Colon pouch (Mainz III) for continent urinary diversion

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OBJECTIVE
To evaluate the use of a continent cutaneous pouch made exclusively of colon (Mainz pouch III), as excellent results with the Mainz pouch III in irradiated patients suggested that the indication for this type of urinary diversion could be extended.

PATIENTS AND METHODS
The outcome of 24 patients with continent cutaneous urinary diversions using colon segments (Mainz pouch III) was investigated retrospectively. Overall, 22 of the patients had a malignant disease and two a benign disease; 16 had a hysterectomy and pelvic exenteration for gynaecological tumours; two men with a rhabdomyosarcoma of the prostate had a radical cystoprostatectomy; one woman had pelvic exenteration for bladder cancer; one man had a simultaneous rectum resection due to infiltrating rectal cancer, and another a left nephrectomy with cystectomy for concomitant kidney and bladder tumour. Benign indications were hyper-reflexive bladder after polytrauma and two cases of neurogenic bladder dysfunction. Eighteen patients had radiotherapy (32–48 Gy) before the urinary diversion.

RESULTS
The mean (range) follow-up was 35 (12–65) months. The mean pouch capacity was 293.8 mL. Three patients died during the follow-up (two from disease progression and one suicide); 20 patients were fully continent, four with reduced pouch capacity (<300 mL) had slight incontinence and are wearing a protective pad (band-aid at the umbilicus). All patients use intermittent self-catheterization (mean catheterization frequency 6.8/day, range 6–12). Complications related to the pouch were one outlet stenosis that required revision. Postoperative pouchograms showed asymptomatic reflux in four patients. None of the patients developed metabolic acidosis or diarrhoea.

CONCLUSIONS
The Mainz pouch III is an alternative to other types of continent urinary diversion

KEYWORDS
colon pouch, urinary diversion, continent

INTRODUCTION
Orthotopic neobladders, low-pressure rectal reservoirs, and pouches with continent stoma
are standard techniques for continent urinary diversion. Each has its special indications and contraindications, with advantages and disadvantages, but there are some common principles, such as creating a low-pressure reservoir, ureteric implantation and a safe, either natural or created, sphincter mechanism. Ekman et al. [1] first described the concept of low-pressure reservoirs from detubularized parts of small bowel in an experimental study, and Kock et al. [2] first presented clinical results with the Kock-pouch. It has long been established that detubularization of the bowel segment results in the formation of a spherical reservoir with a combination of low intrapouch pressure and the largest geometric capacity. These two features are important for the optimum functional outcome of the pouch in achieving continence and minimizing ureteric reflux [3].

There are also arguments for and against the different types of bowel used for urinary diversion. Some prefer to use ileum (i.e. Kock, T-pouches), others the ileo-caecum (Mainz I, Penn, Indiana, Lund, Lundina, Miami, Florida pouches), or colon (Mainz III pouch) [3–13]. The larger diameter of the colon gives a higher capacity than ileum when the same length is used to create the reservoir. The main argument for using the transverse colon in irradiated patients was that this segment is outside of the irradiated field, resulting in a lower complication rate, as reported by Leissner et al. [11]. Based on positive experience in patients after irradiation, we started to extend the use of the colon pouch (Mainz III) to nonirradiated patients.

PATIENTS AND METHODS

In all, 24 patients (19 women, five men) with continent cutaneous urinary diversions using colon segments (Mainz pouch III) were evaluated retrospectively. Of these, 16 had had a hysterectomy and pelvic exenteration for gynaecological tumours, two men with prostatic tumours (rhabdomyosarcoma) were treated with radical removal of the prostate and bladder, one woman had pelvic exenteration for bladder cancer, one man had a simultaneous rectum resection due to infiltrating rectal cancer, and another had a left nephrectomy with cystectomy for concomitant kidney and bladder tumour. Urinary diversion was also used for benign conditions, i.e. one case of hyper-reflexive bladder after polytrauma and two of neurogenic bladder dysfunction. Eighteen patients were treated with radiotherapy (32–48 Gy) before the urinary diversion. Upper urinary tract dilation was present before surgery in six patients, but was not symptomatic. Preoperative creatinine levels were <200 µmol/L (mean 82.9 µmol/L). A contrast-medium enema was used to exclude diseases involving the colon and to estimate the appropriate length of colon. Follow-up consisted of a pouchogram, capillary blood-gas analysis, and electrolytes, including urea and creatinine.

