Detubularized Sigmoid Colon for Total Urinary Bladder Replacement: Clinical Outcome in 51 Patients

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ABSTRACT

Objectives: The technique and results of a detubularized sigmoid neobladder for total urinary bladder substitution after radical cystectomy is described.

Methods: Fifty one patients (44 men and 7 women) having a mean age of 46 (range, 32-61 years). Radical cystoprostatectomy was performed for the male patients and anterior pelvic exenteration for the female patients. This was followed by total replacement of the bladder with a detubularized sigmoid colon. They were selected to have invasive bladder cancer away from the bladder neck. The mean follow-up period was 38.8 months (range 8-96). Blood chemistry was analyzed periodically every month during the follow-up period. Early and late complications, continence and voiding pattern were recorded. Urodynamic studies were performed every 6 months.

Results: Early postoperative complications included, urinary leakage in 7 patients (14%); wound infection in 11 patients (22%); deep venous thrombosis of the lower extremities in one patient (2%). Late complications included stenosis of the ureterointestinal anastomosis in one patient (2%), stenosis of urethral anastomosis in one patient (2%). A reservoir stone occurred in one patient (2%). No metabolic acidosis nor vitamin B12 deficiency was reported. The upper urinary tract function was either improved or stable in 96% of cases. However, deterioration occurred in only 4% of cases. All patients could void voluntarily without catheterization. Patient satisfaction for continence, by daytime and nighttime (nocturnal continence), was 86% and 72%, respectively. The mean neobladder capacity and mean residual urine volume was 463.8 ml (range, 275-603) and 93.7 ml (range 50-189), respectively. Pressure flow analysis showed that the mean basal pressure was 5.1 cm H₂O (range, 1-18) and the mean pressure at maximal capacity was 37.4 cm H₂O (range, 1-73). The mean maximal flow rate was 17.8 ml/sec (range 3.1-24.5), the mean average flow rate was 11.4 ml/sec. (range 1.9-14.6). The mean first sensation volume was 310.1 ml (range, 171-471).

Conclusions: The detubularized sigmoid neobladder provides versatile and satisfactory results after radical cystectomy. It provides one stage total bladder substitution and is feasible with a very low morbidity. Furthermore, the technique can be employed successfully for a cystectomy in a female patient.

Key Words: Sigmoid orthotopic neobladder.

INTRODUCTION

Orthotopic neobladder substitution is now an effective method of urinary reconstruction after radical cystectomy in men and more recently in women for whom the distal two thirds of the urethra can be preserved [1-5].

Greater experience with the procedure and refinements in surgical techniques decreased the mortality and morbidity of continent orthotopic bladder substitution. It has been reported that the complication rate for this procedure does not differ substantially from that associated with ileal conduit diversion. However, debate continues over which type of reconstruction results in the lowest number of complications and provides the best functional outcome [6].

With respect to function, reconstruction should result in an adequate capacity with a low-pressure system that minimizes the incidence of reflux, while conferring optimal continence and voiding and minimal disturbance of metabolism [7].

A variety of detubularized bowel segments have been used to construct continent neobladder in men and more recently in women. These varieties included; detubularized right colon with or without a patch of ileum, detubularized ileum, and detubularized sigmoid colon [1-5,8,9].
The use of sigmoid colon to produce a detubularized neobladder allowed surgeons an alternative for the cystectomy patients and is now a popular choice for urine diversion [5,8]. The main advantages of sigmoid neobladder were summarized by Bassiouny [5] and included: (I) The 30 to 35 cm of the descending sigmoid colon required to construct the neobladder will not burden the patient with any malabsorption complications [10]. (II) The detubularized segment provides a capacious reservoir with low pressure. (III) The incidence of metabolic acidosis is minimal. (IV) The stronger colon allows performing more secure antireflux ureteral anastomosis. (V) The central location of sigmoid colon in the pelvis allows for convenient alignment of both ureters.

We report the results of our experience with the use of a detubularized sigmoid neobladder in 51 patients after radical cystectomy for invasive bladder cancer.

**MATERIAL AND METHODS**

Between 1994 and 2002, 51 patients [44 men, 7 women] with a mean age of 46 years underwent radical cystectomy or anterior pelvic exenteration for invasive bladder cancer and a detubularized sigmoid neobladder diversion. The mean follow-up was 38.8 months (range 8 to 96 months).

