The Use of Unaltered Appendix Transfer in Ileal Continent Reservoir

10 Years Experience, A Novel Technical Modification

Nasser Simforoosh, Abbas Basiri, Seyed Amir Mohsen Ziaee, Farzaneh Sharifiaghdas, Ali Tabibi, Ahmad Javaherforooshzadeh, Reza Sarhangnejad, Emad-Adin Moudi, Farzad Tajali

Introduction: We report a new modified technique of unaltered appendix transfer to ileal pouch and preserving ileocecal segment. This modification enables us to use ileum as the popular type of enteric segment instead of ileocecal segment while using appendix as a catheterizable stoma.

Materials and Methods: Forty-five patients (30 men) who needed reconstruction of the lower urinary tract were enrolled for using appendix as a catheterizable stoma. Reservoir was reconstructed using ileal segment. The appendix was circumcised from its base over its pedicle. The spatulated appendix tip was exteriorized as a catheterizable stoma to the skin, preferably umbilicus, and its base was implanted to the ileal pouch.

Results: Follow-up records of 38 of 45 patients were available. The median follow-up period was 29 months. The mean intermittent catheterization interval was 4.19 ± 1.6 hours. Urodynamic parameters were evaluated for 18 out of 38 patients. The median maximal pouch capacity determined as 380 mL. The median appendiceal closure pressure was 61 cm H_2O. No pouch perforation occurred. Stomal stenosis occurred in 3 patients. They did not catheterize their appendiceal stoma because they restarted catheterization through the urethra.

Conclusion: This novel approach enabled us to use ileum as today's more popular type of bowel segment to reconstruct enteric pouch rather than using ileocecal segment, while using appendix as a catheterizable stoma. One of the unique advantages of this technique is that the postponement of clean intermittent catheterization will not result in pouch perforation since the urine will leak when the pouch become overfill.

Keywords: appendix, ileum, urinary reservoirs, urinary diversion methods

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Urology and Nephrology Research Center and Shahid Labbafinejad Medical Center, Shahid Beheshti University of Medical Sciences, Tehran Iran

Corresponding Author:
Nasser Simforoosh, MD
Department of Urology, Shahid Labbafinejad Medical Center, 9th Boustan St, Pasdaran Ave, Tehran, Iran
Tel: +98 21 2258 8016
Fax: +98 21 2258 8016
E-mail: simforoosh@iurtc.org.ir

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INTRODUCTION

Continent urinary diversion improves the quality of life for many patients with incontinence or low complaint bladder.[1] A specific technique to restore lower urinary tract function is a catheterizable continent stoma.[2] Since patients with advanced urethral problems are not candidates for orthotopic continent urinary diversion, surgeons usually tend to perform cutaneous continent urinary diversion. To date, several organs have been used as catheterizable stoma. The use of appendix as a continent vesicostomy was initially described by Mitrofanoff in 1980 and subsequently modified by Duckett and Synder.[3,4] Woodhouse

and colleagues used all of the available narrow tubes—the appendix, ureter, fallopian tube, and a length of tailored intestine—and tunneled them into several types of reservoirs.[3,4] Although the most appropriate organ for continent diversion seems to be the appendix,[5] the fashioning of continent cutaneous stoma still remains the most challenging aspect of continent urinary diversion.[2]

Bissada initially introduced the reconstruction of cutaneous continent diversion with in situ appendix using reinforcing sutures.[6] By omitting the reinforcing sutures, we previously made a modification to the above technique.[7] Riedmiller and associates modified the Mitrofanoff's technique with embedment of in situ appendix in the anterior tenia of the cecum.[8] The ileocecal segment has important physiologic functions. This segment is regularly removed in the majority of the above techniques, which could lead to bowel dysfunction in long-term, especially in children. Also today, the ileum is becoming the most popular enteric segment used for pouch reconstruction, since it is more flexible and has the advantage of easier bowel anastomosis compared with ileocolic anastomosis. Therefore, we designed a study to use the ileum as reconstructed pouch, while by transferring the unaltered appendix over its pedicle to the pouch, we were able to use the appendix as an excellent catheterizable stoma. To our knowledge, this is the first report of transferring the unaltered appendix to the ileal pouch or to the ileal patch of the augmented bladder while preserving the ileocecal segment intact.

