

## Tubularized Bladder Flap as a Continent Catheterizable Channel in Adults



Pepijn D. Polm, Michel I.A. Wyndaele, Pieter Dik, and Laetitia M.O. de Kort

<b>OBJECTIVE</b>	To describe a modified, less invasive, surgical technique to create a continent catheterizable channel (CCC) in adults: the tubularized bladder flap (TBF).
<b>MATERIALS AND METHODS</b>	We retrospectively reviewed records of patients in whom a TBF CCC was constructed at adult age between 2019 and 2023. We reported on demographics, operative outcomes, and 30-day and post-30-day complications.
<b>RESULTS</b>	A total of 11 patients (10 female) were described. The median operative time was 96 (range 90–115) minutes in patients with only TBF creation. Estimated blood loss was <100 cc in all patients. Within 30 days postoperatively, 6/11 (55%) patients developed a complication, all grade 1 Clavien Dindo. No bowel complications occurred (paralytic ileus, mechanical obstruction, or leakage/perforation). Median follow-up was 25 (range 6–56) months. In 2/11 (18%) patients surgical revision for stenosis was done; 3/11 (27%) patients underwent surgical revision for stomal leakage.
<b>CONCLUSION</b>	TBF as a means to create a CCC avoids intraperitoneal surgery, and bowel closure (appendicovesicostomy) or anastomosis (retubularized ileum). Postoperative bowel complications were not seen in any of our patients. Surgical revision rates for a TBF CCC appear to be comparable to other CCCs. Therefore, TBF could be considered in patients with sufficient bladder capacity as TBF is less invasive than other CCC techniques and avoids potential bowel complications. UROLOGY 187: 140–146, 2024. © 2024 The Author(s). Published by Elsevier Inc. This is an open access article under the CC BY license ( <a href="http://creativecommons.org/licenses/by/4.0/">http://creativecommons.org/licenses/by/4.0/</a> ).

Some patients with lower urinary tract dysfunction require clean intermittent catheterization (CIC) for timely bladder emptying to maintain continence and preserve renal function.<sup>1,2</sup> When transurethral CIC is not feasible or possible, a continent catheterizable channel (CCC) can be an elegant solution by providing an alternative route. In 1980, Mitrofanoff introduced the first CCC. His technique involved the appendix as a channel between the abdominal skin and the bladder. Its mesenteric blood supply is preserved, and a submucosal tunnel within the bladder is created to achieve stomal continence. This appendicovesicostomy (AVS) became known as the “Mitrofanoff principle.”<sup>3</sup>

In cases where the appendix is unavailable or unsuitable due to luminal (sub)obstruction or insufficient length, an alternative CCC technique using retubularized ileum (Monti procedure) can be used. This technique was first described by Yang and Monti and has since been widely adopted in urologic practice.<sup>4,5</sup>

Additional variations have been developed for patients who require a longer channel, such as the spiral

retubularization technique, also known as the Casale procedure.<sup>6</sup> These various modifications to the original Mitrofanoff principle have greatly increased the versatility and applicability of CCCs, allowing urologists to tailor their approach based on individual patient needs and anatomical considerations.

All of the aforementioned techniques require intraperitoneal surgery, bowel involvement, and bowel closure or re-anastomosis. As a result, patients undergoing CCC creation are susceptible to postoperative complications, such as paralytic ileus, mechanical ileus (anastomotic stenosis) or anastomotic leakage, and surgical site infections. Over the past decade, efforts have been made to reduce the invasiveness of CCC creation by focusing on laparoscopic and robotic techniques. While functional outcomes are promising and postoperative return to regular diet is faster compared to the open approach, ileus remains a frequent complication.<sup>7,8</sup>

To avoid intraperitoneal involvement, a new technique was introduced in 2002 in which a tubularized bladder flap (TBF), much like the Boari-flap technique used for ureteric reconstruction, was used to create a CCC. The initial study in children revealed frequent stomal stenosis, leading the authors to state that although it was a viable alternative, it was not the preferred approach compared to established techniques, such as the AVS or retubularized ileum procedures.<sup>9</sup>

