Urological Research 6, 59-63 (1978)

Urological Research

REVIEW

Urinary Diversion

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CLINICAL ASPECTS

Urinary diversion (UD) is always more or less disabling. The indication must therefore be very strict. UD is useless if a bladder tumour has been understaged or unnecessary in some cases with neurogenic reflux which may be successfully managed by ureteroneocystostomy. Alloplastic devices may soon be developed sufficiently for some cases of incontinence (38). The selection of UD has to be tailored to the individual needs of the patient.

Internal UD is excluded if the anal sphincter is inadequate or there is advanced renal damage (39). Internal diversion usually means uretero-sigmoidostomy as the various types of rectal bladder have not proved to have any advantage over uretero-sigmoidostomy and have often been accompanied by faecal incontinence (22). Internal diversion may also be created by the "undiversion" of urinary conduits. If an ileal conduit is changed to an uretero-ileo-sigmoidostomy, the anastomosis between the ileal conduit and the colon must prevent colo-ileal reflux since the ureteroileal anastomosis has no anti-reflux function. Intussusception of the bowel wall allows the distal part of the ileal conduit to be fashioned into a nipple which functions as a valve. This technique was devised 20 years ago as a primary method for internal diversion (32). It proved to be too complicated and offered no advantage over direct uretero-sigmoidostomy. Even though this nipple protects the kidneys from colonic backpressure, it has been confirmed experimentally that ascending infection is better controlled by a submucosal course of the ureters in the colonic wall (17).

External diversion by means of conduits can be performed with any part of the gastrointestinal tract. The physiology of intestinal resorption offers no guide to the most suitable bowel segment. Both the ileum and the colon resorb chloride and secrete bicarbonate and potassium when perfused with urine. In the jejunum no bicarbonate is lost but ions are freely exchanged along osmotic gradients. A hyperosmolar urine results in loss of water and sodium leading to a deficit in extracellular fluid (9, 19).

The anatomy of the small bowel has so far prevented the achievement of a satisfactory antireflux uretero-ileal anastomosis. The best experimental results in this respect were achieved by applying the Mathisen technique. The tip of the ureter was wrapped in a small ileal flap and made to protrude into the intestinal lumen. While the early results were promising the late ones have been disappointing because the uretero-ileal nipple was turned into a diverticulum by spontaneous evagination leading to massive ileo-ureteric reflux (23). It seemed logical therefore to try to prevent the reflux not at the site of the uretero-ileostomy but within the ileal conduit itself. An ileal intussusception in the proximal part of the conduit created a one-way valve preventing reflux of infected urine from the distal part of the conduit into its more proximal part. This technique has been used in a patient (2). The anatomy of the large bowel allows the ureters to be implanted through submucous tunnels in order to prevent colo-ureteric reflux.

Pressure measurements in both ileal and colonic urinary conduits have shown that the pressure is about the same in both kinds of conduits as long as the patients are supine but three times higher in the colonic than in the ileal conduits as soon as a patient is sitting up (6). This suggests that an anti-reflux procedure is compulsory with the colonic conduit. In the ileal conduit reflux into the ureters can usually be demonstrated when the conduit is filled to capacity. If an attempt is made to detect reflux under normal conditions, that is with the stoma open and the conduit containing only a small amount of

0300-5623/78/0006/0059/$01.00

fluid, the incidence of reflux greatly decreases (31). While the significance of the ileo-ureteric reflux remains uncertain it cannot be excluded that antireflux uretero-enterostomy helps the ureteric peristalsis in protecting the kidney from ascending infection, although the experimental results in this respect are controversial: ileal and colonic conduits in dogs have been compared 3 months postoperatively (29). Although there was no obstruction of the upper urinary tracts and no urinary infection following either type of diversion there was histological evidence of pyelonephritis associated with both ileal and colonic conduits. In the experiment based on 2 groups of dogs having either a colonic or an ileac conduit pyelonephritis occurred in 60% (12/18) of colonic and 25% (4/16) of ileal diversions. The reasons for the more favourable findings in the latter were not evident. The experiment based on group of dogs which had one of their kidneys diverted into an ileal and the other into a colonic conduit resulted in an incidence of pyelonephritis of 7% (1/14) for the colonic and of 83% (10/12) for the ileal diversion (21). This difference in favour of the former was thought to be due to the reflux preventing uretero-colostomy. The anatomy of the small and the large intestine therefore seems to favour the colon for creating urinary conduits.

The pathology of the gut, however, may determine which part of the bowel will have to be used in an individual patient without regard for anatomical and physiological considerations. Previous radiotherapy to the pelvis may make it necessary to use either the jejunum or the transverse colon instead of the ileum or the sigmoid. Extensive diverticulitis of the colon is a good reason to prefer small intestine.

For children with an intact anal sphincter uretero-sigmoidostomy is the best type of UD. The absence of a stoma is psychologically advantageous for a growing child since it allows the experience of an intact body. This advantage should not be forsaken without a compelling reason (38). The long term results are good (27, 39) if the operation is performed while the upper tracts are still undamaged (27).

In bladder exstrophy both procedures - UD and vesical reconstruction - can be done simultaneously. The upper tracts are thus protected by an early uretero-sigmoidostomy, while sexual function is not impaired by a premature and possibly unnecessary removal of the bladder. If the reconstructed bladder turns out to function well (when tested with water) the ureters can be reimplanted later (11).