The operative technique was previously described in detail [11]. For the transverse-ascending colonic pouch, a midline laparotomy was used, bypassing the umbilicus on the left side (for transverse-descending pouch, the opposite side). Previous midline skin incisions should be used to avoid umbilical necrosis with subsequent stoma problems. The small and large bowel were mobilized carefully; the ureters were dissected out of the retroperitoneum and resected until there was arterial capillary bleeding from the ureteric stump. A sufficiently long portion of ascending colon and transverse colon (a total of 35 cm) was outlined for the creation of a pouch with adequate capacity (Fig. 1). The colon was detubularized antimesenterically; 6 cm of the oral end was left intact for the creation of the efferent segment, that was tapered over a 18 F catheter. The thus constructed efferent limb (pseudo-appendix) was embedded according to the Mitrofanoff principle, serving as a continence mechanism. Easy catheter gliding through the efferent limb is important and should be checked (Fig. 3).

A refluxing uretero-intestinal anastomosis for each ureter was made with a direct ‘buttonhole’ technique [6]. The pouch was closed and the efferent segment was attached to the anterior surface of the pouch wall with nonabsorbable sutures. The pouch was fixed to the abdominal wall. The anastomosis of the umbilical funnel and
the efferent segment was made at the level of the rectus fascia.

For statistical analyses, continuous variables were tested for normality using the Kolmogorov–Smirnov test; variables not passing this were assessed using nonparametric tests. Variables that passed the normality test were compared using Student’s t-test, unless Levine’s test for homoscedasticity was significant, in which case a separate-variance t-test was used. The Mann–Whitney test was used as a nonparametric surrogate when appropriate. In all cases, due to the small sample size and the danger of overestimating the significance with the asymptotic approximation, we used exact tests.

RESULTS

The mean (range) follow-up was 35 (12–65) months, and the mean pouch capacity was 293.8 mL. Twenty patients were fully continent, and four needed a security pad during long intervals between catheterization. All patients used intermittent self-catheterization with a catheterization frequency of 6.8 (6–12)/day. Three patients died during the follow-up, two from disease progression and one committed suicide for reasons unrelated to the urinary diversion.

There was one pouch-related complication, an outlet stenosis that required revision; correction of the efferent limb had to be combined with revision of the stoma, a second revision was needed and the urinary diversion was converted to a conduit. Early complications unrelated to the pouch included two cases of prolonged ileus (laparotomy) and two cases of secondary wound healing. Late complications were difficult catheterization in one patient and one asymptomatic upper urinary tract dilatation 3 months after surgery. Postoperative urograms revealed reflux in four patients (filling volume >300 mL). Serum creatinine levels remained at the preoperative level in all patients. Therapy for metabolic acidosis was not required and there was no diarrhea related to the urinary diversion.

Table 1 shows the characteristics of the 24 patients. The variable ‘number of catheterizations’ did not pass the normality test (asymptotic P = 0.060, exact P = 0.049) and was assessed with nonparametric procedures. There was a significant difference only in the number of catheterizations between those with pouch incontinence and those without (P = 0.011, Mann–Whitney test). The only difference close to significance was in creatinine levels between those who had previous irradiation and those who had not (P = 0.062, separate-variance t-test).

DISCUSSION

The Mainz III is a low-pressure high-capacity continent cutaneous urinary reservoir made exclusively of colon (40 cm of either ascending and transverse colon, or transverse and descending colon are used). Ileum is used for neither creating the pouch nor the efferent limb carrying the continent mechanism. The exclusive use of colon preserves the ileocaecal valve and the terminal ileum, and as a result, absorption of vitamin B12 by the terminal ileum is not disturbed. In addition, there is no malabsorption of bile acids and/or fat, reducing the risk of stone (renal and gall) formation and steatorrhea, respectively. Consequently, complications related to the malabsorption of liposoluble vitamins and calcium metabolism (osteomalacia, osteoporosis) can be prevented [4]. However, resecting the ileocaecal valve leads to bacterial colonization of the small bowel, resulting in early deconjugation of the bile salts and disturbance of the enterohepatic circulation. In addition, the defecation frequency is 30% higher (diarrhoea).

