Bladder Reconstruction and Continent Urinary Diversion

Lowell R. King
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SECOND EDITION

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FOREWORD

There has been remarkable progress in the surgery allowing the creation of a continent lower urinary tract in recent years. The era of advocating a bag on the abdominal wall as a preferred means of "continence" is coming to an end as innovative approaches to continent internal urinary reservoir construction are developed. Many of the individuals contributing to this book have made notable additions to our knowledge of how this may be achieved. As their work and that of others is reviewed, there appears to be a theme emerging that may be widely applicable to both children and adults. A brief review of several concepts may help to bring this into focus.

Reconstruction of the lower urinary tract is often predicated on the acceptance of clean intermittent catheterization by the patient. With the exception of the artificial urinary sphincter, our success in producing balanced voiding dynamics surgically has not met with great success. With intermittent catheterization, however, lower urinary tract reconstruction requires only that one create a continent low-pressure reservoir that can be catheterized intermittently.

The creation of a satisfactory urinary reservoir requires that it be of adequate capacity and low pressure. When the patient's own bladder is inadequate, then it may be either augmented or replaced, using a portion of the gastrointestinal (GI) tract. Almost any portion of the GI tract has been successfully used to create a urinary reservoir. Perhaps the greatest consideration that goes into choosing a bowel segment is the potential effect on the GI tract of the loss of a particular intestinal segment. For example, loss of an excessive amount of the terminal ileum may be associated with interruption of the enterohepatic circulation of bile salts with resultant bile salt diarrhea, a disaster for the patient with spina bifida who has a neurogenic bowel as well as bladder. Regardless of which segment of the bowel is used, it is important that the peristaltic activity of the bowel be rendered ineffective. The pressure generated in the colon with peristaltic waves that can exceed 50 cm H_2O and the use of intact bowel segments as bladder augmentation or replacement may cause urinary leakage when these peristaltic contractions occur. Opening the bowel segment to be used along its antimesenteric border and then reclosing it to create a patch or pouch without effective peristalsis results in a bowel segment that will gradually dilate and serve as a very satisfactory low-pressure reservoir. This provides the maximum capacitance for the length of bowel utilized. In dealing with a hypertonic bladder, it is important that the bladder be so widely opened that detrusor contractions are likewise rendered ineffectual. If this is not done, a bladder augmentation becomes a progressively enlarging diverticulum arising from the dome of the bladder. If the bladder is very widely opened, there is no need to excise the detrusor.

Indeed, the larger circumference of an opened bladder may facilitate an easier size match with a bowel patch.

Another point that has emerged with long-term follow-up, at least in children, is that antireflux techniques to connect the upper urinary tract to the urinary reservoir appear to result in the best preservation of the kidneys over the long term. This raises the question as to which antireflux technique is most satisfactory. Much work has been done utilizing a nipple technique. This concept has one inherent problem; as a reservoir progressively fills, a nipple in that reservoir will be progressively effaced with the filling of the reservoir. This may then result in progressive shortening of the nipple until it is lost or everted, with resultant reflux. This has been seen in the bladder, in ileocecal segments, and with the Kock pouch. As experience with nipple techniques has evolved, some investigators have begun fixing them to the wall of the reservoir—in effect, changing them into a stable flap valve. A flap valve, analogous to the normal entry of the ureter into the bladder, appears to be a more effective antireflux technique. The flap valve principle requires a small-diameter, supple, tubular structure of adequate length to enter a reservoir in such a fashion as to permit it to be progressively compressed with reservoir filling. Thus, the more the reservoir fills, the more effective the valve becomes in preventing reflux. Adequate capacitance at low pressure in the reservoir and effective low-pressure emptying insures avoidance of the transmission of high pressure back to the upper urinary tract.

A *continent reservoir* can be created by utilizing the same flap valve principle to create a catheterizable channel between the reservoir and the body surface. The stoma can be placed on the abdominal wall, perineum, or even attached to a urethral remnant. All that is required is that the catheterizable channel be of relatively small caliber and sufficiently supple in its junction with the reservoir to provide an antireflux valve in the reservoir for continence. The course of the catheterizable channel must be such as to permit easy instrumentation. A small diameter facilitates the passage of a catheter without kinking or coiling. The possibilities for the construction of such a conduit are myriad. The appendix, ureter, and bladder tubes have all been successfully used. Skin tubes may be possible. The use of the small bowel as a catheterizable channel may also have promise, particularly if it is tapered to reduce its diameter; however, the small bowel has not had a good long-term record as a urinary conduit because of late stenoses, perhaps produced by immunologic changes in the conduit as a reaction to urine. Used as a catheterizable channel, the bowel would not be continuously exposed to urine and might thus avoid some of the problems that have been encountered in the long-term follow-up of ileal conduits or bowel used as a ureter.

