Appendicovesicostomy as an Alternative Procedure for Patients with Complex Urethral Distraction Defects

Amir Reza Abedi[1], Saleh Ghiasy[2]*, Morteza Fallah-karkan[3], Seyyed Ali Hojjati[2], Jalil Hosseini[4]

Purpose: Surgical repair of post-traumatic complex urethral stricture poses a major challenge to urologists. Here, we report six patients with irreparable urethral strictures who were successfully treated by using the appendix as conduit for urinary diversion.

Materials and Methods: Six patients who had underwent urinary diversion using an appendix during 2015 to 2019 were included in our study. All patients had a history of one or more failed attempts of urethral reconstruction in the past. Mean follow-up for patients was 29 months. Continency was defined as being completely dry for at least 3 hours.

Results: Mean age of patients was 40.1 years old (range: 20-70 years). Intermittent catheterization through the conduit was easily performed for every patient without any stomal stenosis. Mild stomal incontinence only occurred in one case which was resolved after a few months. All patients were continent during day and night.

Conclusion: Based on the results of our study, Mitrofanoff's technique is a valuable procedure for managing patients with serious complicated urethral strictures who cannot be treated with common standard approaches.

Keywords: appendix diversion; Mitrofanoff's appendicovesicostomy; urethral stricture; urinary diversion

INTRODUCTION

Urethral stricture and posterior urethral defects are an important clinical problem in male patients[1,2]. Road traffic accidents, iatrogenic injuries, and inflammatory disorders are common causes of urethral strictures. In previous studies, the incidence of posterior urethral stricture after pelvic fracture was predicted to be %5-10[3,4]. The surgical management of urethral stenosis varies based on etiology, position, length, and thickness of the lesion in addition to the extent of fibrosis involving the surrounding tissues[5,6]. Treatment of stenosis of the bulbar part of the urethra includes excision and end-to-end urethroplasty or a short patch onlay substitution anastomosis[7,8]. However, in some patients the urethral defect is so long that it cannot be managed with extensive releasing of urethra from the surrounding fibrosis, inferior pubectomy, and even re-routing maneuvers[9,10]. Various approach have been used to overcome this problem depending on the location and length of the stenosis including oral mucosa graft, enterourethroplasty, and the combination of dorsal graft with ventral penile flap . However, many complications have been related to these techniques[11-13]. In patients with severe and complicated urethral injury, salvage procedures such as perineostomy or suprapubic tube could be performed[14,15]. Patients with a history of past surgical procedures, stenosis longer than 3 cm, accompanying perineal and GI fistulas, presence of diverticulitis adjacent to the duct, and a non-competent bladder neck are defined as complex cases and are not suitable candidates for urethroplasty[13,16]. Although the design of a concealed and easily catheterizable stoma in cases with unreconstructable urethral disease was considered a good practical method, the clinical management of these patients still remains to be a dilemma[17]. In 1980, Mitrofanoff introduced an alternative procedure for continent diversion in which one end of the appendix was brought to the skin surface as a catheterizable stoma and the other end was tunneled into the bladder wall [17-20]. Here, we have reported our experience with this surgical procedure in terms of safety and efficacy.

MATERIALS AND METHODS

Patient Inclusion

Five male and one female patient aged 20 to 70 years old (mean age= 40.1) who had underwent urinary diversion using the appendix during 2015 to 2019 at Shohada-E-Tajrish Hospital, Tehran, Iran were included in the study. All patients had a history of one or more previously failed surgical attempts of urethral reconstruction and had an long urethral defect involving different anatomic segments of the urethra, or were at risk of urinary incontinence after urethroplasty of membranous urethra because of insufficient proximal sphincteric mechanism or patient's denial to undergo surgery (**Figure 1**). Due to the reasons mentioned above, patients became candidates of Mitrofanoff urinary diversion. Prior to enrollment, male patients were informed that

[1]Department Of Urology, Shohada-e-Tajrish Hospital, Shahid Beheshti University Of Medical Sciences, Tehran, Iran.
[2]Men's Health and Reproductive Health Research Center, Shahid Beheshti Medical Science University, Tehran, Iran.
[3]Laser Application in Medical Science Research Center, Shahid Beheshti University of Medical Sciences, Tehran, Iran.
[4]Reconstructive Urology Department, Shohada e Tajrish hospital, Shahid Beheshti Medical Science University, Tehran, Iran.
*Correspondence: Men's Health and Reproductive Health Research Center, Shahid Beheshti Medical Science University, Tehran, Iran. Telfax +98 2122712234, Mob +98 9128198037. Email;Saleh.ghiasy@sbmu.ac.ir.
Received September 2019 & Accepted April 2020

Table 1. Patients' characteristics and procedure outcome.

