The Artificial Urinary Sphincter in Myelomeningocele Patients

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The urological consequences of myelomeningocele are legion and depend on the extent and level of the neurological insult. In patients with lesions that result in incontinence, restoration or establishment of continence, although desirable, is not always the primary aim in urological management as preservation of satisfactory renal function is of paramount importance. When sphincter weakness is the cause of incontinence the implantation of an artificial urinary sphincter (AUS) provides an extremely effective means of achieving continence, whether performed alone or more commonly in combination with cystoplasty to correct coexisting detrusor hyperreflexia. This review is aimed at putting sphincter implantation into context with respect to myelomeningocele-related incontinence.

Over the last 12 years over 350 patents have had artificial urinary sphincters implanted on our unit. In one third of these myelomeningocele was the indication.

Improvements in design of the AUS have improved results and in particular reliability. Consequently the incidence of mechanical failure has fallen but potential problems with infection and erosion have not been eliminated. Early erosion has been reduced by delayed activation of the device.

The artificial sphincter provides an effective means of achieving continence in myelomeningocele patients. Counseling should however be undertaken regarding the risks of infection/erosion and adjustment/replacement of the sphincter but in general a satisfactory outcome for both clinician and patient can be achieved in the medium term. The true long-term results of this form of management are still unknown because of its relatively recent inception.

Background

Prior to the development of the artificial urinary sphincter control of incontinence in myelomeningocele patients involved external devices such as a penile clamp or penile sheath (condom-type) drainage system in the male, or nappies/pads in the female, or in either sex an indwelling catheter. In part because of the unsatisfactory nature of these systems and in part because of the threat that the neuropathic bladder presented to the upper tracts and to renal function, many patients were offered and underwent urinary diversion.

1972 saw the first successful implantation of an artificial urinary sphincter [7]. Early protoyptes were beset by mechanical problems. Some 11 years later a review of the complications of one of these devices, the AS792 (Fig. 1) by Light and Scott revealed a 37 percent failure rate [3]. Of the 94 patients included in this review two thirds had myelomenigocele. Mechanical complications included: cuff leakage, leakage from balloon pump or tubing and control assembly failure. Surgical complications included: tube obstruction from kinking, inadequate pressure in the system requiring balloon volume adjustment, infection and erosion. Consequently design modifications have been made in later devices in an attempt to minimise these complications. The device which is currently most popular is the American Medical Systems AS800 (Fig. 2). The 3 components of the device are the occlusive cuff, the combined control mechanism and pump, and the pressure regulating balloon.

The silicone cuff is teflon coated and although adverse reports of tissue reaction and migration of both agents have been reported with respect to other forms of prosthetic surgery, as yet no major clinical problems have been reported because of the use of these materials.

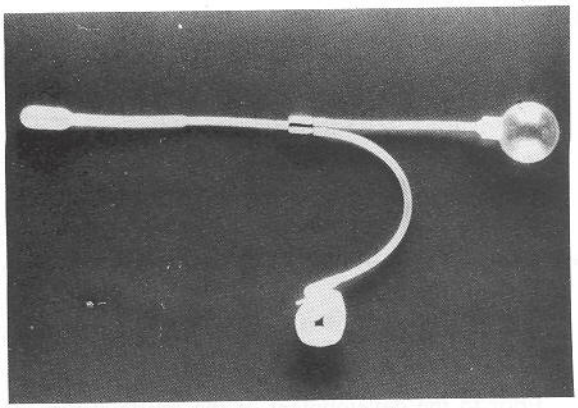

Figure 1. The American Medical Systems AS 792.

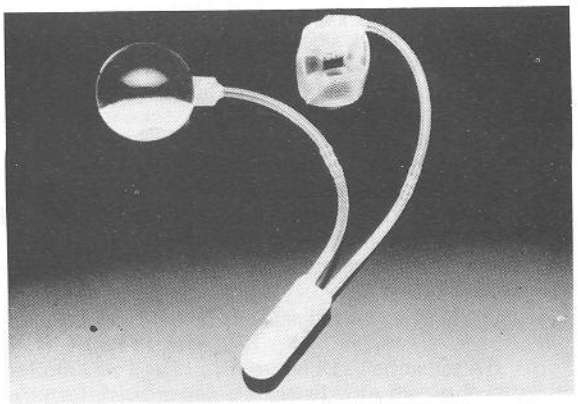

Figure 2. The American Medical Systems AS 800.

Indications

The behaviour of the lower urinary tract in MMC varies from patient to patient. Any type of abnormal bladder function may occur and co-exist with any type of sphincter malfunction. Normality of lower urinary tract function is rare but about 10 % have no symptoms from their bladders. The commonest situation in patients referred for urological appraisal is that there is a degree of sphincter weakness associated with a degree of detrusor hyperreflexia so the net result is incontinence.