Incontinence is an important and debatable issue, with an incidence of 0.6–8% depending on the technique applied and the terminology of continence adopted [5]. There is no published consensus about the definition of incontinence. The Mainz pouch provides ‘true continence’, whereas continence of other pouches (i.e. Indiana) depend on catheterization at strict intervals to avoid urinary overflow and leakage. Continence of continent cutaneous urinary diversions is usually achieved with the aid of the Mitrofanoff principle [10–12,14–17], according to which the appendix or a tubularized bowel segment (pseudo-appendix) is embedded into the pouch wall (between the mucosal and seromuscular layer), creating a flap valve mechanism. Incontinence is rare and can result from an inadequate length of the flap-valve mechanism or from continuously elevated reservoir pressure. Beside this flap-valve mechanism, ileocaecal valve plications, intussuscepted nipples, and/or hydraulic valves (i.e. Benchekroun nipple) serve as continence mechanism in different types of urinary diversion [3,13]. The overall continence rates for most of these reservoirs are >90%, although ‘continence’ is not clearly defined. The continence rate of the Kock pouch was reported to be 77–89% of the Florida pouch >93%, and of the Benchekroun system >93%. Continence rates in larger series using the Mitrofanoff principle are 91–100% [3,10,11,14].

Stein et al. [18] reported on 300 patients who had a Mainz I continent urinary diversion with a follow-up of >5 years (mean 9.3, SD 2.7). In patients with an ileum intussuscepted nipple, re-intervention was necessary in 7% due to incontinence and/or nipple prolapse, and in 16% due to stomal stenosis. In patients with an appendix stoma, re-intervention was required in 35% (28 of 80), exclusively due to stomal stenosis.

Thus, many late complications are related to the efferent limb and/or stomal stenosis,
with rates of stenosis and difficulty in catheterization of 1.5–18% [5]. Stomal stenosis is the most common complication of an appendiceal efferent limb, occurring in 10–35% of patients [18,19].

The main advantage of the Mainz III is the use of the large bowel to create the efferent limb; the latter has a wider lumen than the appendiceal segment, which often can only be catheterized by a small catheter (<16 F). In these patients, regular flushing of the pouch to evacuate mucus can be difficult. Pouchoscopy is only possible using paediatric cystoscopes, reducing the facilities for manipulations, e.g. removal of pouch stones. To avoid or minimize problems with pouch catheterization, the following are of paramount importance: proper fixation and stabilization of the efferent limb, creating a tension-free anastomosis, and preventing angulation of the catheterizable channel. In the present series, only one complication related to the efferent limb and/or stomal stenosis required revision. In a previous study on the Mainz III, stomal stenosis appeared in six of 44 patients and was treated with endoscopic incision or Y-V plasty [11]. As an alternative, we prefer using buccal mucosa to correct stomal stenosis (three of 12 patients with a Mainz I pouch).

Leissner et al. [11] reported an 86% continence rate after Mainz III pouch formation in irradiated patients; they created the efferent limb by leaving 5–6 cm of the oral or the aboral colonic end intact, and tapering it over an 18 F catheter. Kato et al. [10] reported using transverse colon for three patients after pelvic irradiation, and all were continent after surgery; they used a detubularized small colonic ring from the distal end of the segment to create the efferent limb. A similar technique was used by D’Ancona et al. [16] in a previously irradiated female patient. Stein et al. [17] and Bochner et al. [20] created a flap-valve mechanism in ileocaecal pouches with the submucosal implantation of appendix in 27 and 14 patients, respectively, both studies reporting complete continence during the day and night. In the present study, 83% of patients were fully continent after a follow-up of 1 year; adding the patients using security pads, the overall success rate would be 100%.