No	Age (Year)	Defect Length (cm)	Follow up, month	Cause of Injury	Previous surgical intervention	Reason for appendix diversion candidacy	Outcome
1	70	6	24	Long urethral stenosis post radical prostatectomy	One attempt of cystolithotomy, several failed attempts of urethral dilation	Urinary incontinency, long urethral defect (from bladder neck to membranous part)	No residual, No stenosis
2	36	7	27	Pelvic fracture due to entrapment under rubble	Laparotomy cystography and cystostomy, twice end to end urethroplasty, several urethral dilation attempts,One attempt of stent insertion	History of twice failed urethroplasty, long urethral defect	No residual, No stenosis
3	45	8	36	Pelvic fracture due to motor vehicle injury	Laparotomy and cystostomy, Non-competent bladder neck, internal urethrotomy, pubectomy, failed end to end urethroplasty	Long posterior urethral defect	No residual, No stenosis
4	41	10	30	Fournier gangrene	Extensive debridement, several plastic surgeries for scrotal and penile defect	History of two failed attempts of urethroplasty	No residual, No stenosis
5	60	6	24	Pelvic fracture due to motor vehicle injury	Cystostomy insertion, twice failed urethroplasty,, orthopedic surgery	History of twice failed urethroplasty, incontinency and long urethral defect	No residual, No stenosis
6	20	3	33	Pelvic fracture due to motor vehicle injury in childhood	Laparotomy, history of once failed urethroplasty, bladder neck closure and cystostomy	History of once failed urethroplasty, risk of incontinence	No residual, No stenosis

they would need ART (assistance reproductive technology) in case of plans for paternity in the future and then informed consent were obtained from all patients. This study was approved by the Ethics Committee of Shohada- E-Tajrish hospital.

Surgical Technique

A lower midline incision was performed to allow simultaneous access to the bladder, ileocecal junction, and the appendix. After locating the appendix, it was cut separate from the cecum while preserving its mesentery. Then, an opening was created as the blind end and washed. After passing a 14F catheter down the appendix to check for patency, it was implanted into the bladder through a submucosal tunnel of at least 4 cm length to achieve an anti-reflux effect (**Figure 2**). During surgery, the appendix was dilated with a 14F catheter and the catheter was left in-situ for three weeks. The appendix was then secured with absorbable sutures to the bladder muscle and mucosa. The stomal site was prepared based on pre-operative counselling for site selection and the stoma was placed at a level proximal to the bladder so that gravity would assist in achieving continence (**Figure 3**). Also, a cystostomy tube was inserted for all cases to increase safety measures.

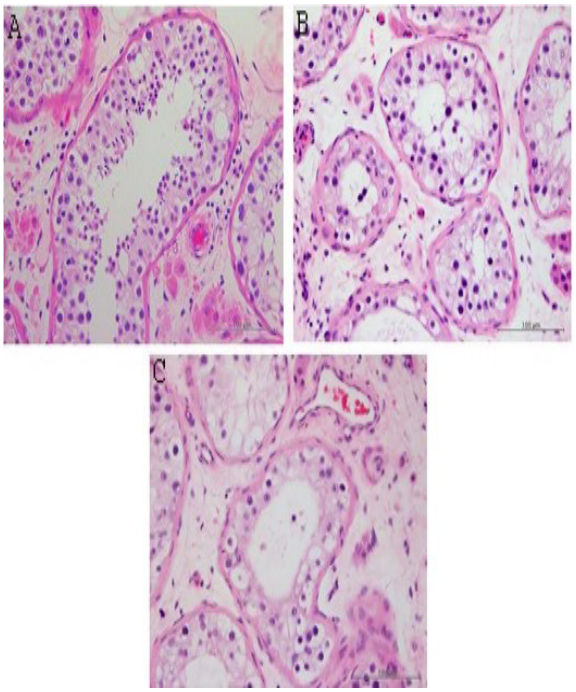

Figure 1. Contrast imaging of all of the included patients.

