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INDIANA CONTINENT URINARY RESERVOIR

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ABSTRACT

Cecoileal reservoirs were created in 29 patients. Tunneled ureteral implantations along the tenia of the cecum provided the antireflux mechanism. Plication or tapering of the terminal ileal segment along with the ileocecal valve provided the continence mechanism.

The tubular configuration of the cecum was disrupted with either an ileal or sigmoid patch, or it was re-configured in a Heineke-Mikulicz type of closure to avoid bolus (unit) contractions. Short-term followup examination with excretory urography showed no upper tract obstruction. X-rays of the pouch showed no reflux and interviews revealed satisfactory continence in 93 per cent of the patients.

The desired attributes of a continent urinary reservoir are basically those of a normal bladder: to preserve upper urinary tract function by avoiding reflux and obstruction, to have low pressure and high capacity, and to allow reasonable continence and the ability to empty. During the last few years interest has been rekindled in old techniques as well as innovative procedures to avoid cutaneous urinary collection devices and to create a reliable reservoir with the aforementioned attributes.

The first reservoir was conceived by Simon more than 130 years ago when he constructed ureterosigmoidostomies in a patient with bladder exstrophy. The patient died 1 year later with ureteral calculi.[1]

Success with ureterosigmoidostomies awaited Coffey, who demonstrated a technique for nonrefluxing ureterocolonic anastomoses.[2] As far back as 1888 Tizzoni and Fogy created ileal bladders in dogs,[3] and in 1898 Gersuny created isolated rectal reservoirs basing continence on the rectal sphincter.[4] In 1950 Gilchrist and associates constructed a cecoileal continent reservoir with submucosal implantation of the ureters in the cecal segment.[5] Continence was based on the ileocecal valve and the antiperistaltic action of the ileum. They presented their long-term followup results in 40 patients in 1973.[6]

The main advantage that a cutaneous incontinent urinary diversion has over a cecoileal continent urinary reservoir is that the incontinent diversion technically is easier to perform. Therefore, the Bricker operation became more popular than any cecoileal continent urinary reservoir from 1950 to 1970.[7] Also, the concept of intermittent catheterization required for the use of the Gilchrist procedure was not readily accepted at that time. It is not surprising that continent urinary reservoirs are gaining popularity at this time based upon the improved techniques for continence and prevention of reflux, along with improved understanding of the urodynamics of isolated bowel segments and the acceptance of intermittent catheterization. The rapid increase in popularity of the Camey and Kock procedures is evidence of this trend.

We present a review of the surgical techniques and our preliminary results of a variation of the cecoileal continent urinary reservoir. Its advantages are tunneled ureteral implantations, a continence mechanism not dependent on the ileocecal valve or an intussuscepted bowel segment, no permanent foreign materials used in its construction and increased compliance from a nontubular bowel segment.

MATERIALS AND METHODS

From February 1982 to April 1986, 11 female and 18 male patients with an average age of 44 years (range 23 months to 76 years) underwent construction of a cecoileal continent urinary reservoir. The mean followup was 14 months, with a range of 6 to 55 months. The indications for construction of a cecoileal continent urinary reservoir included bladder or pelvic malignancy (57 per cent), exstrophy (21 per cent), neurogenic bladder dysfunction (18 per cent) and surgical trauma (4 per cent). Other procedures performed in conjunction with the cecoileal continent urinary reservoir included radical cystectomy (50 per cent), urinary undiversion (36 per cent) and simple cystectomy (36 per cent).

In the initial 10 patients no attempt was made to disrupt the tubular configuration of the cecum. Poor compliance and mass (bolus) contractions produced poor continence in 5 of these 10 patients, who subsequently underwent a procedure to disrupt the tubular nature of the bowel (3 ileal patch and 2 Heineke-Mikulicz re-configuration of the cecum). The subsequent 19 patients underwent procedures to prevent mass contraction of the cecum at the time of the cecoileal continent urinary reservoir construction, including an ileal patch in 15, sigmoid patch in 2 and a Heineke-Mikulicz re-configuration in 2.

Abdominal stomas were created in 24 patients. Of 5 patients with exstrophy as the primary diagnosis 2 boys and 1 man had the tapered ileal segment anastomosed to the reconstructed urethra and 2 women had a stoma created on the anterior vaginal wall. All patients emptied the reservoir by clean intermittent catheterization. Of the male patients 2 required reoperation and placement of the artificial sphincter around the ileal segment for continence.

Patients were selected foremost on their desire and willingness to take on the added responsibility of a continent urinary reservoir. They had to be able to perform clean intermittent catheterization as well as irrigation of the reservoir. Patients with moderate or severe renal impairment were excluded, since any postoperative obstruction could cause further deterioration of renal function. These patients also were more susceptible to hypokalemic hyperchloremic acidosis. Other contraindications were related to life expectancy, primary diseases of the colon and prior high dose radiation to the pelvis.

