СРПСКИ АРХИВ
ЗА ЦЕЛОКУПНО ЛЕКАРСТВО
SERBIAN ARCHIVES
OF MEDICINE

Address: 1 Kraljice Natalije Street, Belgrade 11000, Serbia
☏ +381 11 4092 776, Fax: +381 11 3348 653
E-mail: office@srpskiarhiv.rs, Web address: www.srpskiarhiv.rs

Paper Accepted* **ISSN Online 2406-0895**

Original Article / Оригинални рад

Milan Paunović[1,†], Zoran Krstić[2,3], Miroslav Djordjević[2], Vojkan Vukadinović[2], Svetlana Paunović[4]

Long-term outcomes of catheterizable continent urinary diversion in children

Дугорочни резултати катетеризоване уринарне деривације код деце

[1]University of Kragujevac, Faculty of Medical Sciences, Kragujevac, Serbia;
[2]University Children's Hospital, Belgrade, Serbia;
[3]MediGroup hospital, Belgrade, Serbia;
[4]Clinical Centre Kragujevac, Ophthalmology Clinic, Kragujevac, Serbia

Received: July 31, 2018
Revised: April 3, 2019
Accepted: August 26, 2019
Online First: September 23, 2019
DOI: https://doi.org/10.2298/SARH180731104P

*__Accepted papers__ are articles in press that have gone through due peer review process and have been accepted for publication by the Editorial Board of the *Serbian Archives of Medicine*. They have not yet been copy edited and/or formatted in the publication house style, and the text may be changed before the final publication.

Although accepted papers do not yet have all the accompanying bibliographic details available, they can already be cited using the year of online publication and the DOI, as follows: the author's last name and initial of the first name, article title, journal title, online first publication month and year, and the DOI; e.g.: Petrović P, Jovanović J. The title of the article. Srp Arh Celok Lek. Online First, February 2017.

When the final article is assigned to volumes/issues of the journal, the Article in Press version will be removed and the final version will appear in the associated published volumes/issues of the journal. The date the article was made available online first will be carried over.

†**Correspondence to:**
Milan PAUNOVIĆ
Milovana Gušića 38/11, 34000 Kragujevac
Email: **mpaunovic1969@gmail.com**

Long-term outcomes of catheterizable continent urinary diversion in children

Дугорочни резултати катетеризоване уринарне деривације код деце

SUMMARY

Introduction/Objective The use of bladder augmentation and/or continent urinary diversion has gained wide acceptance, particularly in children with small, abnormal developed bladder or high-pressure bladder that gives a great risk of renal deterioration and incontinence. We discuss indications, results and complications with various types of continent vesicostomies in children.

Methods 68 patients with CV are retrospectively reviewed (51 boys and 17 girls) from 1987 to 2008. The median follow-up time was 17.8 years (from 3 to 22 years). CV include: appendicovesicostomy 31 (41.3%), vesicostomy with distal ureter 27(36.0%), preputial continent vesicostomy 10 (13.3%).CV in patients with augmented bladder in18(26,47%) children

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

Results Continence achieved in 94.64% without statistically significant difference between particular types of the stomas (p = 0.065). Early complications included (stoma necrosis, stoma bleeding, peristomal infection) in 5/68 (7.35%) patients, and late: calculosis 20/68 (29,4%), stomal stenosis 8/68, (11.5 %), difficulties of catheterisation in 3/68, (4.08%). Calculosis was predominant in appendicovesicostomy (p = 0.012).

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

Keywords: children; continent vesicotomy; postoperative complications

САЖЕТАК

Увод/циљ Аугментација мокраћне бешике са или без континетне везикостомије је широко примењена код деце са малом, абнормално развијеном мокраћном бешиком која води оштећењу бубрега и иконтиненцији. Презентиране су индикације, резултати и компликације пацијената с разним типовима континентних уринарних диверзија код деце. Циљ рада је био да прикажемо дугорочне резултате и компликације појединих континетних уринарних деривација код деце као и начин њиховог решавања.

Методе Ретроспективно приказано 68 пацијената (51 дечака и 17 девојчица) са континентним уринарним деривацијама у периоду 1987–2008. Средње време праћења је 17,8 године (3–22 г.). Континетне везикостоме укључују апендиковезикостому 31 (41,3%), везикостому дисталним уретером 27 (36%), препуцијумску везикостому 10 (13,3%). Индикације за извођење континетне везикостоме су разни облици неурогених и мишићних дисфункцаја мокраћне бешике са инконтиненцијом различитих патоанатомских супстрата: аномалије развоја кичмено-можданог сегмента 27, екстрофија мокраћне бешике 10, валвула задњеуретре 15, експанзивни процеси 4,остале аномалије код 12 пацијената. Аугментација мокраћне бешике урађена је код 18 (24,3%).