As can be seen in this brief discussion, the possibilities for lower urinary tract reconstruction are limited only by the imagination of a creative surgeon. Drs. Lowell King, Anthony Stone, and George Webster are again to be congratulated for bringing together such a fine group of surgeons contributing to this rapidly growing and exciting field.

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PREFACE

Bladder reconstruction has come of age since the first edition of this book was published in 1986, and orthotopic replacement of the bladder has become a reality. Unfortunately, malignancy after cystoplasty, usually when performed for benign disease, has surfaced as a real risk. These tumors seem very analogous to the malignancies seen after conventional uretero-sigmoidostomy. Thus far, they have occurred in bowel segments—usually ileum—that have been used for bladder augmentation many years previously. Most patients in whom a malignancy has developed originally underwent augmentation for a benign disease, and subsequently had bacterial colonization of the bladder.

The extent and real risk of later malignancy after cystoplasty is presently unknown, but it seems safest to avoid juxtaposing transitional epithelium and bowel epithelium, whenever possible, when the joint surface will be exposed to bacteria. Except for this concern, progress in bladder reconstruction, continent diversion, and orthotopic bladder replacement has been extraordinary. The surgical techniques have low complication rates, although a successful outcome continues to depend on fastidious attention to intraoperative detail.

Great credit is due to R. Kennedy Gilcrist and James Merricks for pioneering continent urinary diversion. Their original ideas and techniques are fully recounted in the first edition of this book, but since these early experiences are now of mainly historic interest, this chapter has not been reprinted. Dr. Goodwin, however, has updated his chapter on the use of bowel in urologic surgery. The editors believe that his experiences provide an important perspective and valuable insights into the development of the field.

Subsequent chapters detail indications for cystoplasty, discuss patient selection, and outline the general principles that need to be followed if an optimal result is to be achieved. Seemingly nearly everyone agrees that the bowel segment or segments used for cystoplasty need to be detubularized. Hinman clearly shows herein that this maneuver increases subsequent capacity and reduces the risk of subsequent incontinence or bladder hyperactivity. Ileum, cecum, cecum with ileum, cecum with ascending colon, and sigmoid each have advocates who describe the special techniques used and the results achieved.

Mitchell has popularized gastrocystoplasty, which appears to minimize reabsorption of waste produces such as ammonia and electrolytes, and allows the excretion of acid urine without depleting serum and bone buffers. Snow has employed "autoaugmentation," essentially making a large, wide-mouthed bladder diverticulum with similar improvement in biochemical results.

Other chapters deal with the special problems of cystoplasty in children, complications—most often continued incontinence—

and their management, and detail what is presently known about the malignancies that occur after cystoplasty.

Hendren has updated his chapter on undiversion. There is now a consensus that reflux should be prevented or corrected at the time of cystoplasty, and useful techniques are covered fully. Stephenson reports his experience with transplantation in cystoplasty patients, and in those with continent diversion.

Intact ureterosigmoidostomy remains an attractive option in the older patient who must undergo cystectomy but in whom radiotherapy need not be employed. Retik has described a variation of ileocystoplasty in which the cecum is anastomosed to the sigmoid. The ureters are attached to the ileal tail, above a nipple valve, and remain in a sterile environment. It seems likely that this will avoid the increased risk of bowel malignancy seen after anastomosis of the ureters to the intact sigmoid. The Kock pouch has also been adapted for ureterosigmoidostomy.

Kock has revised his chapter in which he explains the rationale and research that led him to fold and refold the opened ileal segment to form the reservoir. He describes the evolution of the technique used to prevent reflux and create a continent stoma. The dry stoma has been the great challenge in continent urinary diversion and seven successful and innovative techniques are described in detail. Truly continent stomas are now achievable.

