Radical cystectomy and bladder substitution

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The incidence of bladder cancer is rising. The main treatment for superficial bladder cancer is local resection and judicious use of intravesical agents. Radical cystectomy can cure organ-confined, invasive disease. The ileal conduit remains the gold standard following cystectomy. Newer methods of bladder substitution and nerve-sparing techniques have resulted in better tolerance of this treatment.

Controversy still exists over the optimal management of patients with invasive transitional cell cancer of the bladder. In some centres within the UK radical radiotherapy is offered as the first-line treatment, in others cystectomy is the preferred option. Sadly, bladder cancer carries a high mortality and there has been little improvement in survival rates over the last 10 years.

The advantages of radiotherapy include the preservation of a functioning native bladder, the preservation of continence and a limited effect on erectile function. The disadvantages of radiotherapy include bladder contraction, recurrent post-radiotherapy haemorrhage and damage to pelvic and surrounding organs. Furthermore, the effects of pelvic irradiation can make subsequent, so-called 'salvage cystectomy' a difficult procedure.

Radical cystectomy is a major operation with significant morbidity. It is frequently associated with erectile dysfunction in men and reduced sexual satisfaction in women (Bjerre et al, 1995). The end result of removing the native bladder has traditionally been an incontinent, device-dependent stoma and the effects of this on the patient's quality of life can be considerable (Månsson et al, 1991). It does, however, offer the potential for cure in organ-confined invasive bladder cancer and is the treatment of choice for carcinoma in-situ which does not respond to intravesical agents. When bladder tumours are bulky (*Figure 1*), or when there is a degree of ureteric obstruction, cystectomy can offer a rapid resolution of symptoms.

Improvements in surgical technique over the last 50 years have made it possible to maintain male sexual function following radical cystectomy by identifying and preserving neurovascular bundles. The use of a bowel segment to fashion a substitute bladder pouch, the orthotopic 'neobladder', allows the patient to maintain natural continence and therefore avoids the need for a permanent stoma. Increasingly, patients are being offered a greater surgical choice and many, especially younger patients, are choosing bladder substitution.

Figure 1. A pathological cystectomy specimen showing a large, invasive bladder carcinoma. This demonstrates how such tumours can compromise bladder capacity.

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RADICAL CYSTECTOMY: THE OPERATION

Classically, the operation of radical cystectomy commences with an 'en block' lymph node dissection along the iliac vessels in the pelvis. Removing the lymph node 'packages' allows the cancer to be accurately staged by the pathologist. During the dissection it is important not to damage the presacral nerves, hypogastric nerves and pelvic plexuses, or the neurovascular bundles that supply the cavernous tissue of the penis or clitoris. Nerve-sparing radical cystectomy is possible without compromising the chance of cure or the disease-free interval. With the best efforts at nerve preservation, however, impotence is still encountered postoperatively by up to 60% of men (Månsson et al, 1988).

Following lymph node dissection, the operation continues in the male patient with removal of the bladder, prostate, prostatic urethra, seminal vesicles, overlying pelvic peritoneum, surrounding adipose tissue and the proximal vas deferens. In the female, radical cystectomy includes removal of the bladder, 1 cm of proximal urethra, the uterus and anterior vaginal wall together with surrounding adipose tissue (Marshall, 1997).

TRADITIONAL URINARY DIVERSION

Once the bladder has been removed the ureters must be diverted to a suitable reservoir. The ileal conduit, as refined by Eugene Bricker, is an elegantly simple urinary reservoir that is still considered the gold standard (Bricker, 1950). The ileal conduit, at its distal end, is configured into a spout as a urostomy to which a bag is applied to collect urine (*Figure 2*). The ileal conduit has no features which render it continent.

Although this form of urinary diversion is a relatively simple procedure and has few inherent complications, it does result in a major distortion of the patient's body image (Nordstrom and Nyman, 1992). Younger women especially may be anxious about the urostomy appliance protruding under their clothes. They are often anxious about urinary leakage and odour despite the fact that this happens very infrequently. Furthermore, several studies have shown that patients with ileal conduits infrequently return to sport and leisure activities and are reluctant to travel away from home or to stay away from their own home overnight (Bjerre et al, 1994).

BLADDER SUBSTITUTION

With the drawbacks of ileal conduit diversion in mind, continent bladder substitution has been developed using many different neobladder designs fashioned from a myriad of different gastrointestinal segments. Orthotopic bladder substitution involves constructing a neobladder using a segment of either small bowel or colon as shown in *Figure 3*.

Figure 2. A typical ileal conduit. Urine drains from a spout of ileum into a urostomy bag.