MATERIALS AND METHODS

Forty-five patients who needed reconstruction of the lower urinary tract underwent continent cutaneous urinary diversion using unaltered appendix transfer with preservation of the ileocecal segment, during a 10-year period (1998 to 2008).

We reconstructed the reservoir with the ileal segment conserving at least 20 cm of the distal ileum and the ileocecal valve. The appendix was circumcised carefully from the cecal base, preserving its blood supply. The proximal end of the appendix was anastomosed to the reservoir without submucosal tunneling (Figure 1), and its spatulated distal end was brought out as a cutaneous stoma (Figure 2). The appendix was placed as a straight tube to facilitate catheterization (Figure 3). As we previously reported,[7] in contrast to other techniques,[6,10] we do not manipulate the proximal end of the appendix and simply implant to the reservoir with the advantages described before. The umbilicus was usually used as the exit site to the skin (Figures 4 and 5). In patients with bladder extrophy, stoma was created at a midway point, between the xyphoid and the symphysis pubis or at the right lower quadrant area, depending on the appendix length.

Urodynamic variables in 18 of 38 patients were

Figure 1. Appendix anastomosis to the ileal pouch.

Figure 2. Distal end of the appendix was brought out as a cutaneous stoma.

Figure 3. Location of the appendiceal stoma with catheter.

evaluated in the supine position, 3 months postoperatively. Three patients died because of metastatic cancer. For urodynamic studies, we utilized an 8-F 3-lumen catheter in the empty reservoir, while using a rectal balloon to measure the intra-abdominal pressure. The pressures of the filling pouch (pouchometry) were recorded using infusion of sterile saline at a rate of 20 mL/min on average. The appendicular pressure profile (APP) was also performed using infusion of sterile saline at a rate of 2 mL/min and the pull-out

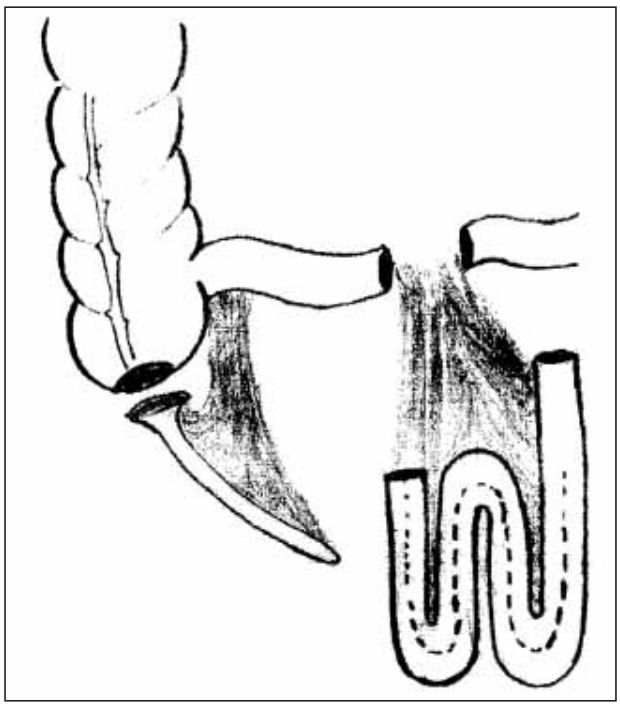

Figure 4. The appendix and ileal segment resections with preservation of the ilocecal segment.