**Funding Support:** No funding was received.

MeSH: Bladder, Neurogenic, Diversion, Catheterization

From the UMC Utrecht, Department of Urology, Utrecht, The Netherlands

Address correspondence to: Pepijn D. Polm, M.D., UMC Utrecht, Department of Urology, Heidelberglaan 100, 3584 CX Utrecht, The Netherlands. E-mail:

[p.d.polm@umcutrecht.nl](mailto:p.d.polm@umcutrecht.nl)

Submitted: November 22, 2023, accepted (with revisions): March 6, 2024

In subsequent small case series with mainly adults and relatively short follow-up periods, the usage of bladder tissue to create a CCC has been further investigated.<sup>10,11</sup> While these studies explore potential alternatives, the limited duration of follow-up raises the need for further research to assess outcomes and complications associated with this approach.

In 2017, our institution published a cohort study of 117 CCCs created in pediatric patients, 31 of which were created from TBF.<sup>12</sup> This study in children showed no significant difference in the incidence of stomal stenosis or other complications when compared to outcomes observed with AVS or retubularized ileum techniques. The lack of significant differences in complication rates within this large cohort led to the use of TBF CCC in the adult population at our academic urology institution. In patients with a good bladder capacity, good storage function, and an indication for CCC, the option of TBF CCC was discussed during preoperative counseling. The potential advantage of avoiding intraperitoneal manipulation was included in counseling.

The purpose of this study is to describe the results of our first cohort of adult patients in whom a TBF CCC was constructed, with emphasis on postoperative complications and functional outcomes.

## MATERIAL AND METHODS

### Study Population

This study was conducted with the approval of the local ethics review board. We included all adult patients in whom a TBF CCC was constructed at our academic institution between 2019 and 2023 and performed a retrospective review of electronic medical records.

Patients with an indication for CCC were counseled extensively by a reconstructive urologist and a specialist nurse. Prior to surgery, a bladder diary was completed and a urodynamic study was performed with evaluation of the maximum cystometric capacity, bladder compliance, and detrusor overactivity during filling cystometry according to International Continence Society standards of practice.<sup>13</sup> Assessment of cystometric capacity was related to posture, with good bladder capacity defined as a maximum cystometric capacity of at least 400 mL or a bladder that would reach the umbilicus when full. Good bladder storage function was defined, as good bladder capacity with the absence of high-pressure detrusor overactivity and a compliance > 20 mL/cm H<sub>2</sub>O. In all patients who opted for CCC creation, especially those with good bladder storage function, TBF was discussed as a potential technique in addition to AVS or retubularized ileum. The TBF was counseled as theoretically the least invasive procedure, as it does not require intraperitoneal and bowel surgery. Furthermore, all CCCs at our center are created by open surgery.

Demographic information, including patient age at the time of surgery, medical history and comorbidities, BMI,

gender, renal function, and length of follow-up, was collected.

Detailed records of the surgical procedure were compiled, including operative time (OT), estimated blood loss, and any concomitant procedures such as autologous fascial sling procedures or colposuspension. OT was calculated as incision-to-closure time and therefore excluded anesthetic preparations.

Perioperative data were collected, including length of hospital stay (LOS), days requiring postoperative intravenous pain medication, and <30-day postoperative complications. Postoperative complications within 30 days were graded according to the Clavien Dindo (CD) grading system and included evaluation of potential paralytic ileus, surgical site infection, and urinary tract infection (UTI) (defined as symptoms accompanied by laboratory findings of a UTI (bacteriuria, leukocyturia, and positive urine culture)).<sup>14</sup>