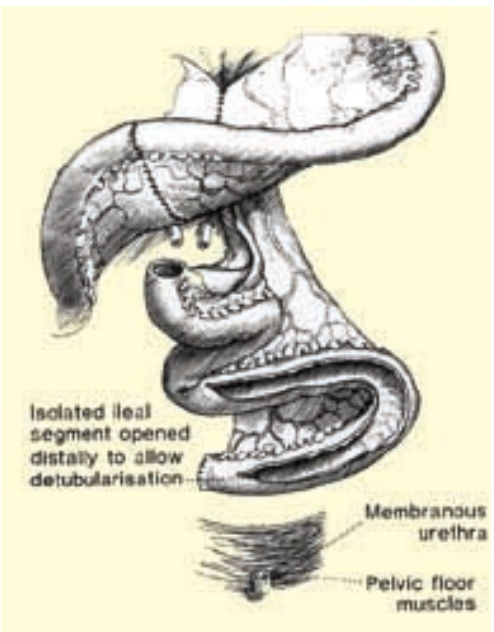

Figure 3. Intraoperative diagram demonstrating how an isolated loop of ileum is detubularized and configured into an orthotopic neobladder ready for anastomosis onto the membranous urethra.

The important properties of a neobladder reservoir are that it should have a low pressure and a good capacity (Colding-Jørgensen and Steven, 1993). Furthermore, it should preserve the native urethral sphincter to provide a continent outlet (*Figure 4*). Ideally the ureters should be 'non-refluxing' to protect the kidneys from recurrent infection and subsequent damage (Kock et al, 1978). Generally, pouches made from the right colon and from the ileum fulfil these principles and are the most commonly used.

Voiding difficulties are common following bladder substitution but fortunately many symptoms improve with time. Because the neobladder is a low-pressure reservoir with no intrinsic muscular activity of its own, voiding is initiated by straining the abdominal muscles. Abdominal straining often leads to incomplete neobladder emptying. For the majority of patients the postmicturition residual urine is of no significance but, for others, recurrent infections and incontinence can result (Nurse et al, 1988). Intermittent self-catheterization is required by some patients to achieve satisfactory bladder emptying and it is routine to teach this technique to patients before their surgery.

Figure 4. Intraoperative photograph demonstrating an orthotopic neobladder being anastomosed to the native urethra. A catheter traverses the urethral stump and enters the newly configured neobladder.

Despite the best intentions of the surgeon urethral sphincter damage can still occur. Furthermore even when the sphincter is adequately preserved some patients can still experience bothersome nocturnal enuresis following bladder substitution. Most of these symptoms resolve rapidly but they necessitate a concentrated postoperative effort by both the patient and continence advisor. The largest series of patients undergoing orthotopic bladder substitution showed overall daytime continence rates in the order of 94% (Skinner et al, 1991).

METABOLIC COMPLICATIONS FOLLOWING BLADDER SUBSTITUTION

The intestine selectively absorbs and secretes nutrients, electrolytes, water and other substances. When intestinal segments are used to store urine, metabolic and acid–base disorders can result. The ileal conduit, because it offers less mucosal contact to urine, has the least potential for metabolic complications. The degree of metabolic disturbance depends on the type of intestinal segment used and the contact time between the reservoir and the urine.

The most common metabolic disorder is hyperchloraemic acidosis. The aetiology of this acidosis is not clear, but the most likely explanation is that urinary ammonium ions are actively reabsorbed by both ileum and colon (Boyce and Vest, 1952). Chronic metabolic acidosis can lead to renal wasting of potassium and overall potassium depletion is found in patients with both ileal and colonic neobladders (Seeman et al, 1995). Occasionally, potassium depletion is severe enough to lead to muscular paralysis. The degree of acidosis and hypokalaemia is much greater in patients with compromised preoperative renal function. For this reason, moderate to severe renal impairment is a relative contraindication to bladder substitution surgery. Fortunately, the overall incidence of severe metabolic disturbance is low (<3%), but its potential requires regular metabolic screening in the follow-up period.

When significant portions of the intestine, particularly small intestine, are removed from the gastrointestinal tract for reconstructive surgery, alterations in the absorptive potential can result in nutritional deficiencies. Loss of ileum, for example, can impair vitamin B_{12} absorption leading to chronic anaemia. Severe diarrhoea may result when the ileocaecal valve or portions of the distal ileum are used in bladder substitutes and dehydration may occur if large segments of colon are used. These com-

plications are minimized by limiting the section of small bowel used to approximately 40 cm and the segment of large bowel used to 24 cm.

THE FATE OF THE URETHRA

To perform a reconstructive operation with an orthotopic neobladder it is necessary to preserve the urethra. In so doing the closest restoration to normality is achieved. The urethra, however, is lined with transitional cell epithelium and traditionally a urethrectomy has been performed at the same time as cystectomy to eliminate the risk of a tumour recurring in the urethra. The chance of a urethral recurrence, however, is low. In a meta-analysis of over 5600 tumour events, urethral recurrences were found in only 6.2% (Erckert et al, 1996). Since urethrectomy is associated with a high incidence of erectile dysfunction, anorgasmia and postoperative morbidity, it is questionable whether prophylactic urethrectomy is justified in the majority of patients (Bell et al, 1999).