**Patient population**

Preoperative evaluation of involvement of the prostatic urethra and bladder neck and radiologic evaluation for metastasis were negative in all selected patients. In all patients the tumor had invaded into the muscle layer. Histologically, transitional cell carcinoma represented (40.8%), squamous cell carcinoma (48.1%) and adenocarcinoma (11.1%). Most of tumors were grade II and III, (96.3%). Rarely grades I and IV were encountered. The pathological stages included, P3a (48.1%), P3b (29.6%) and P2b, (22.3%). Lymph node involvement was positive in (37%).

Renal ultrasound and blood chemistry were normal in all patients. One patient had small atrophic kidney. Preoperative IVP showed mild pelvicalyceal hydronephrosis in eleven patients (21% of cases). Barium enema or colonoscopy was performed routinely in all patients to exclude the presence of an intracolonic mass or significant diverticular disease.

**Surgical technique:**

Radical cystoprostatectomy in men and anterior pelvic exenteration in women were performed in the standard fashion. The prostate was transected at its apex in 24% and at the middle of prostate in 66% of cases, leaving 6 stay sutures 3/0 Vicryl. Stitches inserted at 2,4,6,8.10 and 12 O’clock including the margin of the prostatic urethra. Neurovascular bundles were preserved in 69% of cases.

A 30 to 35 cm segment of the sigmoid and descending colon is isolated on a broad mesenteric pedicle fed by the sigmoid arterial branches of the inferior mesenteric artery (Fig.,1-A). It is crucial to assess the mobility of the segment and the ability to reach the membranous urethra before isolating the colonic segment for neobladder formation.

**Construction of the colonic neobladder:**

Fig. (1) showed our procedure for creation of a sigmoid neobladder. In brief, the sigmoid neobladder was constructed by skeletonizing a 30 to 35-cm sigmoid segment isolated on a broad mesenteric pedicle fed by the sigmoid arterial branches of the inferior mesenteric artery. Gastrointestinal continuity was restored by an end-to-end anastomosis using 3/0 vicryl sutures. It may be necessary to gain additional length by mobilizing down the splenic flexure.

The isolated sigmoid colonic segment must be cleansed with an antibiotic solution until the return from the opposite end is clear. The segment is then placed in a U configuration, and the most dependent part of the segment is marked for performing the neobladder-urethral anastomosis. The whole length is then detubularized along the mesenteric border (the colon segment is incised along the media taenia coli close to the mesenteric border (Fig., 1-B). The adjoining posterior edges of the newly detubularized bowel segment are approximated with a few seromuscular interrupted 3-0 Vicryl sutures before a single continuous through and through suture of 3-0 Vicryl completes the watertight posterior line sutures (Fig., 1-C).

The distal segments of the ureters were mobilized, with particular attention to preservation of the periureteral adventitia and blood
supply. The left ureter was pulled through the sigmoid mesentery. The anti reflux anastomosis of the ureter to the reservoir was performed by creating submucosal tunnel into the posterior wall of colonic segment as reported by Camy and Le duc [11] (Fig., 1-C). In brief, four stay sutures were placed rectangularly at the upper edge of the reservoir. The submucosal tunnel was easily created with the appropriate tension on the four stay sutures. Six interrupted 4-0 and 5-0 absorbable sutures were placed. The ureter-al-colonic anastmosis is secured over a 8 French feeding tube with 5-0 Vicryl suture. The feeding tubes may be brought out through the anterior bowel wall or tied to the tip of 20F Foley catheter.

A finger was placed into the neobladder to determine the portion of the reservoir nearest to the urethra. A 8-mm seromuscular window was cut, and the mucosa was incised and everted using a running 4-0 absorbable Monocryl suture, creating a neobladder neck.

Anastomosis of the neobladder to the urethra was performed with six interrupted 2-0 absorbable sutures, placing a 20F balloon catheter into the neobladder. The previously placed prostatic stay sutures were used and water tight end to end anastmosis was secured in the same manner as reported by Bassiouny et al [9]. In female patients, the vaginal stump was approximated and closed by two layers of 2-0 vicryl. The creation of the anterior wall of the neobladder is completed by approximation of the anterior bowel edges with a single continuous suture of a 3-0 vicryl. While the cephalad transverse portion of the neobladder is still patent, the remaining upper wall of the neobladder was closed transversely using 3-0 vicryl. If instillation of sterile saline through the Foley's catheter into the neobladder reveals the presence of any leaks, additional sutures may be placed as needed (Fig. 1-D).