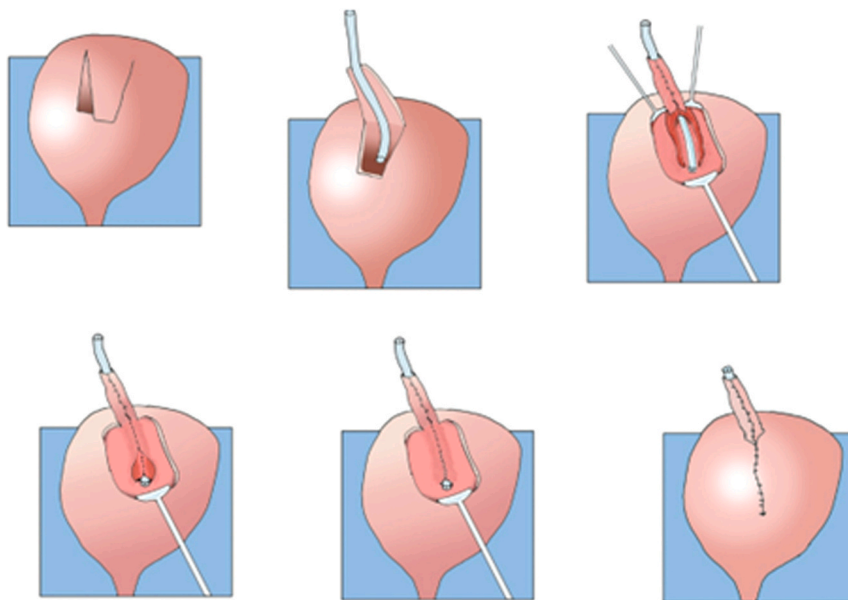
Complications beyond 30 days postoperatively and data were collected and included the prevalence of stomal incontinence, stomal stenosis, recurrent UTI, peri-stomal skin infections, and bladder calculi. The frequency of CIC, renal function, estimated bladder capacity, the need for endoscopic or open revision, and time to first revision, if applicable, were also recorded. The data analyzed during the current study are not publicly available due to local ethical regulations but are available from the corresponding author upon request.

### Surgical Procedure

Surgery was performed under general anesthesia through lower midline laparotomy. Positioning was supine or lithotomy position when the procedure was combined with bladder neck surgery or suspension. A single dosage of cefazolin was given as perioperative prophylaxis. A Foley balloon catheter was inserted transurethrally to first drain the bladder and then fill the bladder with saline (0.9%) to approximately maximum cystometric capacity.

After lower midline laparotomy, the retropubic space was exposed with subsequent visualization of the bladder. The procedure was carried out according to the following sequential steps (Fig. 1).

- A. A U-shaped incision was made on the anterior bladder wall to create a flap approximately 2 cm wide and 5-8 cm long. The dimension depends on the anatomical distance between the bladder and the umbilicus (preferred spot for stomal implantation).
- B. The lateral edges of the incision were then extended 5-7 cm intravesically, traversing the mucosal layer.
- C. The bladder mucosa was then mobilized 0.5 cm medially from the intravesical incision.
- D. The medial edges of the intravesical mucosa and the mucosa of the U-shaped flap were closed with



**Figure 1.** The sequential steps of creating a tubularized bladder flap continent catheterizable channel. (Color version available online.)

4-0 polyglactin 910 suture over a 14F splint, creating a mucosal channel.

- E. The detrusor muscle of the U-shaped bladder flap was closed with 3-0 polyglactin 910 suture to complete tubularization of the extravesical channel.
- F. Intravesically, the lateral mucosal borders were closed with a 4-0 polyglactin 910 suture over the constructed intravesical tunnel.
- G. The distal end of the tube was passed through the abdominal wall and anastomosed to the skin using a small V-shaped incision at the caudal edge of the umbilicus.

A 16-20F catheter was left in place either transurethral or suprapubically for bladder drainage and irrigation (if applicable). The 14F stomal catheter was not used for drainage or irrigation to minimize the risk of catheter dislocation and the balloon channel was cut. As such the balloon could not be inflated, which we prefer in all CCC's to avoid accidental damage to the submucosal tunnel.

