



ORIGINAL ARTICLE / ОРИГИНАЛНИ РАД

Long-term outcomes of catheterizable continent urinary diversion in children

Milan Paunović¹, Zoran Krstić^{2,3}, Miroslav Đorđević², Vojkan Vukadinović², Svetlana Paunović⁴¹University of Kragujevac, Faculty of Medical Sciences, Kragujevac, Serbia;²University Children's Hospital, Belgrade, Serbia;³MediGroup Hospital, Belgrade, Serbia;⁴Kragujevac Clinical Centre, Ophthalmology Clinic, Kragujevac, Serbia**SUMMARY**

Introduction/Objective The use of bladder augmentation and/or continent urinary diversion has gained wide acceptance, particularly in children with small, abnormally developed bladder or high-pressure bladder that poses great risk for renal deterioration and incontinence. We discuss indications, results, and complications with various types of continent vesicostomy (CV) in children.

Methods Sixty-eight patients with CV are retrospectively reviewed (51 boys and 17 girls) 1987–2008. The median follow-up time was 17.8 years (3–22 years). CV included appendicovesicostomy in 31 (41.3%), vesicostomy with distal ureter in 27 (36.0%), and preputial CV in 10 (13.3%) patients. CV in patients with augmented bladder was in 18 (26.47%) children.

The indications for performing CV were various types of neurogenic and myogenic dysfunctions of urine bladder with incontinence due to the following pathoanatomical substrates: anomalies of the brain–spine segment development (27), bladder exstrophy (10), posterior urethral valve (15), expansive processes (4), and other anatomical defects in 12 patients.

Results Continence was achieved in 94.64% of the cases, without statistically significant difference between particular types of the stoma ($p = 0.065$). Early complications included stoma necrosis, stoma bleeding, peristomal infection in 5/68 (7.35%) patients, and late complications included calculosis, in 20/68 (29.4%), stomal stenosis, in 8/68 (11.5%), and difficulties of catheterization, in 3/68 patients (4.08%). Calculosis was predominant in appendicovesicostomy ($p = 0.012$).

Conclusion CV is a safe procedure applied with the main purposes of achieving continence, preservation of renal function, and improvement of the quality of life, along with an acceptably low rate of complications.

Keywords: children; continent vesicotomy; postoperative complications

INTRODUCTION

Resolving urinary incontinence and preserving renal function in children with neurogenic bladder dysfunction has been a serious challenge for pediatric surgeons and urologists for years. Until the mid-1970s, urinary diversion by means of the intestinal conduit was practically the only solution to the problem when Lapidès et al. [1] introduced the technique of clean intermittent catheterization (CIC) through the native urethra, which specifically addressed these issues. However, in a relatively high percentage of cases, the method appeared to be inefficient due to the difficulty in performing self-catheterisation (pain in males, orthopaedic problems) or continuous urinary leakage between catheterizations.

In 1976, in order to overcome this obstacle, Mitrofanoff [2] proposed the alternative forms of continent urinary diversion – appendicovesicostomy or ureterovesicostomy – with bladder neck closure (in most cases). These methods have been most widely applied after the reports of Duckett and Snyder [3], and along with the introduction of other possibilities (prepuce, a

segment of small intestine, bladder wall, oviduct...) they justifiably named it the Mitrofanoff principle [4, 5, 6].

Considering any reservoir and any alternative urinary diversion, continent diversion is associated with a low-pressure reservoir [3, 4]. In most cases, the goal is native bladder preservation, with or without augmentation. The most common complications following continent vesicostomy (CV) are stoma stenosis and urinary leakage [7, 8]. Solving these problems requires further urodynamic volume–pressure testing and further revision or reimplantation if needed [9].

The objective of the study is to present our experiences with indications for performing specific types of CV and complications following the procedure.

METHODS

We performed a retrospective study in children (aged 3–8 years) who underwent a continent urinary diversion at the University Children's Hospital in Belgrade, Serbia, in the 1987–2008

Received • Примљено:

July 31, 2018

Revised • Ревизија:

April 3, 2019

Accepted • Прихваћено:

August 26, 2019

Online first: September 23, 2019**Correspondence to:**

Milan PAUNOVIĆ

Milovana Gušića 38/11

34000 Kragujevac, Serbia

mpaunovic1969@gmail.com

period. Patients were divided into the following three groups: appendicovesicostomy, vesicostomy with distal ureter, and preputial vesicostomy.