Резултати Континетност постигнута у 94,64%, без значајне разлике између појединих типова стома (p = 0,065). Компликације укључују ране (стомална некроза, стомално крварење, парастомална инфекција) у 8/68(11,7%) и касне: калкулоза 20/68 (29,4%), стеноза стоме (8/68) (11,5%) тешкоће изводљивости катетеризације 3/68(4,08%). Калкулоза је предоминатна код апендиковезикостоме (p = 0,012).

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

Кључне речи: дете; континетне везикостомије; постоперативне компликације

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. Lapides introduced the technique of clean intermittent catheterisation (CIC) through the native urethra, which specifically addressed these issues [1]. 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 catheterisations.
In 1976, in order to overcome this obstacle, Mitrofanoff proposed the alternative forms of continent urinary diversion –appendicovesicostomy or ureterovesicostomy – with bladder neck closure (in most cases) [2]. These methods have been most widely applied after the reports of Duckett and Snyder, and along with the introduction of other alternatives (prepuce, a segment of small intestine, bladder wall, oviduct ...) they justifiably named it Mitrofanoff principle [3–6].

Any reservoir and any alternative urinary diversion be applied, 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 aim 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 in the period 1987-2008. Patients were divided into 3 groups: appendicovesicostomy, vesicostomy with distal ureter and preputial vesicostomy.

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

The patients with other ways of bladder emptying (Crede's manoeuvre) or those with CIC(clean intermittent catheterisation) through the native urethra were excluded.

Operating technique

The principle consists in 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, augmentation urinary bladder was performed during the same operation.

Ureteral reimplantation was done using the extravesical 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 or . Some authors suggest the placement of 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 commenced with CIC.

Clean Intermittent Catheterisation was used in standard manner (1) together with the oxybutynin and prophylaxis of urinary infections (I and II generation cephalosporins or co-trimoxazole). By urodynamic testing or measuring bladder capacity, need for oxybutynin was eliminated occasionally

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

The data collected refer to the basic illness, age of the child when performing a stoma , the spot of 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 stoma-revision procedures intosuprafascial (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 difficulty in performing catheterisation. The most common reasons were channel angulation and diverticulum. The incontinence due to insufficient anti-reflux mechanism was solved by 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 G-Power program. The results are expressed in numbers and percentages along with the mean value of +/- standard deviation. Comparing was done by Student's t-test and descriptive statistics by Fisher’s exact test and chi-square test

RESULTS

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

Additional surgery was performed in 18 (26.47%) patient 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%), three patients with appendicovesicostomy, and one for each of the following – 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 continent vesicostomy. Six patients with appendicovesicostomy, two (7.1%) patients with preputial vesicostomy, one patient (3.5%) with continent vesicostomy created by the distal ureter. Statistically, stenosis was significantly more often-in patients with appendicovesicostomy ($p = 0.010$).

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 predominantly in patients with appendicovesicostomy (eight patients or 38%), especially if it was associated with bladder augmentation (substitution) using an intestinal segment. It was also detected one patient in each of the remaining groups. Even if

only patients without augmentation were analyzed, calculosis significantly more frequently appeared 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 anomalies 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 surgical revision and in another three patients, the problem was resolved after 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 and 4.5 years 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 twice subjected to the procedure and the other– 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 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]. The 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].

Appendix vermiformis, rather than other parts of the gastrointestinal system, is preferable for CV since intestinal anastomosis is not required it has an 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 very wide reflux ureteris, 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. Even at 82% of our patients, it was reported between the second and third year after CV. Similar results were reported by Leslie in their slightly larger group of patients, with the highest incidence in stoma from gastrointestinal segments [13, 14]. 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 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, and so is the highest number. In our institution, we suggested that parents used saline solution for more aggressive bladder irrigation once a day as prevention of urolithiasis.

The pathological condition with the largest number of complications was extrophy-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 discussion on complications such as malignancy or nutritional deficiencies, which was not the subject of

this research. Nevertheless, it is long enough that we can 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 quality of life with an acceptably low rate of complications. Stenosis, calculosis, and incontinentia are the three most common complications inherent in certain methods of continent vesicostomy

Conflict of interest: None declared.