#### Postoperative Protocol and Follow-up

Postoperative inpatient pain management was evaluated daily in consultation with the anesthesiologist. Encouragement and facilitation of return to a regular diet were initiated promptly on the day of surgery.

Postoperatively, a 14F splint was left in place for 6 weeks to facilitate and ensure optimal postoperative stability and healing of the TBF CCC. During a 24-hour hospitalization, the catheter was removed by a specialized nurse and CIC was initiated with a 12 or 14F catheter at intervals of approximately 3-4 hours. A cystogram was not performed routinely. During the intercatheterization intervals, a 6 cm, 14F stoma stopper was used to reduce the likelihood of stomal stenosis at skin level.

After successful initiation of CIC, patients were generally followed-up 3 and 6 months later and annually thereafter. Each visit included a detailed interview focusing on UTIs, continence, and catheterization. Measurement of serum creatinine and estimated glomerular filtration rate (eGFR) and renal ultrasound were part of each visit. In cases of stomal incontinence, the urodynamic investigation was repeated to determine the intravesical pressure at which leakage occurred.

## RESULTS

A total of 11 patients (10 female) were included. The median age at time of surgery was 44 (range 27-56) years. Eight patients had adult neurogenic lower urinary tract dysfunction and 3 had non-neurogenic underactive bladder. The median preoperative maximum cystometric bladder capacity was 600 mL (range 300-1000). Baseline characteristics and preoperative data are presented in Table 1.

The median OT for all patients was 110 (range 90-240) minutes. In 4 patients, another procedure was done in addition to the TBF (sling procedure, Malone antegrade enema stoma (MACE), and/or laparoscopic nephrectomy). One patient was initially planned for a retubularized ileum procedure but re-evaluation during surgery due to limited mesenteric length and quality resulted in the choice for a TBF procedure. In 6 patients in whom only a TBF was created (extraperitoneal procedure), the median OT was 96 (range 90-115) minutes.

The median postoperative duration of intravenous pain medication administration was 3 days (range 1-7 days). The median LOS was 5 (range 4-15) days, with the outlier of 15 days being the patient who had TBF combined with MACE. In total, 6/11 (55%) patients had

**Table 1.** Baseline characteristics and pre-operative data of tubularized bladder flap continent catheterizable channels.

Total patients	11
Demographic characteristics	
Female	10
Median age in years at the time of surgery (range)	44 (27-56)
Median BMI in kg/m <sup>2</sup> (range)	22 (19-27)
Mean pre-operative eGFR in mL/min/1.73m <sup>2</sup> (range)	84 (32-90)
Underlying pathology	
Adult neurogenic lower urinary tract dysfunction	8
Myelodysplasia	3
Spinal cord injury	3
Friedreichs' ataxia	1
Arthrogryposis multiplex congenita	1
Non-neurogenic detrusor underactivity	3
Previous bladder surgery	3
Continent catheterizable channel*	1
Sling procedure	2
Detrusorectomy	1
Preoperative urodynamics performed	11
Median maximum cystometric capacity in mL (range)	600 (300-1000)
Detrusor overactivity	2
Impaired compliance (< 20 mL/cm H <sub>2</sub> O)	1

BMI, body mass index; eGFR, estimated glomerular filtration rate.  
 \* Created from urachus remnant.

a < 30-day postoperative complication, all CD 1. No paralytic ileus was observed. Perioperative data and the occurrence of < 30-day postoperative complications are shown in Table 2.

The cohort was followed up for a median of 25 months (range 6-56). The prevalence of > 30-day complications is presented in Table 3.