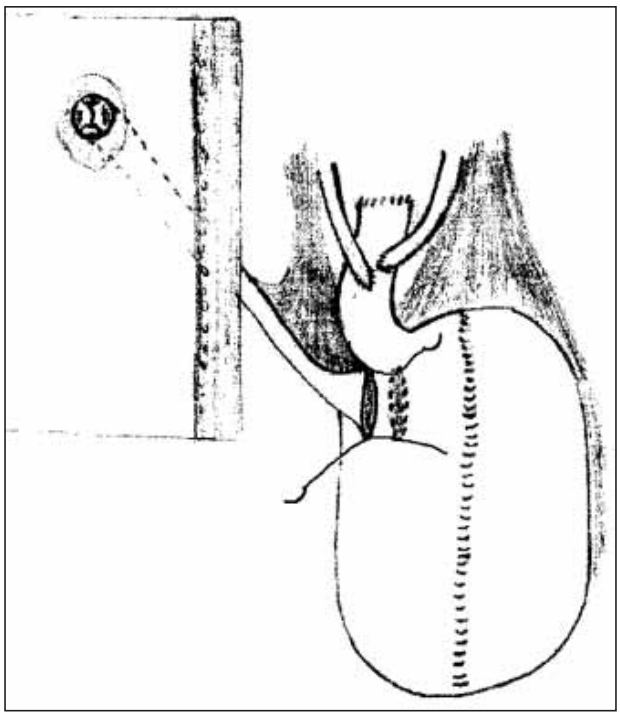

Figure 5. Ileal reservoir configuration and unaltered appendix transfer.

device with a rate of 2 mm/sec. We measured these parameters: maximal pouch capacity (MPC), which is the sense of abdominal discomfort or reaching the pouch pressure to 40 cm H_2O; pouch pressure at maximal capacity (PPMC); maximal appendiular pressure (MAP) which is the peak of the curve of APP; maximal appendicular closing pressure (MACP) which is the difference between MAP and pouch pressure; and functional appendicular length (FAL) which is the length over which appendicular pressure remained higher than reservoir pressure. After lowering the pouch volume to a half, we removed the catheter of the appendix and left the rectal balloon in place. The patients were asked to do the Valsalva maneuver or to perform the Crede maneuver in order to measure the appendicular leak point pressure (ALPP) as an estimation of abdominal leak point pressure.

RESULTS

Records of 45 patients, including 30 men (66.6%) and 15 women (33.3%), were reviewed in this study. During the follow-up period, 7 patients (6 men and 1 woman) were lost. The mean age of the patients was 23.1 ± 4.0 years (range, 2 to 69

years). The underlying diseases of these patients are shown in Table 1.

The median follow-up duration was 29 months (range, 1 to 62 months). We used 10-F catheters in 14 patients (36.8%), 12-F catheters in 19 (50.0%), and 14-F catheters in 5 (13.2%) for pouch catheterization via the appendicular stoma. The stoma was created in the umbilicus in 26 patients (68.4%), at the midpoint between the xyphoid and the symphysis pubis (in case of bladder extrophy) in 7 (18.4%), and at the right lower quadrant area in 5 (13.2%). During the follow-up period, we had no perioperative complications. The mean clean intermittent catheterization interval was 4.19 ± 1.6 hours. Thirty-five patients (92.1%) were continent.

Urodynamic findings are shown in Table 2. The median MPC was 380 mL. The median PPMC, FAL, MAP, and MACP were 19.5 cm H_2O, 5 cm, 85 cm H_2O, and 61 cm H_2O, respectively. All of the patients had an ALPP higher than 84 cm H_2O. Complications included umbilical parastomal hernia in 1 patient; and 3 patients (7.8%) developed stomal stenosis. They were those who performed clean intermittent catheterization through the urethra instead of the appendicular stoma. We did not revise the stoma of these 3 patients because of adequate reservoir drainage. Reservoir calculus developed in 5 patients (13.2%). No pouch perforation occurred during the follow-up period. We could see appendiceal stoma with and without catheter in 1 patient, 10 years after the surgery (Figures 6 and 7).