In children with anal incontinence the urine must be diverted by means of a conduit. The long term results of the ileal conduit are disappointing (25, 28) as far as the preservation of renal function is concerned. The results of the colonic conduit are more promising (13, 16).

Although the two types of conduit cannot be fully compared yet as their follow up is not equally long, in paediatric urology the colon should be used for 3 reasons: Firstly one hopes that the late results will be better with the colonic than with the ileal conduit, secondly the beneficial effect of the antireflux anastomosis upon the incidence of renal infection cannot be excluded and thirdly the antireflux anastomosis will simplify a later "undiversion" (5, 13).

In adults UD is most commonly performed for malignant bladder disease and the final outcome for the patient depends more on the stage of the tumour than on the kind of diversion. The arguments for preferring the colon to the ileum as conduit are therefore not as valid in adults as in paediatric urology. If the tumour stage excludes curative treatment intractable pain can often be relieved by palliative uretero-sigmoidostomy. If the stage permits a curative procedure the combination of radiotherapy and cystectomy (34, 36) offers a better hope of cure than either surgery or radiotherapy alone (4). Diversion prior to radiotherapy and cystectomy is the usual procedure for invasive (T 3) bladder tumours (34, 36). Radiotherapy after uretero-sigmoidostomy is acceptable but uncommon (11, 38). Radiotherapy before uretero-sigmoidostomy increases the risk of fistulas and peritonitis. If UD is indicated after high dose radiotherapy either a conduit made of undamaged bowel or a cutaneous transuretero-ureterostomy may be performed (30).

The tumor-unrelated mortality and morbidity following different types of urinary diversion are summarised in Table 1. Although the reported incidences differ considerably they show that biochemical disturbances occur less frequently after a conduit procedure than after uretero-sigmoidostomy, whereas the latter creates no stoma problems. It is debatable whether the stoma problems are offset by the superior biochemical findings of the conduit diversion or whether the comfort of living without a stoma justifies the risk of the higher incidence of acidosis and pyelonephritis. This is a decision in which the patient should be allowed to participate.

TECHNICAL ASPECTS

The preoperative care must ensure that the bowel is cleared of faeces although not neces-

Table 1

	No. cases	Incidence of complications % (range)					
		Hospital death	Early intestinal obstruction	Normal urogram	Pyelonephritis	Acidosis azotemia	Stoma problems
Ileal conduit (7, 12, 20, 24)	779	9 (3.4-12.6)	8 (4.6-11)	82 (72-90)	14 (7-23)	5 (0.75-10)	25 (3-49)
Colonic conduit (12, 16)	155	6 (1.5-13)	4.5 (4-5)	78 (61-100)	12 (6-28)	4 (0-19)	8 (3-25)
Uretero-sigmoidostomy (15, 20, 35, 37, 39)	659	7 (0-9)	1 (0-5)	66 (60-85)	25 (4-57)	19 (4-47)	0

sarily sterilised and that the patient is not dehydrated by the bowel preparation (26).

The operative technique has not varied greatly over the years.

Uretero-sigmoidostomy is best done by bringing the ureters into the colon from behind where they are naturally located and by implanting them via submucosal tunnels to prevent reflux (10).

The ileal or jejunal conduit should be short and take a route across the peritoneal cavity. The ureters are either implanted separately into the gut or after being united to one another (33). The former procedure would appear to have advantages should one ureter need to be re-explored. There is little agreement as to whether the stoma should be a bud or flush with the skin.

The colonic conduit must also be short. Made of transverse colon it crosses the peritoneal cavity, made of sigmoid colon it runs along the lateral peritoneal wall or takes the extraperitoneal route (16). The ureters are implanted into the colon through submucosal tunnels. The stoma is flush.

The construction of an urinary diversion with a continent stoma requires a reliable continence mechanism consisting of an intussuscepted gut segment (18); a voluminous reservoir made of caecum (1, 8, 40) or of an ileal pouch ileum (3, 14); and a reliable antireflux mechanism. With the caecum reflux may be prevented by submucosal tunnels, whereas in the ileal pouch a second intussusception has to be inserted between the reservoir and the uretero-ileostomies (14). The main problem is not the maintainance of continence but ensuring easy self-catheterisation. At a later stage the ileal resorption of the biliary acids and of vitamin B_{12} could be impaired and give rise to long term problems since the ileocaecal procedure uses the terminal 20 cm of ileum and the ileal pouch procedure uses up to 90 cm of gut located proximal to the lowermost 15 cm of the ileum.

Postoperative care has probably been the single most important factor in reducing the postoperative morbidity and mortality following UD. It aims at preventing any deficit of calories, fluid or electrolytes. A full parenteral supply is maintained until the bowel has resumed normal function (26).

OUTLOOK

UD must be evaluated by its success in preserving renal function and in achieving an acceptable quality of life. The sudden late deterioration of the upper tracts occurring in some cases suggests that our technique has still to be improved. The frequent stomal problems show that the conventional stoma is not optimal. The continent stoma, desirable as it may be, has yet to be perfected and the long term experience must prove that it does not endanger renal function.

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