Two patients developed superficial stomal stenosis despite compliant use of the stoma stopper, requiring suprafascial surgical revision at 5 and 6 months post-operatively. In 1 patient re-revision was needed because of recurrent stenosis. Stomal incontinence was reported in 4 patients. One of these patients had a previous revision for stenosis. In 3 incontinent patients, repeated filling cystometry showed that incontinence occurred with low intravesical pressure, all 3 had good compliance and a maximum cystometric capacity of > 500 mL. These 3 patients subsequently underwent successful surgical revision in which the intravesical submucosal tunnel was lengthened. The other patient who reported incontinence was the patient with a history of detrusorectomy, known preoperatively to have poor compliance, detrusor overactivity, and a maximum bladder capacity of 300 mL. This patient was originally scheduled to receive a retubularized ileum CCC, but a perioperative hostile, adherent abdomen and a very short and vulnerable ileal mesentery led to the choice of a TBF despite the known unfavorable characteristics. Postoperatively, this patient reported frequent nocturnal stomal incontinence. Repeated filling cystometry showed a maximum

**Table 2.** Peri-operative results and < 30-day postoperative complications of tubularized bladder flap continent catheterizable channels.

Total patients	11
Patients with TBF only	7
Perioperative data	
Median OT in minutes (range)	110 (90-240)
Median OT in minutes for TBF only (range)	96 (90-115)
Cases with estimated blood loss > 100 cc	0
Concomitant surgery performed	4
Autologous fascial sling	1
MACE procedure	1
Burch colposuspension	1
Laparoscopic nephrectomy	1
Median LOS in days (range)	5 (4-15)
Median LOS in days for TBF only (range)	5 (4-7)
< 30-day postoperative complications	
Urinary tract infection (CD 1)	4
Surgical site infection (CD 1)	1
Respiratory tract infection (CD 1)	1
No complications	5

CD, Clavien-Dindo grade; LOS, length of hospital stay; MACE, Malone antegrade colonic enema; OT, operative time; TBF, tubularized bladder flap.

**Table 3.** More than 30-day complications of tubularized bladder flap continent catheterizable channels.

Total patients	11
Median follow-up in months (range)	25 (6-56)
Patients requiring surgical revision	4*
Indication: stenosis	2
Indication: stomal leakage	3
Median time to first surgical revision in months (range)	14 (5-23)
Recurrent urinary tract infections	0
Peri-stomal cellulitis	1
Bladder calculi	0

\* One patient required revision for both stenosis and stomal leakage.

cystometric volume of 300 cc with poor compliance. This patient has an extreme lordosis with aberrant position of the bladder. He refused further surgical intervention for the time being.

Seven patients did not have surgical revision, including the other patient who had preoperative detrusor overactivity. One patient has opted for a permanent indwelling catheter despite having a well-functioning CCC, because CIC was no longer feasible. Regarding the other patients, at the last follow-up appointment, 9 out of 10 (90%) TBFs showed good function. Additionally, no patients had recurrent UTIs (defined as > 3 UTIs per year). All patients maintained stable renal function, except for the 1 patient who underwent concurrent nephrectomy, who had a decrease in eGFR from 81-52 mL/min. In addition, no hydronephrosis was observed during follow-up. Median frequency of CIC at last follow-up was 6/day (range 5-8). The median estimated bladder

capacity at last follow-up was 550 mL (range 300-700). Notably, the 2 patients with the lowest maximum cystometric capacity preoperatively (300 mL) both had an estimated capacity of 300 mL at last follow-up.

## DISCUSSION

In this study, we present a cohort of 11 adult patients in whom a TBF CCC was created with good postoperative results. No ileus was observed nor any <30-day postoperative complications CD > 1. During a median 2-year follow-up, surgical revision was required in more than 1/3 of patients. At last follow-up, more than 80% CCCs were functioning well with no reported stomal incontinence.

The selection of appropriate tissue for the creation of CCCs based on the Mitrofanoff principle has been a topic of discussion since the introduction of these procedures in the 1990s. Commonly used options include AVS and retubularized ileum. A TBF CCC has the advantages of a less invasive (extraperitoneal) procedure with no need for bowel closure or anastomosis and therefore less risk of postoperative paralytic ileus, anastomotic leakage, or stenosis.