Patients were usually discharged 3-5 days after surgery, as soon as they could tolerate solid food. After about 3 weeks, the Mitrofanoff or pouch catheter was removed and the supra pubic catheter was left clamped-off. The patient was taught how to catheterize his pouch/Mitrofanoff (clean intermittent catheterization) every 3 hours by using a 12 or 14F Nelaton catheter. Occurrence of urinary leakage throughout the period was considered as the patient being incontinent. As for the night, a catheter was inserted and secured in place to allow for free urine drainage. If there was no difficulty in catheterization, the suprapubic catheter was removed after 3 days.

After that, cases were frequently followed-up at 3, 6, 18 and 24 months, with special consideration given to patients having difficulties with catheterization and incontinence. Follow-up plan included: stoma evaluation, upper urinary tract ultrasonography, measurement of post-catheterization urine residue, serum creatinine level, and catheter size.

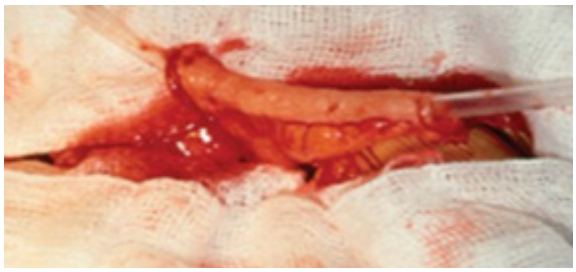

Figure 2. Passing a 14F catheter down the isolated appendix to check for patency.

RESULTS

Etiology of urethral defect in our cases included pelvic fracture, post radical prostatectomy urethral stenosis, and necrotic perineal infection (**Table 1**). The time gap between trauma and Mitrofanoff's procedure ranged from 18 to 120 months (mean ± SD= 49.3 ± 37.2). Patients' characteristics and procedure outcome are presented in **Table 1**.

Sonographic evaluation of upper urinary tract during follow-up did not reveal any pathologic findings. Mean serum creatinine level before surgery was 1.2 mg/dL. Mean surgical time was 2 hours (range= 1-3). Average predicted blood loss was around 150 cc (ranged 50 to 600). There was no need for blood transfusion or adjacent organ injury. All cases were discharged 3-5 days after surgery.

Follow-up duration ranged from 24 to 36 months (mean= 29). Post-operative complica¬tions consisting of dehiscence, wound infection, hematoma, necrosis, or perforations of the appendix tube were not detected in any cases during the fol¬low-up period. Catheter size of patients ranged from 12 to 14F. In five of the patients, catheterization was easily performed through the conduit every 2 hours. Over time, the pouch was expanded to hold more urine and the patient needed to catheterize every four to six hours. The only patient who could not easily catheterize underwent flexible cystoscopy and dilation with a 14F catheter. None of the patients had stomal stenosis during the follow-up period. Mild stomal incontinence occurred in only one case who became continent after a few months.

DISCUSSION

The potentiality of the appendix to be used as a concealed stoma capable of catheterization was discovered in 1980 by Mitrofanoff[21] in an attempt to achieve urinary continence and maintenance of a low-pressure urinary storage reservoir[17]. Later variations of this technique were developed such as the Monti technique in which a short part of the ileum was used according to the same principle[13,22].

The benefit of using the appendix instead of an ileum segment is that intestinal anastomosis is not required in appendicular diversion, thereby the risk of intestinal anastomotic leakage is reduced. Also post-operative fasting period is minimized. On the other hand, the physiologic function of the appendix is unknown in adults; therefore, the removal of appendix does not bring a serious harm to the body and does not lead to any impairment in the body's function. Another disadvantage of the ileum compared to the appendix is the need for tapering and tabularization which increases the likelihood of urinary leakage. Finally, the most important advantage of using an appendix is shortening of operative time since time-consuming procedures such as ileum-ileum anastomosis and tabularizations are not necessary.