Modern practice dictates that the only absolute indication for urethrectomy, at the same time as radical cystectomy, is coexistent urethral malignancy. A frozen section of the membranous urethra is usually obtained during cystectomy and if this is clear of tumour then it is considered safe to proceed to orthotopic substitution (Lebret et al, 1998). Many surgeons are reluctant to perform a neobladder substitution when there is preoperative biopsy evidence of cancer spread to the prostate. In particular, the presence of prostatic stromal invasion, as opposed to prostatic urethral invasion, carries a high risk of subsequent urethral recurrence (Hardeman and Soloway, 1990).

Regular urethroscopy and cytological washings can detect a urethral recurrence after bladder substitution. This is usually repeated every 6 months for the first 5 years and annually thereafter. Most asymptomatic urethral recurrences can be treated easily by fulgaration.

MANAGEMENT OPTIONS WHERE URETHRECTOMY IS NECESSARY

When the bladder neck, urethra or prostatic stroma are invaded by disease then urethrectomy is necessary at the time of radical cystectomy. Although urethrectomy renders a neobladder reconstruction impossible, there are other options that avoid the need for an incontinent stoma. The continent cutaneous reservoir is a bowel segment fashioned into a bladder substitute which is brought to the anterior abdominal wall via a continent outlet. The unobtrusive outlet is regularly catheterized by the patient and there is no need for a urostomy device. The continent outlet is formed either from the ileocaecal valve and terminal ileum or from the patient's appendix (*Figure 5*).

An alternative to the continent cutaneous reservoir is to divert the urine into the sigmoid colon. In this procedure the ureters are implanted into a sigmoid pouch in a non-refluxing manner in order to reduce the risk of faecal contamination of the upper urinary tract. Continence is achieved by the anal sphincter. This form of urinary diversion is offered to patients with adequate anal tone and especially in countries where stomas are considered unacceptable such as areas of the Middle East and Africa.

CONCLUSIONS

Radical cystectomy was once perceived as a mutilating operation. Surgical techniques have improved over the last 50 years such that, with the advent of nerve-sparing cystectomy and bladder reconstruction, patient satisfaction and quality of life have improved. Bladder substitution, with either an orthotopic neobladder or a continent cutaneous reservoir, is a complex procedure with significant complications.

For many patients, the advantages of bladder substitution, the avoidance of a permanent stoma

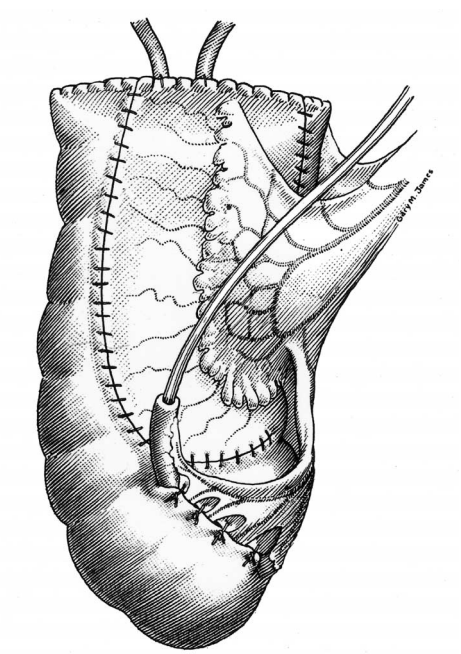

Figure 5. Intraoperative diagram of a continent cutaneous pouch fashioned from terminal ileum and ascending colon. A tube enters the appendix which will ultimately form a catheterizable stoma.

and the potential for continence are overriding issues. For others, a traditional ileal conduit urinary diversion is a perfectly satisfactory option. The preoperative counselling of patients with invasive bladder cancer is, therefore, becoming increasingly complex and time consuming. In the future patients will deserve and demand a range of reconstructive options to complement their cancer surgery. HM

Conflict of interest: none.

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KEY POINTS

- Invasive, organ confined, bladder cancer can be treated by either radiotherapy or radical cystectomy.
- Traditionally, radical cystectomy was accompanied by an incontinent ileal conduit urinary diversion.
- In suitable patients, nerve-sparing cystectomy and bladder reconstruction results in an improved quality of life and postoperative satisfaction.
- Bladder substitution surgery is complex and associated with a significant postoperative complication rate and unusual metabolic disturbances.
- Urethrectomy is no longer an essential part of radical cystectomy provided surgical margins and prostatic stroma are clear of disease.
- Continent urinary diversion can still be offered to patients with urethral disease requiring urethrectomy.
- Improvements in surgical techniques have resulted in a greater choice for the patient with invasive bladder cancer.