REFERENCES

1. Lapides J, DioknoA.C,Silber SJ, Lowe BS. Clean intermittent catheterization in the treatment of urinary tract disease.JUrol.1972;107(3):458-61. [PMID:5070715][doi:10.1016/500225347(05)65158-0]
2. Mitrofanoff P. Trans-appendicular continent cystostomy in the management opf the neurogenic bladder. ChirPediatr. 1980;21:297-305. [PMID:7408090]
3. Duckett JW, Snyder HM III: Continent urinary diversion: Variations on the Mitrofanoff principle. J Urol.1986;136:58-62. [PMID 3712616][doi:10.1016/s0022-5347(17)44725-2]
4. Kroll P, Gajewska E, Zachwieja J, Ostalska-Nowicka D, Micker M, JankowskiA.Continent catheterazible conduits in pediatric urology.One center experience.Adv Clin Exp Med. 2017;26(7):1107-12. [PMID: 29211359] [doi: 10.17219/acem/63032]
5. Krstic ZD. Preputial continent vesicostomy:preliminary report of new technique. J Urol 1995;154:1160-62. [PMID:7637078]
6. Krstic ZD. Ureterocystoplasty. A variant of an operative technique. BJU Int.1999;83(3):334-36.[PMID:10233505]
7. Maruf M, Kasprenski M, Jayman J, Goldstein SD, Benz K, Baumgartner T, Gearhart JP. Achieving urinary continence of clocal extrophy.The surgical cost. J pediatr surg.2018 Oct;53(10):1939-41. [PMID:29555156] [doi:10.1016/j.jpedsurg.2018.02.055]
8. 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 reinterventions. Neurourol Urodyn. 2017 Jun;36(5):1325-132. [PMID:27232199] [doi:10.1002/nau.23045]
9. Reddy PP, Strine AC, Reddy T, Noh PH, DeFoor WR Jr, Minevich E, Sheldon CA, VanderBrink BA. Triamcinolone injection for treatment for Mitrofanoff stomal stenosis.Optimising results and reducing cost of care. J Pediatr Urol. 2017 Aug;13(4):375.e1-375.e5. [PMID:28733160] [doi:10.1016/j.jpurol.2017.06.007.]
10. Faure A, Cooksay R, Bouty A, Woodward A, Hutson J, Brien OM, et al.. Bladder continent cathetirizbleconduit(The Mitrofanoff procedure): Long- term issues that should not be underestimated.J Pedatr Surg.2017;52(3):469-72[PMID:27707652] [doi:10.1016/j.jpedsurg.2016.09.054.]
11. 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 Pedaitr Urol.2015;11(4):210e1-210e7. [PMID:26071074][doi:10.1016/j.jpurol.2015.05.002]
12. 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.[PMID:16006951] [doi:10.1097/01.ju.0000164747.90562.59]
13. 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 Oct;28(12):575-581.[PMID:30082244] [doi:10.1016/j.purol.2018.06.009]
14. Small AC, Perez A, Radhakrishnan J, Desire S, Zachariah P, Creelman LC, Alam SImpact of positive preoperative urine cultures before pediatric lower urinary tract reconstructive surgery. Pediatr Surg Int. 2018 Sep;34(9):983-989.[PMID:30069752] [doi:10.1007/s00383-018-4306-5]
15. Leslie B, Lorenzo AJ, Moore K. Long –term follow-up and time to event outcome analysis of continenet cathterazble channales. J Urol. 2011;185(6):2298-303. [PMID:21511280] [doi:10.1016/j.juro.2011.02.601]
16. Blanc T, Muller C, Pons M, Pashootan P, Paye-Jaouen A, El Ghoneimi A. Laparoscpic Mitrofanoff procedure in children:critical analysis of difficulties and benefits. J Pediatr Urol. 2015 Feb;11(1):28.e1-8. [PMID:25697978] [doi:10.1016/j.jpurol.201407.013]
17. Peard L, Fox PJ, Andrews WM, Chen R, McCraw CO, Klaassen Z, Neal DE Jr.Continent catheterasable vesicostomy.An alternative surgical modality for pediatric patients with large bladder capacity. Urology. 2016 Jul;93:217-22[PMID:26993353] [doi:10.1016/j.urology.2016.03.018] [doi:10.41303/0189-6725.150965]

18. Solanki S, Babu MN, Jadhav V, Shankar G, Ramesh S. Continent catheterisable conduit for urinary diversion in children:Applicability and acceptability. Afr J Paediatr Surg.2015 jan/mar;12(1):33-35[PMID:25659547]] [doi:10.41303/0189-6725.150965]

Table 1. Clinical details of patients

Variables		Appendico vesicostomy	Distal ureteral vesicostomy	Preputial vesicostomy	Total
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 (17.60%)
Total		31 (45.6%)	27 (39.7%)	10 (14.7%)	68 (100%)
Median follow-up time		19.7y	14.9y	10.9y	17.8y
Stoma location	a) umbilical b) non-umbilical	7 24	0 27	3 7	10 58
Augmented urinary bladder		10	6	3	18
Sex	Male Female	20 11	21 06	10 0	51 17

Table 2. Most common complications

Variable	Appendico vesicostomy	Distal ureteral vesicostomy	Preputial vesicostomy	Total	Statistical test
Early complications	3 (9.3%)	1 (3.7%)	1 (3.7%)	5/68 (7.35%)	p = 0,233
Stomal stenosis	5 (13.2%)	1 (3.5%)	2 (7.1%)	8/68 (11.7%)	p* = 0.012
Calculosis	8 (38%)	2 (7.1%)	2 (7.1%)	12/68 (17.64%)	p* = 0.018
Channel angulation	3 (9.3%)	3 (9.3%)	0 (0%)	6/68 (8.8%)	p = 0.028
Continency	29 (90.3%)	25 (89.7%)	9 (92.8%)	63/68 (94.64%)	p = 0.063

p* – statistically significant difference