The ureteral stents are brought out to the same side of the abdominal wall, two suction drains, which lie on either side of the neobladder, are secured and the abdominal incision is closed in the conventional way.

**Postoperative catheter care:**

It is imperative that the Foley and the bilateral ureteral stents are secured to prevent inadvertent premature removal. The Foley catheter must be irrigated every 8 hours to prevent obstruction by mucous secretion. The ureteral stents require irrigation only if their drainage suspiciously diminishes. The first drains to be removed are the suction drains. By the fourth postoperative day, the drainage amount is usually minimal. However, a sample should be sent to the laboratory to determine if the levels of creatinine and urea nitrogen coincide with those of serum. If their values are more that consistent with urine, the suction drain is not ready to be removed. Eighty six percent of cases (44/51 patient) had no urinary leakage and the suction drains were removed ten days postoperatively. The ureteral stents were removed on the thirteenth postoperative day and the Foley catheter was removed after 3 weeks postoperatively. In the seven cases that showed excessive leakage (more than 150 cc/day), the suction drains were not removed until drainage became minimal.

All patients were instructed to avoid the use of condom catheters, since, the patients may become comfortable with them and delay their conscious effort to achieve urinary continence.

**Postoperative evaluation:**

Each patient was evaluated at 1-month intervals during the first year, at 3-month intervals during the 2nd to 5th year and at 6-month intervals thereafter. Each complication was classified as early (3 months or less postoperatively) or late (more than 3 months). Routine examinations, including chest x-ray, urine cytology, renal ultrasonography, determination of serum electrolytes, blood urea nitrogen, and creatinine concentration, liver function tests, and arterial blood gas analysis were performed every 3 to 6 months for 5 years. Abdominal and pelvic computed tomography were performed 3 and 6 months postoperatively and every 6 months thereafter. The upper urinary tract was assessed using intravenous urography. Endoscopic examination of the reservoir and urethra was performed yearly. The incidence of local and distant recurrence were reported.

The continence status and voiding pattern in each patient were assessed by questionnaires and personal interviews at routine follow-up visits at least 6 months postoperatively according to the criteria described by Hautman et al [12].

Continence was classified as: Daytime continence that was classified as; (I) Completely
continent without pads or condom use. (II) Incontinent with major effort and when upright (mild stress incontinence). (III) Incontinent with minor effort. (IV) Incontinent without regard to effort, position, or activity. Nocturnal continence that was classified as continent with or without voiding at regular intervals or incontinent.

The voiding pattern was classified as; (I) Voiding to completion without the need for catheterization. (II) Requiring clean intermittent catheterization for postvoid residual urine. (III) The inability to void. Intermittent catheterization was recommended if the postvoid residual urine volume routinely exceeded 150 mL.

Urodynamic studies were performed in a subgroup of 26 patients. The following parameters were recorded; The mean neobladder capacity, mean residual urine volume, the mean basal pressure, the mean pressure at maximal capacity, The mean maximal flow rate and the mean average flow rate.

RESULTS

Early complications: The reservoir-related early complications included urinary leakage in 7 patients (14%). All of them were managed conservatively and no patients required open surgery for repair. The most common non-reservoir-related early complication was wound infection in 11 patient (22%). All of them were managed with repeated dressing and appropriate antibiotic therapy. Deep venous thrombosis of the lower extremities occurred in 1 patient (2%) and recovered completely with anticoagulant therapy.

Late complications: Late complications included stenosis of the ureterointestinal anastomosis in one patient that was managed by open surgical revision, stenosis of urethral anastomosis in one patient that treated endoscopically. A reservoir stone occurred in one patient and was removed surgically due to large size. Five patients developed incisional hernia. None of them required surgical correction.

Metabolic and nutritional complications:

Metabolic evaluation revealed that no patients had symptomatic hyperchloremic metabolic acidosis. The mean postoperative pH was 7.398±0.028. The mean preoperative and postoperative blood urea nitrogen, creatinine, sodium, and potassium concentrations were similar. None of the patients developed chronic renal failure. Only one patient developed rising of creatinine level after one year of follow up and when investigated there was a strictures of the ureterointestinal anastomosis. This was corrected by surgical reimplantation. Serum vitamin B12 concentration was evaluated in few patients and it was normal without vitamin B12 supplementation.