Table 1. Patients' Diagnoses

Diagnosis	Patients (%)
Extrophy/epispadiasis	9 (20.0)
Neurogenic bladder dysfunction	23 (51.1)
Bladder carcinoma	5 (11.1)
End-stage bladder neck destruction	4 (8.8)
Undiversion from ileal conduit	1 (2.2)
Large vesicovaginal fistula with small contracted bladder	3 (6.6)

Figure 6. Appendiceal stoma without catheter 10 years after surgery.

Table 2. Urodynamic Variables of Patients Who Underwent Bladder Reconstruction

Patients	MPC, mL	PPMC, cm H_2O	MAP, cm H_2O	ALPP, cm H_2O	MACP, cm H_2O	FAL, cm
1	500	17	55	> 110	45	4.0
2	430	8	45	> 95	37	4.0
3	340	28	82	118	57	3.0
4	690	15	67	> 97	44	5.0
5	415	25	95	> 131	75	13.0
6	400	25	84	> 107	76	5.0
7	120	40	114	> 122	82	5.0
8	400	19	114	> 84	73	7.0
9	860	28	131	> 139	90	8.0
10	550	11	85	107	58	5.5
11	1284	14	105	> 176	80	8.0
12	360	20	105	> 92	90	7.0
13	700	20	76	> 98	55	5.0
14	130	15	85	> 108	65	5.0
15	126	11	100	> 88	85	5.0
16	200	9	72	> 121	55	6.0
17	150	21	59	> 103	45	5.0
18	250	23	88	> 98	50	5.5

*MPC indicates maximal pouch capacity; PPMC, pouch pressure at maximal capacity; MAP, maximal appendicular pressure; ALPP, appendicular leak-point pressure; MACP, maximal appendicular closure pressure; and FAL, functional appendix length.

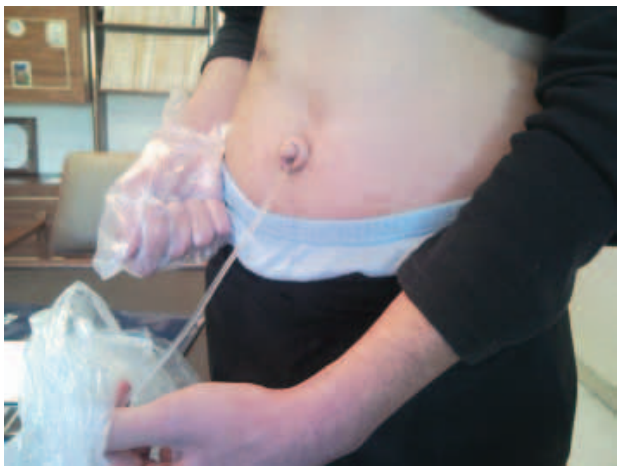

Figure 7. Appendiceal stoma with catheter 10 years after surgery.

DISCUSSION

Continent catheterizable stomas for simple catheterization to achieve socially acceptable dry intervals are important for patients with cutaneous continent urinary diversion.[9] Initially, Mitrofanoff reported the appendicovesicostomy technique using submucosal tunneling. Despite the fact that continence outcomes in Mitrofanoff's procedure are good (more than 90%), the reoperation rate for conduit complications has been reported about 30%, due to stomal stenosis and failure of continence mechanism.[2,4] Moreover, rupture of reservoir possibly caused by lack of "pop-off" mechanism has been reported.[10,11] In this study, postponement of clean intermittent catheterization was associated with urine leakage; therefore, we did not have any pouch perforation in our series. Others have reported such experience previously.[7] In contrast to the classic Mitrofanoff procedure, we exteriorated the distal part of the spatulated appendix as stoma and anastomosed the cecal base to the ileal reservoir. There are several advantages of this innovation. Wider lumen in the base of appendix makes appendicoreservoir anastomosis simpler. We anastomosed the spatulated tip of appendix to the abdominal wall (umbilicus or lower quadrants) without any manipulation or making skin flaps.[7] Interestingly, stomal stenosis was not common following this method. This is due to intermittent dilatation naturally occurs during intermittent catheterization via appendix, which is the routine elected method of pouch emptying. Since, the meso-appendix is usually fanned out in the base and mid portion; exterioration of the distal part seems more feasible, specifically in obese patients.