The first efforts to avoid bowel usage and remain extraperitoneal were made by Cain et al when they introduced an approach using the Rink modification in pediatric patients.<sup>9</sup> This technique involves the creation of a 2-cm bladder strip mobilized from the bladder rim after it is opened in the midline. The creation of an intravesical submucosal tunnel is very similar to the technique described in our study.

The study by Cain et al included 31 patients with a mean follow-up of 41 months. All patients achieved stomal continence. However, stomal stenosis occurred in 45% of cases. In contrast, our study shows a stenosis rate of 18% (2/11). Although this result may be influenced by shorter follow-up, the lower rate of stenosis may also be explained by the better vascularity of a U-shaped bladder flap created from the anterior wall. It is also possible that consistent use of the stoma stopper between catheterizations plays a role in the lower stenosis rates in our study.

Stief et al presented a technique that includes the creation of a U-shaped flap but continues by embedding the created tube in the detrusor muscle, similar to a Lich-Gregoir procedure. Their study included 5 patients, 4 adults, with a mean follow-up of 17 months. Two patients required revision for stomal stenosis.<sup>10</sup>

Baumgart et al described a surgical procedure that uses the formation of a trapezoidal flap, 5-6 cm wide at the base, to construct the tube. Our technique uses a 2-cm wide flap, which theoretically should result in less loss of bladder capacity. To achieve continence, Baumgart et al created a 2-cm tunnel to serve as a flap valve. This was achieved by folding the detrusor muscle or augmented bladder tissue over the stomal base. A total of 15 adult

patients were included in the study. The median OT was 198 minutes, which is notably longer than the median OT of 110 minutes in our study. The mean follow-up duration was 13 months. Out of the 15 patients, 5 reported stomal incontinence and 4 required surgical revision for stomal stenosis.<sup>11</sup>

In contrast to the techniques described by Stief et al and Baumgart et al, we present a CCC technique with an intravesical continence mechanism which is more in line with the technique described by Cain et al. An intravesical submucosal tunnel requires less bladder tissue and therefore results in less loss of bladder capacity. In addition, extravesical wrapping, embedding, or plicating of the CCC may lead to strangulation with impaired vascularization, making it more susceptible to stenosis.

Two previous studies conducted at our academic institution offer a comparison of the prevalence of complications and surgical revision rates between TBF and other CCCs. In a pediatric study of 117 CCCs, of which 31 TBF, the results showed a surgical revision rate of 52%, with no notable differences between the 3 conduit types.<sup>12</sup> In a larger study involving 173 CCCs with both pediatric and adult patients (including 7 adult TBF patients), 53% of patients required surgical revision over a median follow-up of 12.4 years. Major revisions were required in 40%, with a higher prevalence observed in retubularized ileum CCCs compared to AVS and TBF. As a result of these findings, TBF has been recommended as the preferred CCC in patients with good bladder storage function.<sup>15</sup>

TBF is preferred due to its minimally invasive approach, avoiding intraperitoneal involvement and the need for bowel anastomosis, thus reducing the risk of postoperative ileus. This hypothesis is confirmed by our results, as none of our procedures were complicated by paralytic ileus. However, it is important to note that the studies referenced above exclusively report data on surgical revision. Data on LOS and 30-day postoperative complications, such as ileus, were not reported. A study conducted by Famakinwa et al presented perioperative data on minimally invasive robot-assisted AVS and found ileus in 3/18 patients and a mean LOS of 5.2 days.<sup>7</sup> A study by Galansky et al showed a 50% reduction in LOS when comparing robotic vs open CCC surgery in children (6.8 vs 13 days).<sup>8</sup> We found a median LOS of 5 days in our study, but it should be noted that it is difficult to compare adult surgery to pediatric surgery.

