FUNCTIONAL RESULTS OF ORTHOTOPIC ILEAL NEOBLADDER WITH SEROUS-LINED EXTRAMURAL URETERAL REIMPLANTATION: EXPERIENCE WITH 450 PATIENTS

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ABSTRACT

Purpose: We report functional results of the orthotopic ileal neobladder using a serous-lined extramural tunnel as an antireflux procedure.

Material and Methods: One-stage radical cystectomy and orthotopic ileal W-shaped neobladder creation were performed in 353 male and 97 female patients for invasive bladder cancer. The ureters were reimplanted using a serous-lined extramural tunnel for reflux prevention. Of the patients 344 were evaluable at a mean followup plus or minus standard deviation of 38 ± 25 months. Evaluation included clinical and radiographic studies to determine functional and oncological outcomes.

Results: Four patients (0.8%) died in the hospital. Early complications in 42 patients (9%) were treated conservatively but 3 women underwent vaginal repair of a pouch-vaginal fistula. During the observation period there were 90 oncological failures, of which 3 were isolated urethral recurrence. Late complications included pouch stones in 10 cases, outflow obstruction in 11, mucous retention in 2, adhesive bowel obstruction in 3 and hypercontinence in 9 females. The incidence of daytime and nighttime continence was 93.3% and 80%, respectively. The upper tracts remain unchanged or improved in 96.2% of the reimplanted renal units, while reflux was observed in 3%.

Conclusions: The serous-lined extramural tunnel has proved its efficiency and durability as an antireflux technique.

KEY WORDS: bladder, urinary diversion, ileum, replantation, ureter

Patients and Methods

From January 1992 through January 2000 orthotopic bladder substitution with an ileal W-shaped neobladder and serous-lined extramural tunnel was performed in 450 patients, including 353 males and 97 females 23 to 65 years old (mean plus or minus standard deviation 47 ± 8). Cystectomy for invasive bladder cancer was the indication in all cases.

Generally patients were fit or became fit enough for prolonged surgery. Synthetic liver function was adequate with serum albumin greater than 3 gm./dl. and prothrombin time greater than 75%. Creatinine clearance less than 50 ml. per minute was considered a contraindication. Male patients with diffuse carcinoma in situ or posterior urethral involvement were excluded from study. Females without extension to the bladder neck region or anterior vaginal wall were suitable candidates for the procedure. Furthermore, a urethral pressure profile was performed to exclude women with urethral sphincteric deficiency. Since only small bowel was used, no specific bowel preparation was necessary. An oral fluid diet was given 1 day before surgery, which was stopped 6 hours before the induction of anesthesia.

In male patients standard radical cystoprostatectomy was done. The urethra was transected distal to the prostatic apex. Technical details have been described previously.4 In women radical cystohysterectomy was performed without an attempt at nerve preservation. The urethra was transected distal to the bladder neck.5 In each sex frozen sections of the cut end of the urethra were obtained to ensure a disease-free safety margin.

The steps for construction of the ileal neobladder have been reported previously.2,3 The reservoir was constructed from a 40 cm. segment of distal ileum. The isolated segment was arranged into a W-shaped configuration. The stented ureters were implanted using the serous-lined extramural tunnel technique.

Two tube drains were placed in the pelvic cavity and brought out through separate incisions in the abdominal wall. Only gravity drainage was used. Intravenous alimentation was maintained until normal bowel functions resumed. Prophylactic antibiotics were routinely administered. The tube drains were removed after fluid drainage had ceased. The ureteral stents were removed after 10 to 12 days and the urethral catheter was retained for 3 weeks.

After hospital discharge the patients were scheduled for monthly followup visits for the first 6 months and at 3-month intervals thereafter. Followup was 8 to 88 months (mean 38 ± 25). Patient evaluation included symptom analysis for daytime continence, enuresis and voiding frequency. They were clinically examined for evidence of local recurrence or distant metastasis. Additional imaging modalities were performed in cases of clinical suspicion. Excretory urography (IVP) was done every 6 months during the first year. There-

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The stricture segment was excised and the spatulated filled pouch. A pull-through procedure was then performed through an anterior tunnel via an incision in the anterior wall of the previously scopic failure (fig. 3). Revision was necessary in 12 cases, including those of endo-
tempted in 16 renal units was successful in 10. Open surgical to anastomotic stricture was noted in 26 implanted ureters or had evidence of decompression (fig. 2). Deterioration due indicated that all except 26 of the 677 renal units were stable with a voiding frequency of 0 to 2. The remainder had various degrees of incontinence. hypercontinence, defined as post-void residual urine volume greater than 100 cc, was observed in 9 female patients. An obstructing mechanism should be incorporated into these systems. Despite such treatment half of them had persistent bacteriuria. In other words, the procedure provided a unidirectional nonobstructed flow of urine in the majority of cases (93% or greater). orthotopic bladder substitution is now considered the method of choice for urinary diversion after cystectomy. Despite extended operative time and technical complexity the procedure is associated with low mortality and acceptable morbidity. A postoperative mortality rate of less than 2% has been reported in most published data. These values compare favorably with those after conventional means of diversion. Improved anesthetic techniques, the availability of broad-spectrum antimicrobial therapy, better understanding of fluid and electrolyte balance, prophylactic anticoagulation and digitalization have helped to achieve this end. In our series an additional factor in the low mortality and morbidity was our younger population of patients with a mean age of 47 years.