Other recent studies on the flap valve as a continence mechanism in irradiated patients report continence rates of 7–28% [17,20]. Another advantage of the tailored large bowel segment as the efferent segment is that its length can be easily adapted to the obesity of the patient. Using exclusively colon, only one bowel anastomosis is required.

The type of uretero-intestinal anastomosis remains a matter of debate. The risk of renal reflux seems high in all uretero-enteric anastomoses with no valve mechanism. Various investigators report that all patients with catheterizable pouches are infected, yet most patients with chronic bacteriuria do not present with symptoms or complications [21,22]. Several authors reported that, when kidneys were directly punctured to obtain urine cultures, there was no difference between refluxing and nonrefluxing systems in the incidence of bacteriuria [21,23]. Bacteriuria alone did not seem to present a danger for morbidity nor a risk for a decrease in renal function except in patients with Proteus or Pseudomonas found in the urine cultures. It was concluded that only the latter patients should be treated [24]. Nevertheless, various techniques of nonrefluxing and refluxing ureteric implantation have been developed with the aim of reducing the theoretical risk of pyelonephritis and renal deterioration. However, the search for the ‘ideal’ anastomosis technique continues [6,21]. Nonrefluxing uretero-intestinal implantation results in stricture rates of 2.2–3.8% [6]. By contrast, Hohenfellner et al. [6] reported an obstruction rate of up to 30% after antirefluxive implantation; they concluded that a direct refluxing ureteric implantation in low-pressure, high-capacity reservoirs is superior, as it is has a minimal risk of anastomotic obstruction and subsequent deterioration of kidney function; other groups agree with this [8,9]. In the present study, there were four cases of reflux with no consequences, despite using a refluxing implantation technique, and no there was no stenosis of the implanted ureters.

The use of the Mainz III in irradiated patients was reported previously. Radiation is responsible for damage to the intestinal and ureteric blood supply; the subsequent ischaemia results in a greater incidence of leakage or stenosis at the site of uretero-intestinal anastomosis, malfunction of the stoma, fistulae, infection and/or dehiscence [17]. It is well established that the use of irradiated bowel for urinary diversion has a high postoperative complication rate of 28–90% [6,17]. Wammack et al. [12] reported a four-fold and Wilson et al. [24] a five-fold increase in complication rates in irradiated patients. Recently, Wilkin et al. [25] reported that their radiotherapy group had an 83% complication rate, vs 57% in the nonirradiated group, and that secondary surgical interventions were required more often in irradiated patients. Uretero-enteric complications present a significant proportion of pouch-related complications after pelvic radiation, of 22–37% [11,12]. Nonirradiated large bowel segments, ascending or descending, alone or together with transverse colon, have been used for urinary diversion. As the Mainz III reservoir is in the upper abdomen, ureters can be cut at a very high level (out of the irradiation field) ensuring an excellent capillary blood supply and reducing the risk of complications at the implantation site. This was confirmed by Leissner et al. [11], who reported a low complication rate with the Mainz III in irradiated patients. Reports on previously irradiated patients showed better results for the colon pouch and the flap valve as a continence mechanism than other techniques using irradiated bowel [7,10–12,16,25–27]. Stein et al. [17] and Bochner et al. [20] recommend the caecum for creating the pouch, while the terminal ileum substituted the distal part of the ureter (uretero-ileo-anastomosis), the ileocaecal valve serving as the antireflux mechanism.

Reservoir-related complications include pouch stones and urinary leakage, each with an incidence of ~10% [5]. Pouch perforation is rare. None of these complications occurred in the present series. The absence of pouch stones could be related to the normal absorption in the terminal ileum and the unimpaired function of the ileocaecal valve.

In conclusion, the Mainz III is an excellent technique for urinary diversion, especially in patients who have had previous radiotherapy. The use of nonirradiated bowel, the better capillary blood supply of the ureters cut at a high level, and the preservation of the ileocaecal valve and terminal ileum, are strong arguments for this form of low-pressure high-capacity reservoir. A nonrefluxing ureteric implantation is not needed. Based on our experience with this type of urinary diversion we have expanded our indication to nonirradiated patients.
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CONFLICT OF INTEREST

None declared.

REFERENCES


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