Voiding status and continence:

All patients could void to completion without the need of catheterization. Urinary continence status evolved gradually and improved with time. The final status usually reached after 6 months. Forty four patients (86%) were continent (Thirty seven patients = 72%) were completely continent by day and night and seven patients (14%) were incontinent only by night and required either condom appliance or pad). Two patients (4%) were incontinent with minor effort, three patients (6%) were incontinent regardless effort, position, or activity and two patients (4%) were incontinent with major effort when upright (mild stress incontinence). Six out of seven female patients were completely continent by day and night.

Urodynamic findings:

Urodynamic studies were performed in 26 patients after at least 6 months postoperatively. The mean neobladder capacity and mean residual urine volume was 463.8 ml (range, 275 - 603) and 93.7 ml (range 50-189), respectively. Pressure flow analysis showed that the mean basal pressure was 5.1 cm H2O (range, 1-18) and the mean pressure at maximal capacity was 37.4 (range, 1-73). The mean maximal flow rate was 17.8 ml/sec (range, 3.1-24.5), the mean average flow rate was 11.4 ml/sec. (range, 1.9-14.6). The mean first sensation volume was 310.1 ml (range, 171-471).

Upper urinary tract status:

Excretory and ascending urogram showed no postoperative deterioration of the renal functions in 49 patients (96%). Eleven of those 49 patients had preoperative mild deterioration of pelvicyceal system, seven of them were stable
postoperatively and the other 4 (8%) showed gradual improvement (Figs. 2,3). A long term renal function deterioration occurred in two patient (4%) without renoureteral dilatation or reflux.

Follow-up ultrasonic examination in all patients showed no change in the renal parenchyma. The renal cortical thickness was preserved within 1.5±0.52 cm (for the right kidney) and 1.5±0.31 cm (for the left kidney).

Pelvic recurrence:

Over 24 months, seven patients developed local pelvic recurrence without urethral involvement. This did not affect neobladder function. The actuarial 5 year survival was 54% for all patients.

![Fig. (1): A- Sigmoid colon is isolated on a broad mesenteric pedicle. B- The colon segment is placed in a U shaped position. Most dependent location is marked for future urethral-neobladder anastomosis. Lateral tenia is marked for ureteral anastomosis. C- Colon segment is detublarized, ureteric stents are brought anteriorly through bowel wall and the posterior edges of neobladder are approximated with a running 3-0Vicryl sutures. D- Anterior bowel edges, followed by cephalad portion of the neobladder is approximated with running 3-0Vicryl. Anastomosis to urethra over a Foley catheter.](image1)

![Fig. (2-A): Preoperative CT scanning showing a small atrophic left kidney and mild hydroureteric changes of the right kidney.](image2)

![Fig. (2-B): Postoperative CT scanning of the same patient after two years of detublarized sigmoid neobladder diversion. Note, the previously deteriorated renal function remains stable.](image3)
DISCUSSION

The techniques for the construction of a neobladder have evolved markedly in the recent years, leading to lower mortality and morbidity rates. Benson et al [6] reported no difference in the complication rates of patients undergoing ileal conduit versus orthotopic right colon, hemi-Kock, and sigmoid neobladder diversion. Perioperative mortality rates in large series of radical cystectomy patients with orthotopic bladder substitution range from 1% to 3.8% [13-16]. In the present study perioperative mortality rate was 0%.

With respect to ideal function of an orthotopic neobladder, reconstruction should result in an adequate capacity with a low-pressure system that minimizes the incidence of reflux, while conferring optimal continence and voiding and minimal distortion of metabolism [7]. The function of the sigmoid neobladder, was excellent in the present study. It maintained a low pressure environment, while having a good capacity. This is comparable to that reported by Bassiony [5], Reddy [8] and Khalaf [32].