The reasons for deciding to create a Mitrofanoff stoma are irreparable loss of the urethra, continence problems, neurogenic bladder with incontinence, unreconstructable bladder (e.g. exstrophy), unreconstructable urethral disease, and congenital anomalies like urogenital sinus [23]. The Mitrofanoff principle can also be performed in combination with a bladder augmentation technique.[24] Appendicular diversion can be used in cases who have complicated urethral trauma after accidents[25].

The benefits of appendix diversion include maintaining complete continence; easy catheterization; excellent body image; and rarity of post-surgical complications such as dermatitis and urinary tract infection[26]. Regarding the length of appendix ,the cutaneous stoma can be placed in the umbilicus or the lower right abdominal quadrant[27]. Yang et al.[28] demonstrated that the submucosal tunnel and abdominal wall muscles are critical factors in the success rate of continence.

However, like any other surgery, the Mitrofanoff procedure is associated with some complications such as leakage from the stoma and non-catheterizable channel. Recent reports showed an overall complication rate of

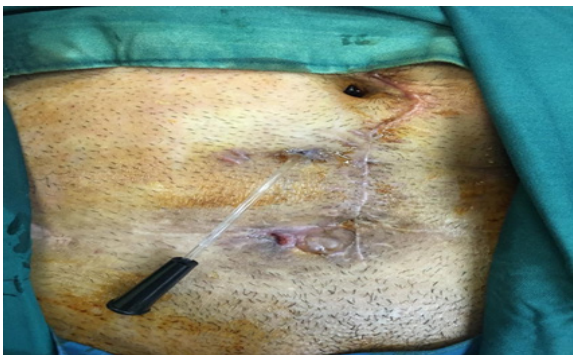

Figure 3. The stoma was created at a level relative to the bladder so that gravity would assist in achieving continence.

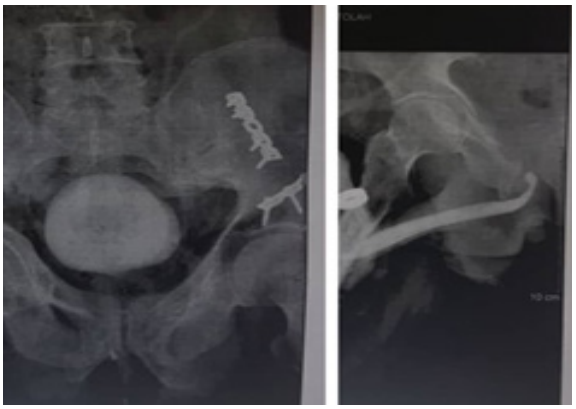

Figure 4. Urethral stricture shown in retrograde urethrogram (RUG)

6.2%[18]. The incidence of stomal stenosis was 10-23%, incontinence 2-7%[29,30] and stoma revision was required in 16-20% of cases [29,30]. Adherence to the technique which provides ease of catheterization intraoperatively, wide reflection of the cecum to preserve vascularity, and fixation of the bladder to the anterior abdominal wall guarantees a durable achievement [30]. The downside is that the prevalence of catheterization and stomal problems increases with the length of follow-up[24].

Our study enrolled patients with long urethral strictures who had failed attempts of urethroplasty. Thus, the only alternative method that would make them catheter-free and continent was appendix diversion using Mitrofanoff principle. Although these patients need to perform CIC to empty their bladder, it does not interfere with their daily activities.

The patients enrolled in our study suffered from complicated urethral stricture and were dependent on suprapubic catheter for emptying their bladder ever since. After performing appendicular urinary diversion, these patients became catheter-free and did not have any difficulties with intermittent catheterization for over two years. Our study reports a continence rate of 100% with good satisfactory results, consistent with the reports of previous articles[29-32]. In our study, none of the six patients had stomal stenosis during the fol–low-up period. This means that our results were more satisfying than other studies.[17,24,33].

