stenosis (*n*=1), cystitis (*n*=2)

<sup>11</sup>Ureteroileal anastomosis stenosis (*n*=2), cutaneous stenosis (*n*=7), neobladder stone (*n*=1), acute urinary false passage (*n*=1), urethral carcinoma relapse (*n*=1)

There was no significant difference in the early and late postoperative complications between the two groups. Mean (SD) length of stay was  $28.3 \pm 15.1$  days for group A and  $24.9 \pm 4.5$  days for group B ( $P=0.8$ ). Survival rates in this study were 100% at 1 year, 94% at 3 years, 89% at 5 years and 88% at 10 years. Two patients died following a tumour recurrence.

### Outcome measures

Regarding the functional results, median follow-up was 5.4 years (IQR: 1.4–7.9). Continence was achieved in 11 patients (79%) undergoing the Miami procedure and 12 patients (71%) after a Mitrofanoff/Monti procedure; this difference was not statistically significant ( $P=0.3$ ). There was no significant difference in the ability to perform

self-catheterisation between the two groups (group A, 92.9% vs. group B, 100%;  $P=0.263$ ). Patients in group B experienced more cutaneous stenosis than patients in group A (eight (47%) vs. one (7%) patient, respectively;  $P=0.02$ ). There was no difference in the rate of revision surgery between the two groups (six patients (43%) in group A vs. 12 patients (71%) in group B;  $P=0.119$ ). Mean reservoir capacity was significantly higher in group B vs. group A ( $520 \pm 149$  ml vs.  $390 \pm 105$  ml, respectively;  $P=0.008$ ).

The BCI results are shown in Table 3. Based on five major BCI questions, digestive discomfort was the only significant difference between the two groups (Table 3). Overall, patient satisfaction was 8.6/10 ( $\pm 1.4$ ) in group A vs. 8.9/10 ( $\pm 1.1$ ) in group B ( $P=0.5$ ).

**Table 3** Functional results

Variable	Group A (Miami/Indiana) (N=14)	Group B (Mitrofanoff) (N=17)	P value
Continence, n (%)	11 (79)	12 (71)	0.3
Ability to self-catheterise, n (%)	12 (92.9)	17 (100)	0.4
Number of intermittent self-catheterisations per day, mean ( $\pm$ SD)	5.0 ( $\pm$ 0.95)	5.3 ( $\pm$ 1.0)	0.4
Nocturnal leaking, n (%)	2 (14)	3 (18)	0.4
Daily leaking, n (%)	2 (14)	4 (24)	0.7
Cutaneous tube stenosis, n (%)	1 (7)	8 (47)	0.02
Revision surgery, n (%)	6 (43)	12 (71)	0.119
Pyelocalyceal cavity dilation, n (%) <sup>1</sup>	1 (7)	4 (25)	0.3
Reservoir capacity (ml), mean ( $\pm$ SD)	390 ( $\pm$ 105)	520 ( $\pm$ 149)	0.008
1-year eGFR (ml/min/1.73 m <sup>2</sup> ), mean ( $\pm$ SD)	79.9 ( $\pm$ 18.4)	105.1 ( $\pm$ 28.2)	0.010
Digestive discomfort, n (%)			0.003
None	14 (100)	9 (53)	
Moderate	0 (0)	7 (41)	
Important	0 (0)	1 (6)	
Urinary discomfort, n (%)			0.8
None	12 (86)	13 (76)	
Moderate	1 (7)	3 (18)	
Important	1 (7)	1 (6)	
Body perception, mean ( $\pm$ SD)	5 ( $\pm$ 3)	4.8 ( $\pm$ 4.4)	0.7
Overall satisfaction, mean ( $\pm$ SD)	8.6 ( $\pm$ 1.4)	8.9 ( $\pm$ 1.1)	0.5

SD standard deviation; eGFR estimated glomerular filtration rate

<sup>1</sup>One missing data, group B

## Discussion

The results of the present study showed that a Miami ileocolic pouch and an ileal pouch with an efferent tube based on Mitrofanoff's principle gave comparable functional outcomes in terms of continence rate and ability to self-catheterise. The continence rates of 79% and 71% found in groups A and B, respectively, were not significantly different. These figures are lower than those reported by previous studies in patients undergoing CCUD and RC for bladder cancer [3], but could be explained by the strict definition of continence used (no leakage during the day or the night). Moreover, bladder capacity was more important in group B although this did not impact the frequency of daily catheterisation. Furthermore, when comparing eight Mitrofanoff and nine Monti procedures in group B, we found no significant difference on continence, early and late complications or stenosis rates.