The indications for performing CV were various types of neurogenic and myogenic dysfunctions of the urinary bladder with incontinence due to the following pathoanatomical substrates: anomalies of the brain–spine segment development (27), bladder exstrophy (10), posterior urethral valve (15), expansive processes (4), and other anatomic defects (12).

The patients with other ways of bladder emptying (Credé's maneuver) or those emptying through the native urethra were excluded.

Operating technique

The principle consists of the interposition of the appendix vermiformis or other tubular structure between the bladder and the skin, with an anti-reflux technique, which facilitates self-catheterisation and establishes a continent mechanism. When necessary, urinary bladder augmentation was performed during the same operation.

Ureteral reimplantation was done using the extravascular approach (Lich–Gregoire technique) or detrusor submucosal tunnelling anti-reflux technique. Stoma should be located as close as possible to the bladder reservoir to provide a short and straight pathway. It is usually the right lower abdominal quadrant when using the appendix, and the distal right ureter, or the left lower abdominal quadrant when using the left ureter. Some authors suggest the placement of the stoma in the umbilicus because of the lower incidence of stenosis and less visibility [10].

The patient carries a suprapubic catheter in the Mitrofanoff canal for 21 days, and then commences CIC.

CIC was used in the standard manner together with the oxybutynin and prophylaxis of urinary infections (first- and second-generation cephalosporins or co-trimoxazole) [1]. By urodynamic testing or measuring bladder capacity, the need for oxybutynin was eliminated occasionally.

Bladder augmentation was performed in children with low-capacity bladder and/or poor detrusor compliance.

The data collected refers to the basic illness, age of the child when performing a stoma placement, the spot of the stoma placement, continence, complication rate, indications for surgical revision, type of surgical revision, and results. We divided the complications into two groups – early (up to 12 months after the stoma placement) and late.

We classified the stoma-revision procedures into suprafascial (skin level revision) and infrafascial (deep complications that require additional laparotomy). Suprafascial revisions were applied in cases of stoma stenosis, stoma prolapse, or granulation tissue around the stoma, and were categorized as stoma revisions. Subfascial revisions was performed due to difficulties in performing catheterization.

The most common reasons were channel angulation and diverticulum. The incontinence due to insufficient anti-reflux mechanism was solved by a subfascial revision or endoscopically (STING procedure).

The study was approved by the Research Ethics Committee of the institution where it was conducted.

Statistical analysis was performed using the G*Power software (Heinrich Heine University Düsseldorf, Düsseldorf, Germany). The results are expressed in numbers and percentages along with the mean value \pm standard deviation. Comparisons were done by Student's t-test and descriptive statistics by Fisher's exact test and χ^2 test.

RESULTS

The analysis included 68 patients, 17 (25%) of which were girls and 51 (75%) were boys. CV included appendicovesicostomy in 31 (41.3%), vesicostomy with distal ureter in 27 (36%), and preputial vesicostomy in 10 (13.7%) patients.

Additional surgery was performed in 18 (26.47%) patients in the form of augmentation of the urinary bladder, and bladder neck reconstruction (exstrophy-epispadias complex) was performed in 10 patients. Bladder neck closure was not performed. The median follow-up time was 17.8 years (3–22 years). Clinical details of our patients are presented in Table 1.

Continence achieved in 63 patients (94.64%) without significant statistical difference between the types of stomas ($p = 0.063$).

Early complications (infection, dehiscence, gastrointestinal problems, febrile conditions) occurred in 5/68 patients (7.35%) – in three patients with appendicovesicostomy, and in one each for distal ureteral stoma and preputial tube. No statistically significant difference between the types of CV (χ^2 test, $p = 0.233$).

Stomal stenosis occurred in 9/68 (11.7%) patients who underwent CV – six patients with appendicovesicostomy, two (7.1%) patients with preputial vesicostomy, and one patient (3.5%) with CV created by the distal ureter. Statistically, stenosis was significantly more frequent in patients with appendicovesicostomy ($p = 0.010$).