Fortuitously in many cases the urethral incompetence acts as a safety valve preventing the generation of high intravesical pressures which could adversely affect upper tract function. Consequently an isolated procedure such as AUS implantation to increase outflow tract resistance may be detrimental to renal function if adequate pre-operative assessment is not undertaken.

Many patients present with incontinence secondary to hyperreflexic detrusor activity and only a minor degree of sphincter weakness which responds to manipulation of the detrusor alone without the need for sphincter implantation. There are also intermediate cases where anticholinergic drugs or a cystoplasty to pacify the detrusor, together with a bladder neck suspension procedure or the insertion of the sphincter cuff alone (without the pump or reservoir), will be adequate to produce continence. Isolated sphincter weakness with a docile bladder that does not actively contribute to the incontinence is much less common. These are the circumstances for which AUS implantation is most appropriate.

If a satisfactory outcome is to be obtained adequate patient selection is important. This not only includes the pre-operative urodynamic assessment which will be outlined below but involves appraisal of the patient's mental attitude and physical ability to work the artificial urinary sphincter and if necessary to become adept in the art of self catheterization. These considerations are particularly important in MMC patients as they frequently suffer a degree of associated hydrocephalus that adversely affects mental ability, concentration and mobility, and ability to gain easy access to the relevant parts of their anatomy for self catheterisation. A side issue in wheelchair bound individuals is selection of the site of cuff implantation: ideally a bladder neck cuff should be inserted; permanently sitting on a bulbar cuff in a male may predispose to erosion.

Pre-operative assessment

Physical examination helps select patients suitable for sphincter implantation. Severe degrees of physical deformity, particularly hip contractures, severe adduction deformities of the legs and severe degrees of kyphoscoliosis with abnormal "shortening" may render a patient unsuitable for this type of surgery.

Renal function should be assessed, ideally by measurement of the glomerular filtration rate and some form of upper tract imaging such as ultrasonography should be performed.

Video urodynamic studies are the mainstay of lower urinary tract assessment. In keeping with other neuropathic conditions patients with MMC may have chronic bacteriuria and antibiotic prophylaxis should be considered.

The urodynamic parameters on "slow fill" cystometry of particular importance are:

The presence or absence of residual urine
The presence or absence of bladder sensation
The degree, if any, of hyperreflexia
The compliance of the bladder
The functional, and overall bladder capacity
The appearance and shape of the bladder
The presence or absence of vesico-ureteric reflux
Video assessment of the bladder neck and distal sphincter

If an artificial sphincter is indicated a decision can then be made as to whether or not additional procedures such as augmentation, or substitution cystoplasty are required. For those cases undergoing undiversion a similar assessment of urethral function can be performed and "cycling" of the native bladder may improve pre-operative capacity.

Ablation of the native sphincter practised in other types of neuropathy is rarely necessary for MMC patients prior to sphincter implantation.

The procedure

The technique of implantation has been well described by other authors [2]. Some general principles to be born in mind are to avoid excessive handling of the device, to use vascular or rubber-shod forceps to avoid damaging the silicone and to avoid the entrance of blood or serum into the tubing to prevent valve blockage. Air must similarly be kept out of the system.

Site of implantation

In most patients with MMC a bladder neck approach is preferable and, so a low Pfannenstiel or Cherney incision can be used to gain access to the retropubic space. A balloon urethral catheter allows the palpation of the area of the bladder neck. In the male the endopelvic fascia is incised bilaterally and dissection can then be performed between the bladder neck (identified by the catheter) and the accessory sex structures identified by the vas deferens and seminal vesicles. Blunt dissection establishes the appropriate plane and ultimately sharp dissection completes the tunnel. In difficult cases and when there has been previous surgery, opening the bladder to facilitate dissection of a subtrigonal tunnel and the use of a "TUR steridrape"-covered finger to demarcate the rectal wall can be particularly helpful.

In the female peroperative vaginal examination using a "TUR steridrape" can be conducted to ensure dissection of the appropriate plane.

Once the plane has been established around the bladder neck a cuff sizer is introduced followed by the cuff itself. It is important to check the patency of the cuff by prior test inflation, but the cuff should be empty when implanted. The control pump is tunnelled into the scrotum or labium, and the balloon reservoir placed in the intra-abdominal extraperitoneal plane. The system should be filled with isotonic fluid. Ideally an appropriate diluted radio-opaque contrast to allow post-operative radiological evaluation. The device is left deactivated and, generally, a Foley urethral catheter is left in situ in the immediate post-operative period.