Regarding the overall early and late postoperative complications, our results are in line with those reported previously in the literature with 11% uretero-enteric strictures and 7% of urolithiasis in a series of 73 ileo-colonic reservoirs [7]. However, our 39% rate of acute pyelonephritis was twice higher than the previous reported rates [7]. The rate of cutaneous stenosis was significantly higher in the Mitrofanoff/

Monti group compared to the Miami group: we hypothesise that the greater diameter of the efferent tube and more constant vascularisation over time with the Miami pouch procedure may prevent cutaneous stenosis.

In our study, 6 events were reported in the Miami group, requiring an additional surgery: 2 open cystostomies for neobladder stones, 1 nephroureteroscopy to remove an upper ureteral stone, 2 surgical repairs of umbilical eventrations and 1 surgical repair of an ureterovesical anastomosis stenosis. In the Mitrofanoff group, 12 events were reported: 2 surgical repairs of ureterovesical anastomosis stenosis, 1 case of acute urinary false passage, 7 cases of cutaneous stenosis, 1 non-continent diversion due to relapse of a urethral tumour and 1 open cystostomy for a neobladder stone. Thus, the profile of late complications differ between the two groups: in the Miami group, late complications were more related to the reservoir, the abdominal wall and the uretero-reservoir anastomosis, whereas in the Mitrofanoff group, they were more related to the efferent tube itself. These results are in accordance with data found in the literature especially in adult neuro-urological patients [6] and paediatric series [18]. Indeed 3 out of 6 of surgical revisions in the Miami group were directly due to the reservoir, while 8 out of 12 surgical revisions in the Mitrofanoff group concerned the efferent tube.

When considering HRQoL, the Miami pouch group had less bowel discomfort but similar patient satisfaction. However, we believe the Miami pouch exclusion criterion of bowel problems to be more extensive [8]. We found no difference regarding sexual activity, personal health perception ( $P=0.31$ ) or body image ( $P=0.73$ ). The interpretation of the data is limited by the absence of preoperative questionnaires.

One of the strengths of this study is that both centres strictly followed the same surgical indications; both groups were comparable in patients' characteristics and population size. Cases of bladder cancer with urethral or vaginal invasion, women with a trigonal location and men with prostatic extension, were contraindicated to orthotopic neobladders: if intermittent stoma catheterisation was feasible, surgeons offered patients the continent and incontinent alternatives and help the patient choose knowingly.

The exclusion criteria were also the same in the two centres: a history of radiotherapy in the pelvic region contraindicated both surgical techniques as irradiated ileal segments are at higher risk of neobladder fistulisation [19] and ureteral anastomosis stenosis.

We believe that reconstructive surgeons should be familiar with different CCUD techniques and be able to offer several types of CCUD based on a case-by-case discussion, including contraindications. For example, a Miami pouch procedure should be offered to patients without an appendix, patients favouring a right iliac fossa stoma to an umbilical stoma due to body image preferences. The ileal pouch with Mitrofanoff's principle should be offered in cases of malignant colonic polyps, ulcerative colitis of the right colon and in cases of preference for an umbilical stoma. Continent urinary diversions for oncological cases represented less than 10% of all urinary diversions performed during the same period by the two centres. The number of CCUD procedures performed for oncological cases has been gradually increasing in both centres along time. As a matter of fact, the number of procedures in Group A (Miami pouch) vs Group B (Mitrofanoff/Monti) were as follows: zero vs two (2001–2005); zero vs three (2006–2010); six vs six (2011–2015) and seven vs five (2016–2020).

In centre A and centre B, during the same period more than 50 and 250 continent cutaneous urinary diversions, respectively, were performed for non-oncological cases, especially for neuro-urological patients. As the two centres were large academic hospitals, the functional results and complication rates may be more favourable than expected [20].

Our study has several limitations, including its retrospective nature and the small number of patients included. Patients undergoing CCUD tend to have fewer comorbidities than patients undergoing non-continent urinary diversions; complication rates may be consequently lower than for other

non-continent urinary diversion techniques. Although the use of a questionnaire could lead to a potential recall bias, most questions regarded present-day information.

## Conclusion

Cutaneous continent urinary diversion procedures after cystectomy or pelvicotomy for bladder cancer are an effective alternative to their non-continent counterparts in selected patients. However, when an ileal pouch with Mitrofanoff/Monti's principle was compared with a Miami pouch, no significant differences were found regarding continence rate, ability to self-catheterise, long-term complication rate and overall patient satisfaction.

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