The final chapters deal with orthotopic bladder replacement. The great advantage of these techniques is to allow the resumption of voiding postoperatively in most patients. Bladder replacement is not yet a reliable option in women, unless used in conjunction with an artificial sphincter, and is not applicable in men who must have a total urethrectomy. However, it represents the ultimate in rehabilitation in cystectomy patients, and will clearly become the preferred solution when safely feasible.

Bladder replacement, continent urinary diversion, and cystoplasty each offer tremendous advantages to specific patient groups, and every urologist must become conversant with the results that can be and are being achieved. Many of these operations are relatively simple, both in concept and execution.

Lowell R. King, M.D.
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CONTENTS

Chapter 1

Experiences With Intestine as a Substitute for the Urinary Tract

Willard E. Goodwin, M.D.

In 1972, I wrote the following in *Urological Research:*

> The Uses of Intestine in Urology (a "gut reaction"): The intestine, readily available to the urological surgeon, as an ureteral substitute, an isolated conduit, or a closed system for urinary diversion and bladder replacement, is an important and much used part of urological surgery. Most of the techniques we have learned and later employed were first worked out in the animal laboratories, first in the laboratory of Professor William Wallace Scott—and subsequently at UCLA. In my view, each urological surgeon in training should have the benefit of this important and useful experience.[68]

The fact is that almost all the uses of intestine to be described in this book had been thought of and tried in many ways in various European and American experimental laboratories before Coffey[25, 26, 86] made his great contribution on the technique of ureterosigmoidostomy (Fig 1–1). Surgical texts of that period such as Morris[137] reveal the astonishing amount of experimental work that had been done, particularly in France and Italy. For example, Morris wrote:

> Tizzoni and Poggi excised the bladder of a dog and sutured the ureters into a loop of bowel which they had isolated at a previous operation. This loop of bowel they grafted to the neck of the excised bladder. By this remarkable experiment, they made a substitute receptacle for the urinary bladder. (*La Reforma Medica,* 1888)[137]

Camey's operation must be a direct derivation from this principle.[119]

Morris listed six "cases of implantation of the ureter into the bowel," beginning with Simon's first case in July 1855 (Fig 1–2). Probably French surgeon Tuffier[172, 173] was the first to report clinical success with ureterosigmoidostomy in a patient who survived. All these procedures were first tried (and mostly failed) in animal laboratories before the early 1900s. Except for ureterosigmoidostomy, urologic surgeons after Coffey made very little practical clinical use of the intestine until the 1950s when Bricker's cutaneous urinary diversion by use of an isolated segment of ileum achieved increasing popularity.[15–19] Perhaps when future generations of surgeons reflect on this period, the 25 years after the Second World War will be recognized as the time when urologic surgeons first made extensive use of the intestine in urology.

One of the finest and most scholarly articles describing the urologic use of intestine up to that time was "A Critical Study of the Differ-

FIG 1–1.
Dr. Robert C. Coffey, the originator of Coffey's operation for implantation of the ureter or severed bile duct into the intestine.

ent Principles of Surgery Which Have Been Used in Uretero-Intestinal Implantation"[104, 105] (Fig 1–3). Although almost all various combinations of use of intestine in the urinary tract had been devised and tried experimentally by that time, their broad, clinical application occurred after 1950, with the additional safeguards of antibiotics, blood transfusions, and vastly improved, extremely precise surgical technique. In some ways this great explosion of use of intestine in the urinary tract is comparable to the immense strides made in the rapidly expanding field of vascular surgery after the Second World War, beginning with Blalock's "blue baby operations" in this same period.

URETEROSIGMOIDOSTOMY

My first experiences with ureterosigmoidostomy were in the 1940s when I observed Jewett[107, 108] using his carefully worked out method of ureteral implantation as a staged procedure. This was intended to be a safer improvement on Coffey's technique, which was then the most widely used method of ureterosigmoid anastomosis throughout the world.

In 1946 and 1947 Harris and I worked out a technique of ureterointestinal anastomosis through the open bowel in dogs. When we later employed it in a patient for the first time, it was remarkably simple.[84] We have continued to use it with satisfaction.[184]

Ureterosigmoidostomy, which I have written about extensively, is probably still the most widely employed method of closed urinary diversion throughout the world.[75, 78, 88, 89] It has the great advantage of not requiring any type of collecting device except a toilet. In my view, even the well-known hazards and complications of the procedure do not outweigh or interdict its usefulness in properly selected cases. When it works well, it is spectacularly successful.[30, 138]

The problems and complications* of urinary infection and electrolyte imbalance can be foreseen and controlled with proper medication and management.[44, 69, 70, 163] In our own practice we sustain the patients on daily antibacterial treatment with sulfamethoxazole-trimethoprin or nitrofurantoin during the immediate postoperative period and then allow them to keep a supply of these drugs to use as needed later on. We also insist on a low sodium chloride diet and addition of extra sodium and potassium citrate to forestall electrolyte imbalance, hyperchloremic acidosis, and potassium depletion.