An interesting development in the field of CCCs is the continent cutaneous ileal cecocystoplasty (CCIC), which seems to be gaining popularity among reconstructive urologists, especially in the United States. This technique involves a modified Indiana continent urinary reservoir in which the cecum is used as an augmentation cystoplasty and the CCC is formed from the adjacent terminal ileum.<sup>16</sup> A study by Redshaw et al compared CCIC to tunneled CCCs in an adult population with a median follow-up of 16 months. They found that CCIC patients required nearly 4 times fewer

secondary interventions for complications and reported less stomal leakage (43% vs 29%).<sup>17</sup> In particular, the low number of patients requiring surgical revision in the CCIC group (4 out of 31) is promising compared to the surgical revision required in our TBF study (4 out of 11). In our study, 4 out of 11 TBF reported stomal leakage, 3 TBF underwent surgical revision to lengthen the intravesical tunnel resulting in good continence in all 3. CCIC has the advantage that it can be created in patients with low bladder capacity and obese patients. However, in non-obese patients with good bladder capacity and storage function, TBF has the advantage of being much less invasive with a small lower midline incision only, avoiding intraperitoneal access, the use of bowel and bowel anastomosis. Ideally, both techniques are part of a reconstructive urologist's toolbox.

This study presents the largest cohort of TBF CCCs in adults published to date. The study demonstrates that TBF is viable in patients with good bladder capacity and upholds the theoretical advantages of a less invasive procedure than AVS, retubularized ileum, or CCIC. The retrospective design of the study has certain limitations that could have led to problems, such as loss to follow-up or missing data. However, close patient follow-up and meticulous event tracking were maintained throughout the study, so we are confident that no patients or events were missed or omitted. The primary objective of this study was to present the novel technique and demonstrate its encouraging postoperative outcomes. This objective was well achieved, but the relatively brief follow-up period may not fully capture long-term outcomes and complications. More importantly, the lack of Quality of Life assessment tools in our evaluation is another limitation, as these tools can provide valuable insight into the overall patient experience and satisfaction with the TBF procedure.

Future research in the field of CCCs should focus on assessing the impact on patients' Quality of Life. Prior studies have predominantly focused on surgical outcomes and associated complications. However, it is necessary to investigate the broader implications of CCCs on patients' overall well-being.

The physiology behind stomal stenosis is not well understood, but ischemia due to impaired tissue perfusion may play a role. It seems logical to assume that the wider the base of the bladder flap, the better for its distal perfusion. On the other hand, a wider base results in more bladder volume loss and a larger caliber proximal channel, which complicates intravesical tunneling. In our series, we did not observe stomal necrosis, but we did see distal stomal stenosis in 2 patients despite compliant use of a stoma stopper between catheterizations. In future research, it may be useful to investigate the role of indocyanine green fluorescence to assess tissue perfusion.<sup>18</sup>

Furthermore, the refinement of techniques should focus on minimizing invasiveness of CCC surgery. Recent studies have shown that robotic-assisted methods for creating AVS and retubularized ileum CCCs are promising innovations, as

they result in comparable functional outcomes and complication rates, while shortening LOS and reducing postoperative discomfort.<sup>7,8</sup> However, robotic surgery is expensive and not available in all institutions. Furthermore, not all patients are suitable for robotic surgery due to anatomical deviations. In non-obese patients with good bladder storage function, TBF CCC can be created everywhere with reduced/minimal invasiveness, resulting in a low rate of serious postoperative complications and limited LOS.

## CONCLUSION

CCC creation with TBF avoids intraperitoneal involvement and bowel closure (AVS) or anastomosis (retubularized ileum), potentially leading to less postoperative complications. No postoperative bowel complications were seen in our patients. Surgical revision rates for TBF appear to be similar to those of other CCCs. Therefore, TBF could be considered in patients whose bladder capacity is sufficient as TBF is less invasive than other techniques for CCC creation.

## Statements relating to our ethics and integrity policies

In accordance with local regulations, informed consent was not required for this anonymous retrospective study, which was approved by the local ethics review board (research protocol number 22/1050).