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Initial concern about a potential increase in the number of tumor recurrences in the urethra became a nonissue. As a result of the proper selection of candidates and elimination of the subpopulation at high risk, only 3 patients (1%) had isolated urethral recurrence. Similar data have been reported by others. In our 3 cases complete urethrectomy and conversion to continent cutaneous diversion were performed.

Based on the mathematical model proposed by Hinman and the experimental evidence of Shaaban et al there is no dispute that detubularization and reconfiguration of the chosen segment of intestine are prerequisites for a reservoir of large volume and low pressure. Several operative techniques have been applied to achieve this goal. In our opinion the difference in the functional outcome is only marginal. Nevertheless, controversy still exists on the optimal methods of ureterointestinal anastomosis and whether an antireflux mechanism should be incorporated into these systems.

Conventional wisdom suggests that unless an antireflux technique is used during the construction of a urinary reservoir a deleterious effects on renal function may be expected. Does this apply to reservoirs of low pressure and large capacity? In our opinion the incorporation of an antireflux

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<th>Table 1. Early complications of the ileal W-shaped neobladder</th>
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<td><strong>No.</strong></td>
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<tr>
<td><strong>Jaundice</strong></td>
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<tr>
<td><strong>Hematemesis</strong></td>
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<tr>
<td><strong>Wound infection</strong></td>
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<td><strong>Deep vein thrombosis</strong></td>
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<td><strong>Urinary leakage</strong></td>
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<td><strong>Lymphatic collections</strong></td>
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<td><strong>Pouch-vaginal fistula</strong></td>
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* Bilateral nephrostomy tube in 1 patient.
† Percutaneous drainage in 3 patients.
‡ Successful repair via the vaginal approach.

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<th>Table 2. Current status of the ileal W-shaped neobladder</th>
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<td><strong>No.</strong></td>
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<tr>
<td><strong>Death from Ca</strong></td>
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<tr>
<td><strong>Disease</strong></td>
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<tr>
<td><strong>Death from unrelated cause</strong></td>
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<tr>
<td><strong>Evaluable</strong></td>
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<td><strong>Total No.</strong></td>
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<th>Table 3. Late complications of ileal W-shaped neobladder</th>
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<td><strong>No.</strong></td>
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<tr>
<td><strong>Urethral stricture</strong></td>
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<tr>
<td><strong>Urethro-ileal stenosis</strong></td>
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<tr>
<td><strong>Mucous retention</strong></td>
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<tr>
<td><strong>Bowel obstruction</strong></td>
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<td><strong>Hypercontinence in women</strong></td>
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‡ Medical Engineering Corp., New York, New York.
mechanism is necessary, although these systems are low pressure. This opinion is based on some experimental findings as well as on several clinical observations. In a series of canine experiments Kristjansson et al used various reimplantation techniques after subtotal cystectomy and cup illeocystoplasty.20 Evidence was provided that refluxing ureters were associated with bacteriuria in the upper tract as well as with pyelonephritis. In the clinical setting symptomatic persistent bacteriuria is common in patients with orthotopic substitution.21–23 A prevalence of 24.2% 5 years after surgery was reported by Steven and Poulson.24 Pressure within orthotopic bladder substitutes is low during the storage phase. Is this also true during evacuation? Gotoh et al provided evidence that voiding is achieved by increasing intra-abdominal pressure.25 As a result, pressure within the reservoir is markedly increased to a mean of 77.3 cm. water. In 44% of their patients an extremely high pressure of 80 to 150 cm. water was recorded. May such pressure acting on the ureter and renal pelvis generate a force capable of preventing reflux? The 2 factors of bacteriuria and high voiding pressure are alarming and should raise concern, particularly in the long term.

Several techniques have been proposed to provide an antireflux system for intestinal reservoirs derived from the ileum. The creation of a mucosal sulcus in which the ureter is embedded was proposed by LeDuc et al.26 It appeared to be an attractive procedure because of its technical simplicity. Critical evaluation of the published data and our results indicate that the procedure has a complication rate of 20% to 30%.27–29 The unpredictable results of this technique may be attributable to irregular and often delayed creeping of the intestinal mucosa to cover the bare ureter. Ureteral adven-

![Fig. 1](image1.png)

**Fig. 1.** A, plain x-ray shows multiple stones in neobladder. B, IVP demonstrates excellent upper tract, perhaps due to efficient antireflux mechanism.