Continence rates after orthotopic bladder substitution have been reported to vary between 65% and 98% for daytime continence and 37% and 85% for nighttime continence [5,8,17,18]. In the present study, the mean continence rate was comparable, 86% and 72% for daytime and nighttime respectively. The reservoir expands to some extent over time, which may explain why the rate of incontinence, particularly at night, was relatively high soon after surgery when the reservoir capacity was small. Melchior et al. [18] found that segments containing colon had higher average pressure spikes on urodynamic studies despite detubularization and are most likely related to the muscular nature of the sigmoid colon than those containing mostly ileum, such as the Hautmann. The high rate of continence in women in this study (86%), though of the small number, was comparable to that reported by Abol Enein and Ghoneim [25].

Self-catheterization because of delayed decompression or poor emptying was not recorded in our patients. Comparing with the rate reported in other series, the ileal neobladder is associated with a rate of 1.7% and 15.4% for occasional and regular intermittent catheterization, respectively. [14,16,19,20,21]. Thus, our patients generally expressed satisfaction with voiding and continence status. However, we have relatively higher mean postvoidal residual volume when compared with other series [5,8,18]. A variation

Fig. (3): Urethrography (A) and excretion urography (B) of the same patient in fig. (2) after two years postoperatively. Note, the large capacity of the neobladder without reflux and stability of the previously deteriorated renal function.
in the preservation of neurovascular bundles and residual prostatic tissue left in 69% of cases may be the contributing factors.

Because reflux can lead to renal damage, [17,22,23,24,33] prevention is one of the most important facets of reconstruction. The reflux rate was 2% and 3.3% for the orthotopic Kock [13] Hautmann [15] pouches with anti-refluxing ureteral anastomoses. Bassiouny [5] reported no reflux for sigmoido-recto-cystoplasty using submucosal tunneling antirefluxing technique. However, he reported recently a reflux rate of 8% using the same antireflux technique for W shaped ileal neobladder [9]. Abol Enein and Ghoneim [25] reported a reflux rate of 3% with the use of serous-lined extramural ureteral implantation technique. In the present study, 98% of patients had stable pelvicalyceal system. Additionally 8% (4 patients) showed improvement. A possible cause might be the low pressure of the neobladder.

In contrast, Hautmann [26] demonstrated that there is no longer justification for the use of any antireflux mechanism. Reflux prevention in the neobladder was even less important than in a normal bladder. [27] Studer et al [19] compared two different methods of construction between the bladder substitute and the ureters. One is an afferent isoperistaltic tubular ileal ureter, the other is an antireflux nipple valve or a split cuff technique. The long-term results of this prospective, randomized study showed no major differences between the patients with an afferent isoperistaltic ileal segment and those with antireflux nipples interposed between the ureters and the intestinal reservoir, except for an increased rate of upper urinary obstruction in the patients with antireflux nipples [28]. Therefore, the clinical value of antireflux in ureteral anastomoses remains an issue for debate.

Ureterointestinal stenosis is a technical pitfall of any type of orthotopic bladder substitution. Studer et al [16] reported a 3% rate of obstruction using ureteral direct anastomoses. Roth et al [29] reported obstruction rates of 3.6% and 20.4% for direct ureteral anastomoses and an afferent loop using the LeDuc antireflux technique. In the present study the rate of stenosis ureterointestinal anastomosis was 2% which is comparable with other large series of orthotopic neobladder constructions [16,29].

The 30 to 35 cm of descending sigmoid colon required to construct the neobladder will not burden the patient with any malabsorption complications (vitamin B12, bile salts, or folic acid) or diarrhea [10]. Koch reported that there is a progressive risk of vitamin B12 deficiency with the ileal neobladder, and 12% to 25% of patients develop hypovitaminosis [23,24,30]. Such complications were not seen in the present study. Thus, sigmoid neobladder construction confers an important advantage for patients who underwent neobladder construction and lived for a long time.

Studer et al [31] stated that metabolic acidosis is dependent on the length of the isolated ileum. Therefore, up to 50% of patients expected to develop metabolic acidosis in the ileal neobladder. In this study there is no significant disturbances in serum electrolytes or serum pH, the mean serum pH was $7.398 \pm 0.028$ which was another important advantage favoring the use of the sigmoid colon for construction of a urinary reservoir.

Conclusions:

The detublarized sigmoid neobladder appeared to function well as other types of neobladders. Sigmoid, when ideal (ie, a long sigmoid segment without diverticula, or excessive fat) is a useful colonic segment in the creation of a continent neobladder.

REFERENCES


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