The reason for a lower rate of stomal stenosis in our study might be the preservation of the mesenteric base of the appendix through wide reflection of the cecum with minimal manipulation which helped attain vascularity to decrease inflammation and mucosal dysfunction. Also, a minimum tension was placed on the appendix between the bladder and the skin due to the appropriate selection of the location of the ostoma and, if necessary, the bladder was sutured to the rectus sheath. Using a suitable catheter size for insertion and then catheterization, appendix end speculation at the stoma site, as well as careful training of the catheterization technique could be other reasons.

Although the results of appendix diversion are desirable, sometimes the appendix is not usable because of insufficient length or quality, short mesentery, or histopathologic changes consistent with chronic inflammation or fibrous lumen obstruction[34]. Regarding these situations, techniques such as the Monti method, or using a bladder or cecal flap to partially span the distance between the bladder and abdominal wall are good alternative methods.[13,35]

CONCLUSIONS

Based on the results of our study, Mitrofanoff technique is a valuable procedure with low incontinence and complication rates and should be considered in cases with unreconstructable urethral damage who cannot be treated with other routine methods to achieve urinary continence and low-pressure reservoir.

ACKNOWLEDGEMENTS

The authors are thankful for the assistance of the urology ward staff due to their invaluable help throughout this study. We thank the medical librarians at Shohada-E-Tajrish hospital who helped us with data collection.

CONFLICT OF INTEREST

The authors report no Conflict of interest in this work.

REFERENCES

1. Webster GD, Ramon J . Repair of pelvic fracture posterior urethral defects using an elaborated perineal approach: experience with 74 cases. J Urol. 1991;145:744-8.
2. Mirzazadeh M, Fallahkarkan M, Hosseini J. Penile fracture epidemiology, diagnosis and management in Iran: a narrative review. Transl Androl Urol. 2017;6:158.
3. Gibson GR . Urological management and complications of fractured pelvis and ruptured urethra. J Urol. 1974;111:353-5.
4. Hosseini J, Tabassi KT. Surgical repair of posterior urethral defects: review of literature and presentation of experiences. Urol J. 2008;5:215-22.
5. Hampson LA, McAninch JW, Breyer BN . Male urethral strictures and their management. Nat Rev Urol. 2014;11:43.
6. Mathur R, Nayak D, Aggarwal G, et al. A retrospective analysis of urethral strictures and their management at a tertiary care center.Nephro-Urol Mon. Online ahead of print.2011;3:109-113.
7. Andrich D, Mundy A . Substitution urethroplasty with buccal mucosal-free grafts. J Urol. 2001;165:1131-4.
8. Barbagli G, De Angelis M, Romano G, Lazzeri M. Long-term followup of bulbar end-to-end anastomosis: a retrospective analysis of 153 patients in a single center experience. J Urol. 2007;178:2470-3.
9. Wu D-L, Jin S-B, Zhang J, Chen Y, Jin C-R, Xu Y-M. Staged pendulous-prostatic anastomotic urethroplasty followed by reconstruction of the anterior urethra: an effective treatment for long-segment bulbar and membranous urethral stricture. Eur Urol. 2007;51:504-11.
10. Kinnaird AS, Levine MA, Ambati D, Zorn JD, Rourke KF. Stricture length and etiology as preoperative independent predictors of recurrence after urethroplasty: A multivariate analysis of 604 urethroplasties. Can Urol Assoc J. 2014;8:E296.
11. Chapple C, Barbagli G, Jordan G, et al. Consensus statement on urethral trauma. BJU Int. 2004;93:1195-202.
12. Xu Y-M, Qiao Y, Sa Y-L, et al. Substitution urethroplasty of complex and long-segment urethral strictures: a rationale for procedure selection. Eur Urol. 2007;51:1093-9.
13. Hosseini J, Kaviani A, Mazloomfard MM, Golshan AR. Monti's procedure as an alternative technique in complex urethral distraction defect. Int braz J Urol. 2010;36:317-26.
14. Scorer C. The Suprapubic Catheter A Method

Of Treating Urinary Retention. Lancet. 1953;262:1222-5.