All patients underwent mechanical and antibiotic bowel preparations according to surgeon preference. The operative procedure with an ileal patch to disrupt the tubular structure of the cecum is discussed in detail elsewhere[8] and only the salient features are presented. Approximately 20 cm. of cecum and ascending colon are taken along with 15 to 18 cm. of terminal ileum (fig. 1, *A*). A 12 to 15 cm. portion of the terminal ileum also is divided to create a patch along the antimesenteric border of the spatulated end of the cecal segment (fig. 1, *B* and *C*). An alternative is to use a segment of sigmoid colon, again opening it on the antimesenteric border to serve as a patch on

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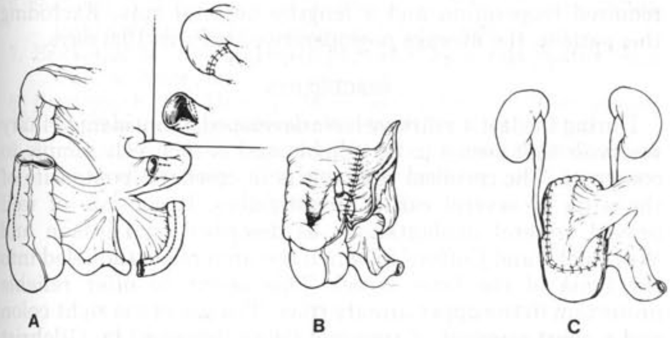

FIG. 1. *A*, ileocecal segment used for reservoir and ileal segment that is used as patch on cecal pouch. Dotted lines show incisions that are made along antimesenteric portion of each segment. Inset reveals spatulation of ileum to compensate for size difference between bowel segments before enteroenterostomy. *B*, suturing ileal patch to cecal segment. *C*, completed patch on pouch.

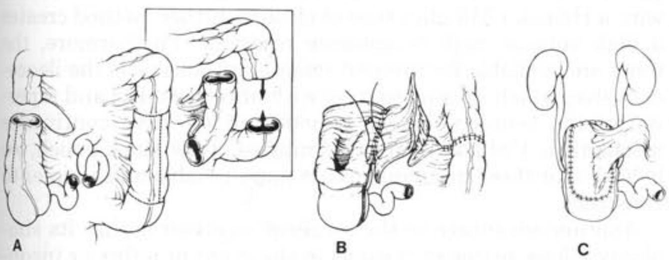

FIG. 2. *A*, ileocecal segment used for reservoir and sigmoid segment that is used as patch on cecal pouch. Dotted lines show incisions to be made in each bowel segment. Inset illustrates colonic enteroenterostomy. *B*, suturing of sigmoid patch to cecal segment. *C*, completed sigmoid patch on cecal pouch.

the cecal segment (fig. 2). Most recently, a Heineke-Mikulicz type of re-configuration of the cecal segment has been performed by taking a 20 to 24 cm. segment of the cecum and ascending colon, and splitting it along its antimesenteric surface for approximately three-fourths of the length from the cephalad to the caudal end (fig. 3). The ileocolostomy is performed by spatulating the terminal ileum to compensate for the discrepancy of size between the ileum and ascending colon (figs. 1 *A*, and 3, *B* and *C*).

The continence mechanism is created by plicating the terminal ileum over a 12F Robinson catheter (fig. 4). The first layer of sutures is comprised of a series of Lembert sutures 8 to 10 mm. apart beginning at the ileocecal valve and extending to the end of the ileal segment. After the plication is completed the Robinson catheter is replaced with an 18 to 20F catheter. If this catheter passes easily then the pouch is filled with 300 to 400 ml. saline and the catheter is removed. Firm pressure is placed on the cecal reservoir to test the continence of the terminal ileal segment. If there is leakage of saline through the terminal ileum, additional reinforcing sutures of 3-zero silk are placed. After this is completed the catheter must be passed again to make certain that the sutures are not so tight as to obstruct the terminal ileum. After catheterization and continence are satisfactory a second layer of 3-zero silk suture is placed over the Lembert sutures to reinforce the suture line (fig. 4, *C*). If an appendectomy has not been performed it should be done during the procedure. Also a 24F Malecot catheter is used as a cecostomy tube to drain the pouch during the first 3 weeks postoperatively. As described previously the ureters are tunneled into the cecal segment through the tenia to give antirefluxing anastomoses (fig. 5).[8]

After the pouch has been created the location of the pouch can be secured by tacking it to the abdominal wall with absorbable suture. The terminal ileum then can be led to either the right or left lower quadrant as dictated by the needs of the patient. Also in children the pouch may be placed in a pelvic location with the terminal ileum being led to a urethral remnant or anterior vaginal wall. The cecostomy tube is passed through the abdominal wall. The pouch is tacked to the anterior abdominal wall around the site of the cecostomy tube to prevent leakage when the tube is removed subsequently. Also, if ureteral stents were used during ureteral implantation they may be led through the abdominal wall by separate stab wounds. A Penrose drain usually is placed in the opposite lower quadrant of the abdomen, and it is led across the pelvis and behind the pouch.