Table 1. Clinical details of patients

Variables	Appendicovesicostomy n (%)	Distal ureteral vesicostomy n (%)	Preputial vesicostomy n (%)	Total n (%)
Anomalies of the brain–spine segment development	17 (25)	5 (7.4)	5 (7.4)	27 (39.8)
Exstrophy-epispadias complex	8 (11.7)	2 (2.9)	0 (0)	10 (14.6)
Posterior urethral valve	3 (4.41)	11 (16.22)	1 (1.47)	15 (22.1)
Expansive processes	2 (2.9)	0 (0)	2 (2.9%)	4 (5.9)
Other diseases	1 (1.47)	9 (13.23)	2 (2.9%)	12 (17.6)
Total	31 (45.6)	27 (39.7)	10 (14.7)	68 (100)
Median follow-up time (years)	19.7	14.9	10.9	17.8
Stoma location	umbilical non-umbilical	7 27	0 7	3 10 58
Augmented urinary bladder	10	6	3	18
Sex	Male Female	20 11	21 06	10 0 17

Table 2. Most common complications

Variable	Appendicovesicostomy n (%)	Distal ureteral vesicostomy n (%)	Preputial Vesicostomy n (%)	Total n (%)	P
Early complications	3 (9.3)	1 (3.7)	1 (3.7)	5/68 (7.35)	0.233
Stomal stenosis	5 (13.2)	1 (3.5)	2 (7.1)	8/68 (11.7)	0.012*
Calculosis	8 (38)	2 (7.1)	2 (7.1)	12/68 (17.64)	0.018*
Channel angulation	3 (9.3)	3 (9.3)	0 (0)	6/68 (8.8)	0.028
Contineny	29 (90.3)	25 (89.7)	9 (92.8)	63/68 (94.64)	0.063

*statistically significant

In only 1/68 (1.47%) of the patients, a stomal prolapse (distal urethral stoma) developed, which was resolved by revision surgery and fixation.

Calculosis was predominant in patients with appendicovesicostomy (eight patients or 38%), especially if it was associated with bladder augmentation (substitution) using an intestinal segment. One patient in each of the remaining groups was also detected. Even if only patients without augmentation were analyzed, calculosis appeared significantly more frequently in patients with appendicovesicostomy ($p = 0.0015$).

There was no statistically significant difference between the specific types of CV regarding difficulty in catheter angulation ($p = 0.028$, test: binary logistic regression).

Incontinence occurred in 5/68 (7.36%), mostly in patients with distal ureter stoma (3/27; 14.6%). No statistically significant difference between the types of CV ($p = 0.065$).

Most complications occurred in patients with exstrophy-epispadias complex – 6/10 (60%) – and in patients with anomalous brain–spine segment development.

Six patients with appendicovesicostomy were subjected to stoma revision due to stomal stenosis, with a median follow-up time of 2.3 years (min. 1.8 years, max. 9.8 years). In three patients, stoma-specific complications required a surgical revision, and in another three patients the problem was resolved after the dilatation of the stenosis.

In one patient with a distal ureteral stoma, the stoma revision (prolapse) was performed 2.6 years after the major surgery.

Two patients with preputial vesicostomy were subjected to stoma revision 2 years and 4.5 years, respectively, after the performance due to stenosis.

Most additional interventions, due to incontinence, were performed in patients with CV with distal ureter. STING procedure was employed in four patients. A secondary revision was performed in two patients (one was subjected to the procedure twice and the other one three times) due to incontinence (eight months and 2.6 years after the primary revision). In one patient, stenotic ureteral orifice was balloon dilated.

A subfascial revision of appendicovesicostomy was performed in three patients (channel angulation). There were no revisions to the secondary surgery. Statistically, there was a significant difference related to this type of revision in favor of patients with CV formed from the distal ureter.

DISCUSSION

The role of CIC is to protect the upper urinary tract and to achieve continence [4]. CV enables easier execution of CIC [5]. CV should be performed in carefully selected patients when CIC through the native urethra is not possible. Difficulties due to the sensitivity of the urethra, especially in boys, are the main reason [7, 8, 9].

Accessing the urethra in children with orthopaedic deformities or paraplegia appeared to be considerably difficult, which is why CV is clearly indicated in this group of patients. Patients with exstrophy-epispadias complex or posterior urethral valve have difficulty while performing self-catheterisation due to anatomical reasons.

CV is associated with a number of early and late complications [9, 10]. Children and their parents should be properly informed about numerous benefits, but also potential risks and complications [10, 11, 12].

The appendix vermiformis, rather than other parts of the gastrointestinal system, is preferable for CV since intestinal anastomosis is not required, it has adequate lumen and sufficient vascularisation, suggesting significantly lower predisposition for ischemia. Damage due to frequent catheterisation or channel diverticular pouches is most often the consequence of a slightly longer intravesical part of the channel [12].