![Fig. 2](image2.png)

**Fig. 2.** A, preoperative IVP. B, IVP 1 year after surgery. C, IVP 7 years after surgery configuration is perfectly maintained.
titia exposed to urine becomes the seat of an inflammatory reaction with subsequent scarring. It is interesting to note that when the intestinal mucosa was sutured in front of the embedded ureter, the complication rate significantly decreased.

Based on the experimental and clinical observations of Mann and Bollman, Hinman and Oppenheimer, and Sarramon et al. Studer et al proposed a long afferent loop for reflux prevention. The spatulated ureters are anastomosed to the proximal end of a long afferent segment. Consistently good results were reported by Studer et al as well as by others. However, it must be noted that to provide a functional antireflux mechanism the afferent segment should be at least 20 cm. Good results may be expected as long as the urine is sterile, the ureters have normal peristalsis and pouch evacuation is complete and achieved at low pressure. The functional integrity of this system for reflux prevention would be undermined under circumstances of distal obstruction and/or hypercontinence.

We and others have used the Kock ileal neobladder extensively. Since the ureters are anastomosed to the inlet of the intussusception valve by a spatulated mucosa-to-mucosa anastomosis, the incidence of stricture has been low at less than 4%. Nevertheless, the reported number of valve related complications is important. Desuscepton, valve stenosis and stone formation over the metallic staples have been observed.

It was obvious that for the further evolution of orthotopic substitution a technique must be developed in which stapling was not needed and an extra length of bowel was not required. In a series of animal experiments a new technique for reflux prevention, called the serous-lined extramural tunnel, was developed and evaluated. The first clinical experience was published in 1994, followed by another report in 1995. In view of its technical simplicity and excellent functional results the operation is routinely performed in our practice.

The procedure has several distinct advantages. Only 40 cm. of distal ileum are required, which is far shorter than the critical length beyond which metabolic complications resulting from reabsorption or malabsorption are anticipated. Metallic staples or synthetic materials are not required and, thus, complications resulting from the interaction of a foreign

![Fig. 3. A, preoperative IVP. B, followup IVP shows bilateral hydronephrosis. C, IVP after endoscopic dilation and stenting. D, IVP shows failure of endoscopic dilation. E, IVP reveals good result after open surgical revision.](image-url)
material with urine are avoided. The spatulated end of the ureter is anastomosed by a mucosa-to-mucosa technique to the intestinal mucosa at the distal end of the trough. Accordingly, the incidence of anastomotic stricture is low at less than 4%. This value compares favorably with those reported after a direct anastomotic technique. Successful open revision is feasible when necessary. As demonstrated by ascending studies, reflux was observed in only 3% of renal units. Thus, a nonobstructed unidirectional flow of urine was achieved in more than 93% of cases. The incidence of stone formation is markedly decreased compared to after Kock neobladder construction, in which staples are used (3% versus 13% to 24%). Moreover, this technique is versatile and applicable to ureters of various calibers. The surgeon may tailor the length and cross-sectional diameter of the tunnel according to clinical need. Furthermore, the reimplanted ureters lend themselves easily to retrograde studies, including uroscopy.

Of our evaluable patients 93% were completely continent during the day. Values within the same range have been observed by others. On the other hand, the reported rate of nighttime continence is generally lower (75% to 95%). This wide range of difference may be attributed to the adoption of different definitions. Some groups consider that the use of a single pad at night is a good result. In our series patients were considered continent at night when they did not use pads or medication and had a nighttime frequency of 2 voids or less.

The need for intermittent self-catheterization was rare in our male patients, usually due to outflow obstruction resulting from urethral stricture or stenosis at the urethrogram-ileal junction. Similar low rates have been noted by Elmajian et al. and Hautmann et al. Nevertheless, Steven and Poulson reported that the prevalence of patients requiring intermittent self-catheterization increased from 15.4% at 6 months to 43.2% at 5 years. We postulate that this difference may have been due to the fact that in our series the neobladder body was constructed from only 40 cm. of bowel. In addition, our average patient age was a decade less. On the other hand, 9 of our female patients (15%) had a significant volume of post-void residual urine. The mechanisms involved in and lines of treatment for such a problem have been previously described in detail.

The basic technique has 2 limitations, namely grossly dilated ureters and/or a concomitant pathological condition in the distal ureters, necessitating their excision. These shortcomings were faced and a solution was proposed that relied on the same principle of embedding a tubular structure in a serous-lined trough. A separate 6 to 8 cm. segment of ileum is tapered and embedded in a serous-lined trough. The ureters are then anastomosed to the inlet of the embedded segment using the mucosa-to-mucosa technique. This principle was reported by Stein et al., who used it with the Kock neobladder as an alternative to an intussuscepted nipple valve.

CONCLUSIONS

The serous-lined extramural tunnel as an antireflux uretero-ileal reimplantation technique has proved its efficiency and durability. Its results have been reproduced by others. Its versatility has been realized and it is now used routinely in our practice.

REFERENCES