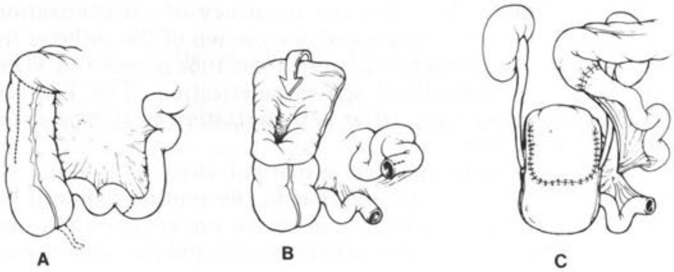

FIG. 3. *A*, ileocecal segment used for reservoir. Dotted line on antimesenteric surface of cecum indicates incision made in cecum to re-configure segment. *B*, opened cecal segment. Arrow indicates how segment is folded before transverse closure. *C*, completed transverse closure of cecal segment (Heineke-Mikulicz re-configuration).

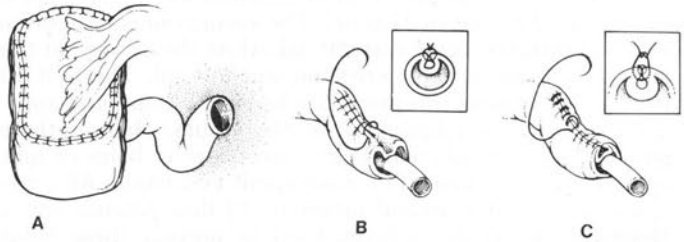

FIG. 4. *A*, ileocecal segment with patch before plication of terminal ileum. *B*, Lembert sutures 8 to 10 mm. apart extending over entire length of terminal ileal segment. *C*, after continence and ease of catheterization have been tested, running suture is used to reinforce suture line. Insets show end view of ileum.

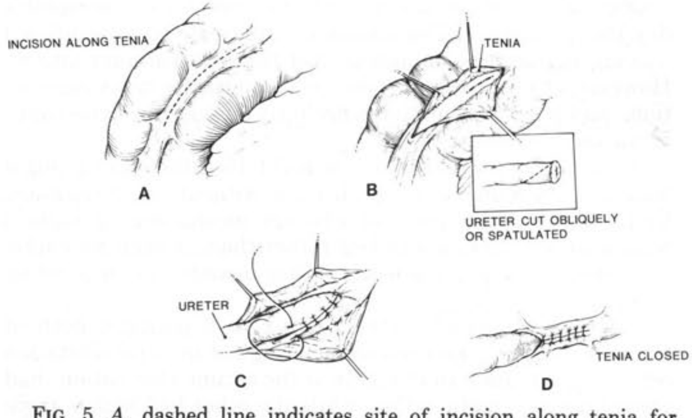

FIG. 5. *A*, dashed line indicates site of incision along tenia for ureteral implantation. *B*, dashed line shows site of incision in colonic mucosa for ureteral anastomosis. Inset shows preparation of ureter. *C*, anastomosis of ureter to colonic mucosa with interrupted sutures. *D*, closure of tenia to create tunnel to support ureter.

The cecostomy tube is irrigated every 2 to 3 hours initially with 30 to 60 ml. saline to prevent obstruction of the catheter with mucus. Approximately 3 weeks postoperatively an x-ray of the pouch and an excretory urogram (IVP) are performed to evaluate the pouch for leakage, reflux or upper tract obstruction. If no leakage is demonstrated the patient catheterizes the stoma every 2 to 4 hours and irrigates 4 times a day. The patient gradually decreases the frequency of catheterization and irrigation if continence and obstruction of the catheter by mucus are not a problem. The cecostomy tube is removed when the patient has mastered self-catheterization. The Penrose drain is removed 1 day after catheterization is started if no drainage is present.

Routine followup included outpatient visits 1, 3, 6 and 12 months after surgery. In addition to the routine followup by the primary surgeon, a detailed interview was conducted by one of us (J. A. P.) to evaluate catheterization and incontinence in a uniform fashion.