Prior to CV, it is necessary to estimate compliance, urinary bladder capacity, and detrusor overactivity by urodynamic testing. CV is best performed on low-pressure bladder [13]. Regardless of our channels being implanted using an anti-reflux method, provided that the intravesical pressure was not low, the likelihood of urinary leakage was considerably higher [14].

Despite the increasing number of catheterizations and high-dose anticholinergic therapy, the incontinence problems were more frequent in patients with CV created using the distal ureter (14.6%). In these patients, CV was created from a very wide ureteral reflux, and the length of the submucosal tunnel (anti-reflux mechanism) had to be longer than in the other two types. The good side of these CVs is that incontinence can be endoscopically resolved (STING procedure) [13].

Stoma stenosis is the most common complication in our group of patients – 8/68 – with a somewhat more frequent occurrence in patients with appendicovesicostomy (Table 2). Even at 82% of our patients, it was reported between the second and third year after CV. Similar results were reported by Leslie et al. [15] in their slightly larger group of patients, with the highest incidence in stoma from gastrointestinal segments. Stenosis usually occurs on mucocutaneous junction due to poor vascular support [14]. Later, this is largely due to micro trauma resulted from frequent catheterizations. The stoma location has no effect on the incidence of stenosis [15].

It is known that vesicostomy and urinary bladder augmentation are associated with an increased risk for

calculosis [16]. In our group of patients, those with appendicovesicostomy were more often diagnosed with calculosis. Chronic bacteriuria, mucous production, and urine pathways are the causes of calculosis. All three risk factors can be present in appendicovesicostomy. In our institution, we suggest that parents use saline solution for more aggressive bladder irrigation once a day for preventing urolithiasis.

The pathological condition with the largest number of complications was exstrophy-epispadias complex, which is different if compared to numerous other studies, where it was more common in patients with the posterior urethral valve or central nervous system anomalies [17, 18].

Our median follow-up time was not long enough to enable a discussion on complications such as malignancy or nutritional deficiencies, which was not the subject of

this research. Nevertheless, it was long enough so that we could infer that CV significantly improved the quality of life of our patients.

CONCLUSION

Continent urinary diversions are safe procedures whose main purposes are continence, preserving renal function, and improving the quality of life, with an acceptably low rate of complications. Stenosis, calculosis, and incontinence are the three most common complications inherent in certain methods of CV.

Conflict of interest: None declared.

REFERENCES

- Lapides J, Diokno AC, Silber SJ, Lowe BS. Clean intermittent catheterization in the treatment of urinary tract disease. *J Urol.* 1972;107(3):458–61.
- Mitrofanoff P. Trans-appendicular continent cystostomy in the management of the neurogenic bladder. *Chir Pediatr.* 1980; 21(4):297–305.
- Duckett JW, Snyder HM 3rd. Continent urinary diversion: variations on the Mitrofanoff principle. *J Urol.* 1986;136(1):58–62.
- Kroll P, Gajewska E, Zachwieja J, Ostalska-Nowicka D, Micker M, Jankowski A. Continent catheterizable conduits in pediatric urology. One center experience. *Adv Clin Exp Med.* 2017;26(7):1107–12.
- Krstic ZD. Preputial continent vesicostomy: preliminary report of new technique. *J Urol.* 1995;154(3):1160–1.
- Krstic ZD. Ureterocystoplasty. A variant of an operative technique. *BJU Int.* 1999;83(3):334–6.
- Maruf M, Kasprenski M, Jayman J, Goldstein SD, Benz K, Baumgartner T, et al. Achieving urinary continence of cloacal exstrophy: The surgical cost. *J Pediatr Surg.* 2018;53(10):1939–41.
- Reuvers SHM, van den Hoek J, Blok BFM, de Oliveira Barbosa TC, Wolffenbuttel KP, Scheepe JR. 20 years experience with appendicovesicostomy in paediatric patients. Complications and their re-interventions. *Neurourol Urodyn.* 2017;36(5):1325–9.
- Reddy PP, Strine AC, Reddy T, Noh PH, DeFoor WR Jr, Minevich E, Sheldon CA, et al. Triamcinolone injection for treatment for Mitrofanoff stomal stenosis: Optimizing results and reducing cost of care. *J Pediatr Urol.* 2017;13(4):375.e1–375.e5.
- Faure A, Cooksay R, Bouty A, Woodward A, Hutson J, Brien OM, et al. Bladder continent catheterizable conduit (The Mitrofanoff procedure): Long-term issues that should not be underestimated. *J Pediatr Surg.* 2017;52(3):469–72.
- Szymanski KM, Whittam B, Misseri R, Flack KC, Hubert KC, Kaefer M, et al. Long-term outcomes of catheterizable continent urinary channels: What do you use, where you put it and does it matter. *J Pediatr Urol.* 2015;11(4):210e1–7.
- Radojicic ZI, Perovic SV, Vukadinovic VM, Bumbasirevic MZ. Refluxing megaureter for the Mitrofanoff channel using continent extravesical detrusor tunneling procedure. *J Urol.* 2005;174(2):693–5.
- Lefèvre M, Faraj S, Camby C, Guinot A, de Napoli Cocci S, Leclair MD. Appendicovesicostomy (Mitrofanoff procedure) in children: Long-term follow-up and specific complications. *Prog Urol.* 2018;28(12):575–81.
- Small AC, Perez A, Radhakrishnan J, Desire S, Zachariah P, Creelman LC, et al. Impact of positive preoperative urine cultures before pediatric lower urinary tract reconstructive surgery. *Pediatr Surg Int.* 2018;34(9):983–9.
- Leslie B, Lorenzo AJ, Moore K. Long-term follow-up and time to event outcome analysis of continence catheterizable channels. *J Urol.* 2011;185(6):2298–303.
- Blanc T, Muller C, Pons M, Pashootan P, Paye-Jaouen A, El Ghoneimi A. Laparoscopic Mitrofanoff procedure in children: critical analysis of difficulties and benefits. *J Pediatr Urol.* 2015;11(1):28.e1–8.
- Peard L, Fox PJ, Andrews WM, Chen R, McCraw CO, Klaassen Z, Neal DE Jr. Continent Catheterizable Vesicostomy: An Alternative Surgical Modality for Pediatric Patients with Large Bladder Capacity. *Urology.* 2016;93:217–22.
- Solanki S, Babu MN, Jadhav V, Shankar G, Ramesh S. Continent catheterizable conduit for urinary diversion in children: Applicability and acceptability. *Afr J Paediatr Surg.* 2015; 12(1):33–5.