Follow-up

Activation is usually performed 6 weeks post-operatively.

Complications

Infection

This is a consequence of contamination at the time of implantation and therefore usually presents within 3 months. Rigid adherence to pre-operative and perioperative hygiene measures has reduced the incidence of sepsis. Pre-operative bowel preparation is routinely performed if an AUS is to be inserted at the time of an adjunctive cystoplasty procedure. Prophylactic intravenous antibiotics should be employed. The components of the device should be soaked in an iodine-based antiseptic solution or antibiotic solution immediately prior to implantation. In myelomeningocele patients in particular asymptomatic bacteriuria is prevalent and all such sepsis should be treated presumptively. Once established infection inevitably leads to erosion unless treated promply by removing the device in its entirety.

Erosion

This is usually a consequence of infection but may be the result of trauma or poor tissue perfusion. It, too, generally presents early after implantation. Once erosion has occurred infection becomes inevitable. Late activation and staged pressure increases have in part reduced this complication.

Late erosion [1] has recently been reported the cause of which is not clear. Once an erosion has occurred, removal of the whole device is required. Occasionally the fibrous reaction at the site of the cuff which remains after the cuff has been removed may be sufficient to maintain continence.

Mechanical failure

Primary malfunction is rare. Failure after months or years of satisfactory function is almost always due to perforation of the cuff where the inner inflatable layer tends to crease. Less commonly the connectors leak. When leakage occurs the fluid is lost from the system and can no longer be seen on x-ray.

Incontinence

It must be remembered that not every case of persistent incontinence is due to the urethral sphincter and an assessment of bladder or cystoplasty contractility should be undertaken urodynamically.

When to reimplant

If an AUS device has had to be removed, replacement with a new device can be undertaken immediately except in those cases where infection or erosion have occurred when a resolution period of at least 3 months is recommended.

Troubleshooting

Tube Kinking

This has largely been eradicated by the development of non-kink tubing. Attention to length at the time of operation is important as redundant tubing is of no benefit.

Pump migration

Although the pump is not sutured in position in the scrotum or labia, a strategically placed suture above the pump between the two emergent tubes or at the neck of the track from the iliac fossa incision will help prevent migration. Care must be taken not to puncture the tubing.

Activation difficulty

If insufficient fluid is left in the pump to allow activation, manipulation of the control mechanism to push the deactivation pin into the activated position can be performed, or the mechanism can be manually bent to allow further fluid to return to the pump so that enough force can be generated by the pump to achieve activation.

Leakage

The use of x-ray opaque contrast to fill the system will help determine if leakage has occurred but will rarely pinpoint its site. The use of the Quick-connect system had reduced the incidence of leakage from the connections. Manometry or radiological screening of the individual components after open operative disconnection of the tubing may occasionally be required to determine the site of perforation but it is almost always the cuff that is at fault. If components are to be removed and replaced, the use of diathermy as a cutting tool rather than a scalpel will prevent damage to the remaining components.

Incomplete continence

If radiological assessment of the AUS shows satisfactory function but the pressure provided by the cuff is inadequate to keep the patient sufficiently dry, then an increase in the pressure of the system by replacement of the pressure regulating balloon with one with a higher pressure or replacement of the cuff with a smaller one may be required.

Specific problems in myelomeningocele

The bowel

The mere establishment of urinary continence does not guarantee patients a pad free lifestyle. Many patients with MMC will have fecal incontinence although many will have established a relatively soil-free existence by controlled constipation. A recent addition to the surgical armamentarium in this regard has been the Antegrade Continent Enema, the ACE procedure. This can be performed simultaneously with sphincter implantation so that the chance of the patient achieving double continence can be improved. The procedure involves use of the appendix as a cutaneous conduit to allow enemata to be administered to the cecum and thereby permit antegrade colonic cleansing [6].

Certain enthusiasts of the AUS have even tried to establish fecal continence by using the device around the bowel. Extensive experience of this is not available but the consensus of opinion appears to be that such sphincters are not safe for use around intestinal segments and certainly that the current model of the AUS is unsuitable for the treatment of fecal incontinence [8].

Immobility

Wheelchair bound patients are at a disadvantage compared to walking patients with MMC when sphincter implantation is to be considered. Potential pressure necrosis can develop and predispose to erosion if a patient sits on any part of the AUS device whether it be the pump in the scrotum or labium or the cuff in the perineum. Also ability to manipulate the pump must be taken into account.

Overall success

Despite the problems alluded to in this review the AUS has an established role in treating sphincter weakness due to congenital neuropathy and with persistence continence may be achieved in 90 % of patients [4,5].

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