## Declaration of Competing Interest

The authors declare that they have no conflict of interest.

**Acknowledgment.** None

## References

1. Dik P, Klijn AJ, van Gool JD, de Jong-de Vos van Steenwijk CC, de Jong TP. Early start to therapy preserves kidney function in spina bifida patients. *Eur Urol.* 2006;49:908–913.
2. Lapidus J, Diokno AC, Silber SJ, et al. Clean, intermittent self-catheterization in the treatment of urinary tract disease. *J Urol.* 1972;107:458.
3. Mitrofanoff P. Trans-appendicular continent cystostomy in the management of the neurogenic bladder. *Chir Pediatr.* 1980;21:297–305.
4. Yang WH. Yang needle tunneling technique in creating antireflux and continent mechanisms. *J Urol.* 1993;150:830–834.
5. Monti PR, Lara RC, Dutra MA, De Carvalho JR. New techniques for construction of efferent conduits based on the Mitrofanoff principle. *Urology.* 1997;49:112–115.
6. Casale AJ. A long continent ileovesicostomy using a single piece of bowel. *J Urol.* 1999;162:1743–1745.
7. Famakinwa OJ, Rosen AM, Gundeti MS. Robot-assisted laparoscopic Mitrofanoff appendicovesicostomy technique and outcomes of extravesical and intravesical approaches. *Eur Urol.* 2013;64:831–836.

8. Galansky L, Andolfi C, Adamic B, Gundeti MS. Continent cutaneous catheterizable channels in pediatric patients: a decade of experience with open and robotic approaches in a single center. *Eur Urol.* 2021;79:866–878.
9. Cain MP, Rink RC, Yerkes EB, Kaefer M, Casale AJ. Long-term followup and outcome of continent catheterizable vesicostomy using the Rink modification. *J Urol.* 2002;168:2583–2585.
10. Stief CG, Becker AJ. A simple and reliable continent bladder stoma constructed from bladder wall. *World J Urol.* 2003;21:144–146.
11. Baumgart E, Stoffel JT. The Boari bladder flap: an effective continent stoma for the high-compliance neurogenic bladder. *BJU Int.* 2010;105:1291–1294.
12. Polm PD, de Kort LMO, de Jong TPVM, et al. Techniques used to create continent catheterizable channels: a comparison of long-term results in children. *Urology.* 2017;110:192–195.
13. Rosier PFWM, Schaefer W, Lose G, et al. International Continence Society Good Urodynamic Practices and Terms 2: urodynamics, uroflowmetry, cystometry and pressure-flow study. *Neurourol Urodyn.* 2017;36:1243–1260.
14. Dindo D, Demartines N, Clavien PA. Classification of surgical complications: a new proposal with evaluation in a cohort of 6336 patients and results of a survey. *Ann Surg.* 2004;240:205–213.
15. Polm PD, Christiaans CHH, Wyndaele MIA, Dik P, de Kort LMO. Continent catheterizable urinary channels: lessons for lifelong urological care from a comparative analysis of very long-term complications and revision-free survival of three different types. *Neurourol Urodyn.* 2023.Epub ahead of print.
16. Khavari R, Fletcher SG, Liu J, Boone TB. A modification to augmentation cystoplasty with catheterizable stoma for neurogenic patients: technique and long-term results. *Urology.* 2012;80:460–464.
17. Redshaw JD, Elliott SP, Rosenstein DI, et al. Procedures needed to maintain functionality of adult continent catheterizable channels: a comparison of continent cutaneous ileal cecocystoplasty with tunneled catheterizable channels. *J Urol.* 2014;192:821–826.
18. Licari LC, Bologna E, Proietti F, et al. Exploring the applications of indocyanine green in robot-assisted urological surgery: a comprehensive review of fluorescence-guided techniques. *Sensors (Basel).* 2023;23:5497.