Удаљени резултати континентних везикостомија код деце

Милан Пауновић¹, Зоран Крстић^{2,3}, Мирослав Ђорђевић², Војкан Вукадиновић², Светлана Пауновић⁴

¹Универзитет у Крагујевцу, Факултет медицинских наука, Крагујевац, Србија;

²Универзитетска дечја клиника, Београд, Србија;

³Општа болница *Medigroup*, Београд, Србија;

⁴Клинички центар Крагујевац, Клиника за офталмологију, Крагујевац, Србија

САЖЕТАК

Увод/Циљ Аугментација мокраћне бешике са континентном везикостомијом или без ње је широко примењена код деце са малом, абнормално развијеном мокраћном бешиком, која води оштећењу бубрега и инконтиненцији. Описане су индикације, резултати и компликације болесника с разним типовима континентних уринарних диверзија код деце.

Циљ рада је био да се прикажу дугорочни резултати и компликације појединих континентних уринарних деривација код деце, као и начин њиховог решавања.

Методe Ретроспективно је приказано 68 болесника (51 дечак и 17 девојчица) са континентним уринарним деривацијама у периоду 1987–2008. Средње време праћења је 17,8 година (3–22 г.). Континентне везикостоме укључују апендиковезикостому код 31 (41,3%), везикостому дисталним уретером код 27 (36%), препуцијумску везикостому код 10 (13,3%) болесника. Индикације за извођење континентне везикостоме су разни облици неурогених и мишићних дисфункција мокраћне бешике са инконтиненцијом различитих

тих патоанатомских супстрата: аномалије развоја кичмено-можданог сегмента (27), екстрофија мокраћне бешике (10), валвула задње уретре (15), експанзивни процеси (4), остале аномалије код 12 болесника. Аугментација мокраћне бешике урађена је код 18 болесника (24,3%).

Резултати Континентност је постигнута код 94,64% случајева, без значајне разлике између појединих типова стома ($p = 0,065$). Компликације укључују ране (стомална некроза, стомално крварење, парастомална инфекција) код 8/68 (11,5%) болесника и касне: калкулоза 20/68 (29,4%), стеноза стома 8/68 (11,5%) тешкоће изводљивости катетеризације 3/68 (4,08%). Калкулоза је предоминантна код апендиковезикостоме ($p = 0,012$).

Закључак Континентне везикостомије дају висок степен континентности, мали број компликација и позитивно утичу на бубрежну функцију.

Кључне речи: дете; континентне везикостомије; постоперативне компликације