15. Myers JB, McAninch JW. Perineal urethrostomy. BJU Int. 2011;107:856-65.
16. Santucci RA, McANINCH JW, Mario LA, et al. Urethroplasty in patients older than 65 years: indications, results, outcomes and suggested treatment modifications. J Urol. 2004;172:201-3.
17. Freitas Filho LGd, Carnevale J, Melo Filho A, Vicente N, Heinisch A, Martins JL. Posterior urethral injuries and the Mitrofanoff principle in children. BJU Int. 2003;91:402-5.
18. Lemelle J, Simo AK, Schmitt M. Comparative study of the Yang-Monti channel and appendix for continent diversion in the Mitrofanoff and Malone principles. J Urol. 2004;172:1907-10.
19. Gerharz EW, Köhl UN, Melekos MD, Bonfig R, Weingärtner K, Riedmiller H. Ten years' experience with the submucosally embedded in situ appendix in continent cutaneous diversion. Eur Urol. 2001;40:625-31.
20. Simforoosh N, Razzaghi M, Danesh A, Sharifi F, Gholamrezaie H, Mousavi H. Continent ileocecal diversion with an unaltered in situ appendix conduit. J Urol. 1998;159:1176-8.
21. Mitrofanoff P. Cystostomie continente trans-appendiculaire dans le traitement des vessies neurologiques. Chir. Pediatr. 1993;150:830-4.
22. Turner-Warwick R. Prevention of complications resulting from pelvic fracture urethral injuries--and from their surgical management. Urol clin North Am. 1989;16:335-58.
23. Filipas D, Fisch M, Leissner J, Stein R, Hohenfellner R, Thüroff J. Urinary diversion in childhood: indications for different techniques. BJU Int. 1999;84:897.
24. Gowda BD, Agrawal V, Harrison SC. The continent, catheterizable abdominal conduit in adult urological practice. BJU Int. 2008;102:1688-92.
25. Mohr AM, Pham AM, Lavery RF, Sifri Z, Bargman V, Livingston DH. Management of trauma to the male external genitalia: the usefulness of American Association for the Surgery of Trauma organ injury scales. J Urol. 2003;170:2311-5.
26. Kobayashi M, Nomura M, Yamada Y, Fujimoto N, Matsumoto T. Bladder-sparing surgery and continent urinary diversion using the appendix (Mitrofanoff procedure) for urethral cancer. Int J Urol. 2005;12:581-4.
27. Hakenberg OW, Ebermayer J, Manseck A, Wirth MP. Application of the Mitrofanoff principle for intermittent self-catheterization in quadriplegic patients. Urology. 2001;58:38-42.
28. Yang W-H. Yang needle tunneling technique in creating antireflux and continent mechanisms. j Urol. 1993;150:830-4.
29. Harris CF, Cooper CS, Hutcheson JC, SNYDER HM. Appendicovesicostomy: the Mitrofanoff procedure—a 15-year perspective. J Urol. 2000;163:1922-6.
30. Cain MP, Casale AJ, King SJ, Rink RC. APPENDICOVESICOSTOMY AND NEWER ALTERNATIVES FOR THE MITROFANOFF PROCEDURE: RESULTS IN THE LAST 100 PATIENTS AT RILEY CHILDREN′ S HOSPITAL. J Urol. 1999;162:1749-52.
31. Okada Y, Ogura K, Ueda T, et al. Urinary reconstruction using appendix as a urinary and catheterizable conduit in 12 patients. Int J Urol. 1997;4:17-20.
32. Chen K-C, Lai W-M, Chen Y-K, Chiang H-S. The Use of the Appendix or Tapered Ileal Segment as a Continent Cathererizable Efferent Limb of Urinary Reservior. fu jen journal of medicine. 2005;3:69-74.
33. Aggarwal SK, Goel D, Gupta CR, Ghosh S, Ojha H. The use of pedicled appendix graft for substitution of urethra in recurrent urethral stricture. J Pediatr Surg. 2002;37:246-50.
34. Sgourakis G, Sotiropoulos GC, Molmenti EP, et al. Are acute exacerbations of chronic inflammatory appendicitis triggered by coprostasis and/or coproliths? World J Gastroenterol: WJG. 2008;14:3179.
35. Tsuji I, Kuroda K, Ishida H. A new method for the reconstruction of the urinary tract: bladder flap tube. J Urol. 1959;81:282-6.