RESULTS

The average frequency of catheterization was 3.7 hours or 5 to 7 catheterizations in 24 hours. The average amount of urine for each catheterization was 291 ml. while the average of the greatest volume of catheterization was 508 ml. The first 10 patients undergoing this procedure had no attempt at disrupting the tubular configuration of the cecum. Half of these patients experienced incontinence secondary to bolus or unit contractions documented by urodynamic evaluation. All 5 patients underwent a second procedure (3 ileal patches and 2 Heineke-Mikulicz re-configurations) to prevent these bolus contractions, and they are now continent. In 2 children artificial urinary sphincters were placed for incontinence and both subsequently were continent. The sphincter was placed around the plicated terminal ileum that was anastomosed to the urethra with the reservoir being located in the orthotopic or pelvic position.

Over-all, 27 of 29 patients (93 per cent) have acceptable daytime continence. The remaining 2 patients have significant leakage requiring a cutaneous bag between catheterizations. However, cystometrograms do not demonstrate bolus contractions and both patients have declined a revision of the continence mechanisms.

Of 22 patients who are dry at night 15 catheterize at night once and 7 are able to sleep all night without catheterization. Of the remaining 7 patients who are incontinent at night 5 wear a cutaneous drainage bag rather than awaken for catheterization and 2 are those with daytime incontinence who refuse revision.

Cystograms showed ureteral reflux in 2 patients, both of whom had undergone ureteral tapering for ureteral dilatation before implantation in the tenia of the cecum. One patient had grade I asymptomatic reflux, while the other had higher grade reflux and has since undergone a successful secondary reimplantation. A postoperative IVP showed no evidence of obstruction of the upper tracts in any patient. On urodynamic evaluations of the continent reservoirs the pressure does not reach more than 20 cm. water even with low intensity contractions.

The postoperative complications are listed in the table. One patient had urinary leakage with sepsis and peritonitis that required reoperation and a lengthy hospital stay. Excluding this patient, the average postoperative stay was 10.5 days.

Postoperative complications

No. Pts.	Complication	Treatment
1	Myocardial infarct	Medical
1	Small bowel obstruction 1 yr. postop.	Tube decompression
3	Pouch leaks	Conservative (1), percutaneous drainage of infected urinoma (1), surgical exploration, drainage and closure (1)
1	Cholecystitis	Cholecystectomy
1	Parastoma hernia	Repaired at time of secondary placement of ileal patch

DISCUSSION

During the last 4 years we have developed a continent urinary reservoir that seems to be reliable and is relatively simple to construct. The cecoileal reservoir is in essence a composite of the work of several earlier investigators. It consists of well proved ureteral implantations as described by Hinman and Weyrauch,[9] and Coffey,[2] in which the ureters are tunneled into the tenia of the large bowel. This seems to offer reliable protection to the upper urinary tract. The use of the right colon and a short segment of terminal ileum described by Gilchrist and associates[5] creates a high capacity pouch that is not costly in terms of the amount of bowel used when compared to the Kock[10] or Camey procedures.[11] However, the cecal segment requires disruption of the tubular configuration to avoid unit contractions. This can be accomplished either by placing a patch on the cecal segment or by re-configuration of the cecum with a Heineke-Mikulicz type of closure. Either method creates a high volume, high compliance reservoir. Furthermore, the tenia are available for ureteral reimplantations as is the ileocecal valve, which in combination with antiperistalsis and tapering of the terminal ileum, provides an effective continence mechanism. Unlike the inverted nipples of the Kock pouch, we believe that these mechanisms are more reliable and simpler to construct.

Another advantage of the cecoileal reservoir is that its simplicity allows rescue operations in the event of reflux or incontinence. One patient underwent repeat tunneling of the ureter without disruption of the reservoir. In 2 children sphincters were placed for better continence of the reservoirs, which were anastomosed to the urethra. Additional tapering or an add-on ileoileostomy can be performed with minimal disruption of the reservoir should incontinence develop postoperatively. A cecoileal continent urinary reservoir is applicable to children and adults. It can be placed either abdominally with a stoma in the right or left lower quadrant, or orthotopically in the pelvis with anastomosis of the terminal ileum to the natural urethra or with the terminal ileum being brought out as a neourethra for a female subject.

If results improve with greater experience with this procedure we can anticipate a superb outcome, since the success rates of continence and antireflux mechanism are greater than 90 per cent at this time. We also anticipate greater acceptance of this procedure by urologists, since the steps of this technique (creation of isolated bowel segments, enteroenterostomy, implantation of the ureter along tenia and plication of the terminal ileum with Lembert sutures) already are familiar to them. Furthermore, patient awareness of the possibility of continence with diversion will create "consumer demand" for this procedure, which will stimulate urologists to offer a cecoileal continent urinary reservoir as an alternative form of urinary management.

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