The well-recognized, serious problem of increased incidence of colon carcinoma in patients who have a longstanding ureterosigmoidostomy[61] is elegantly dealt with in the first edition of this book in the chapter by Spence and Hoffman. They describe the available literature on this subject very clearly and conclude, "ureterosigmoidostomy still remains a useful form of urinary diversion for certain pa-

*Goodwin WE: *Complications of ureterosigmoidostomy*, in Smith RB, Skinner DG (eds): *Complications of Urologic Surgery: Prevention and Management*. Philadelphia, WB Saunders Co, 1976, p 229.

CASES OF IMPLANTATION OF THE URETER INTO THE BOWEL.

Date.	Name.	Method, &c.	Result.	Why performed.
1855, July.	Simon: "Surgical Treatment of Children's Diseases," Holmes, p. 147; *Lancet*, vol. ii., 1852, p. 567; *Path. Soc., Trans.*, vol. vi., p. 256.	Loop of thread, passed by means of needles worked within a cannula, made to ulcerate through contiguous portions of ureter and rectum. Communication resulted. Urine escaped by the anus after the 10th day, phosphatic concretions formed in the lower ends of uterus, and the boy's condition, though oscillating, was more or less serious throughout.	Death one year after operation. Suppurating pyelitis on both sides.	For exstrophy of the bladder.
1878	T. Smith: *St. Bartholomew's Hospital Reports*, 1879, vol. xv., p. 29.	Each ureter inserted into the back of the colon on the corresponding side. Operation on the second ureter 14 months after operation on the first; fatal in 24 hours.	Necropsy.—Left kidney, the first one submitted to operation: hydro-nephrotic from stenosis—a probe passed along the ureter would not enter the bowel. Right kidney: obstruction to the passage of urine at junction with bowel. Ureteritis and acute septic pyelo-nephritis on the right side.	For exstrophy of the bladder.
1891	Küster: Langenbeck's *Archiv.* 1891.	Both ureters into the rectum, after complete cystectomy for cancer. The mucous membranes were sutured together with fine catgut and on the peritoneal aspect the ureter and rectum were fastened with silk sutures.	Death; purulent peritonitis; sutures did not hold; renal infection but ureters were not dilated.	Cystectomy for cancer.
1892, Sept.	Chaput: *Archives Générales de Méd.* 1894, vol. i., p. 11.	Ureter dilated; junction made with postero-internal surface of the colon on the left side.	Successful; drain in posterior peritoneal space. 12 months after there was no sign of infection.	For uretero-vaginal fistula following operation for vaginal hysterectomy.
1892, Nov. 1893, March.	Chaput: *Archives Générales de Méd.*, 1894, vol. i., pp. 23 and 24.	The first, the left ureter, was successfully implanted into the sigmoid flexure; the right ureter was implanted into the cæcum three months later.	First operation successful. Death occurred the same day after the second operation. The patient became comatose; there was suppression of urine, the watery motions ceasing. No necropsy.	For tuberculous cystitis and vesical fistula following operation.
	Leet.	Operation performed for relief of severe tuberculous cystitis.	Successful.	

By means of Maydl's method, Fowler, Carl Beck, Dudley P. Allen, Nové-Josserand, E. Herczel, and several other surgeons have had successes by grafting the bladder tissue or the two ureters with the sigmoid flexure or the rectum.

FIG 1–2.
Morris table (1903) describing the first six cases of implantation of the ureter into the bowel.

tients." They recommend frequent stool examinations for blood, and periodic colonoscopy. This topic was addressed and well discussed in the article by Starling et al. entitled "Value of Colonoscopy After Ureterosigmoidostomy." They write:

Despite the disadvantages of US [ureterosigmoidostomy], the likely increased popularity of this procedure mandates that all patients be followed regularly for polyps and cancer. Our data support the following recommendations: (1) surveillance colonos-