In 1993, Bissada used in situ appendix as a continent catheterizable stoma in 20 adult patients. He used reinforcing silk sutures in patients with intra-operative leak pressure lower than 75 cm H_2O to 80 cm H_2O.[6] Five years later, we reported the above technique without using the reinforcing suture with similar success.[7] In our previous report, we used ileocecal segment as pouch and the distal tip of the appendix was brought out to skin as stoma. Today, the use of the ileum as augumenting patch or urinary pouch has become more popular comparing ileocecal segment. Because of discrepancy in lumen size of ileum and colon, ileocolonic anastomosis seems technically more difficult than ileo-ileal one. Moreover, by preserving ileocecal segment, long-term complications like chronic diarrhea, megaloblasitc anemia, biliary stone, neuropathic disorders, and steatorrhea could be prevented.[12] That is why we made this new modification to our previously reported technique.[7] To be able to use the ileum, we decided to transfer the appendix to the ileal pouch as we described in our new modification to previous report.[7]

With creation a window in the mesoappendix, Riedmiller and colleagues made a modification to the Mitrofanoff technique and embedded in situ appendix in the tenia of cecum.[8] The abdominal leak point pressure has not been standardized with respect to bladder volume. Some have recommended using near capacity volumes,[13] whereas others have suggested filling to 250 mL or half the functional capacity.[14,15] In the urethra, it is generally accepted that with abdominal leak point pressure lower than 60 cm H_2O and/or maximum urethral closure pressure lower than 20 cm H_2O, some degrees of intrinsic sphincter deficiency may develop.[16,17] Although the appendix has usually lower internal diameter comparing with the urethra, ALPP and MACP measured more than above limits in all patients. Moreover, in our technique, the appendix was not located in a dependent position. Therefore, these characteristics, together

with compliance improvement, could explain the excellent continence rate of this procedure (92.1%), if regular pouch emptying was employed. Furthermore, adequate appendiceal length, higher appendiceal pressure than reservoir pressure and external compressive force toward appendix secondary to intra-abdominal pressure could help to the continence mechanisms.

To reduce the rate of appendicular stomal stenosis, Subramaniam and coworkers used an antegrade continence enema stopper in catheterizable channels and followed the patients for 3 to 6 months postoperatively. They showed the beneficial effects of this stopper to eliminate the occurrence of stomal stenosis.[18] We think that the effect of this stopper is like clean intermittent catheterization for prevention of stomal stenosis.

In this study 3 patients (7.8%) developed stomal stenosis. This low incidence seems secondary to little manipulation of appendix and its vasculature, and especially due to intermittent catheterization (every 4 hours) which acts as regular dilatation. This hypothesis is strengthened by observing that the 3 patients who stopped clean intermittent catheterization by the time (reduction of urethral problem during follow up period) developed appendicular stomal stenosis further confirmed by Subramaniam and colleagues' study. Development of a small parastomal hernia in one of our cases, who refused to perform herniorraphy, sounds related to obesity.

CONCLUSION

Our novel technique of transferring the appendix to the ileal neobladder seems to be safe, simple, and successful. It is associated with little manipulation of appendix, the "pop-off" mechanism, and intact ileocecal segment. Also, one of the distinct advantages of our technique of transferring appendix is that the procedure enables us to use ileum as the popular type of bowel as pouch rather than ileocecal segment, while enjoying the use of appendix as an excellent catheterizable stoma. Although our experience has been limited to 38 patients, the clinical and urodynamic outcome of the procedure was satisfactory in various situations. Further studies with higher number of patients and longer follow up will determine whether this new procedure would be associated with a long-term success and lower rate of complications.

CONFLICT OF INTEREST

None declared.

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