Section of Urology

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[*October* 28, 1943]

Paralysis of the Bladder

[*Abridged*]

PRESIDENT'S ADDRESS

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The Mechanism of Micturition

THE theory of sympathetic and parasympathetic antagonism fails to provide a satisfactory explanation of the peripheral mechanism of micturition. There is no separately innervated sphincter at the internal vesical orifice; the muscle here forms part of the detrusor musculature and is supplied by the parasympathetic nerves. Contraction of the longitudinal fibres of the detrusor pulls the bladder neck open mechanically whilst the circular fibres exert pressure on the contents. Interruption of the parasympathetic nerves causes paralysis of the whole bladder with relaxation at the internal orifice. The striated external sphincter and perineal muscles complete the continuity of the vesical and urethral musculature. The segmental origin of the parasympathetics (S. 2, 3, and possibly 4) to the detrusor, and of the somatic supply (S. 3 and 4) to the external sphincter make up the sacral "centre" for micturition. Cerebral control is inhibitory to the parasympathetic-detrusor mechanism, and its removal by transection of the cord allows the stretch reflex to act unhindered.

The trigone, innervated by the sympathetic, is not essential for normal micturition (Langworthy, Kolb and Lewis, 1940) and is concerned with the sexual function (Macalpine, 1934).

This account is based on a study of 30 cases of bladder paralysis seen in routine practice and 35 war injuries of the spine seen in the special centres and reported elsewhere (Riches, 1943*b*).

Methods of Study

The special urological methods used are cystoscopy, cystography and cystometry.

Cystoscopy shows alteration in size from atony, or hypertrophy at a later stage, fine trabeculation, and relaxation of the bladder neck giving a funnel-shaped deformity (Barrington, 1915; Burns, 1917). The funnel neck is an almost constant occurrence and was present in 23 out of 25 cases cystoscoped, the other 2 being females. Its degree usually depends on the amount of bladder distension, but it may become fixed and very wide in a contracted bladder. It can be simulated after endoscopic resection of the prostate, or in lateral lobe enlargement, and it can be produced temporarily by a spinal anæsthetic. It is the most important sign of bladder paralysis, but it must be looked for deliberately if it is not to be missed.

Cystography.—An atonic paralysed bladder is often bilocular; if the bladder has been allowed to become contracted there may be a ureteric reflux, but this is not seen in the atonic stage and is not the route of early ascending infection. Peri-ureteral lymphatics form the more probable route.

Cystometry is of some value as a record of the type of bladder under observation, and as a check on progress. A modification of the existing appliances has been described as the "Double Y" tidal irrigator and cystometer (Riches, 1943*a*) and is convenient for clinical use.

CLINICAL MATERIAL

Of the 30 cases studied 13 have had spina bifida occulta, 5 were tabetics, 2 had cord lesions, 6 cauda equina lesions, 2 had disseminated sclerosis and in only 2 where signs of bladder paralysis were present was it impossible to find a neurogenic cause.

A. *Spinal Fusion Defects*

Although the defect may only be a mild degree of spina bifida occulta the constant accompaniment of the typical cystoscopic picture leaves no doubt that the urinary symptoms are produced by it.

CASE I.—*Enuresis:* A boy of 14 with lifelong nocturnal enuresis of such degree that he he could not be kept at a public school. Cystoscopy under a general anæsthetic showed

FIG. 1 (*Case II*).—Sacral spina bifida occulta.

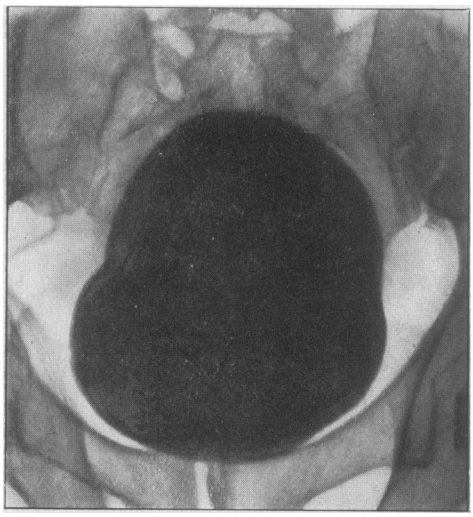

FIG. 2 (*Case II*).—Spina bifida occulta. Cystogram.

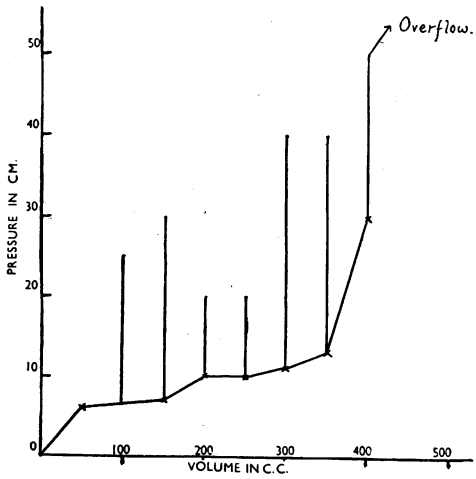

FIG. 3.—Cystometrogram of Case II. 5.12.42.

a clean bladder of 8 oz. capacity and a complete funnel-neck deformity visible at every degree of distension. X-ray showed failure of fusion of the first and second sacral laminæ. He was referred for examination prior to proposed psychological treatment; it is not likely that it would have helped him.

CASE II.—*Frequency:* A man of 29 complaining for one year of hourly frequency of micturition by day and little better by night. The urine was not infected and there were no abnormal signs in the central nervous system. Cystoscopy showed a clean trabeculated bladder with a capacity of 9 oz. and a complete funnel-neck deformity. There was radiological evidence of non-fusion of the laminæ of S. 1-4 (fig. 1); the upper urinary tract was normal, blood urea 23 mg. per 100 c.c. and Wassermann reaction negative. A cystogram (fig. 2) showed the domed bladder often found with nerve lesions, and cystometry an irritable bladder with many detrusor contractions emptying at a fill of 400 c.c. and a pressure of 50 to 60 cm. (fig. 3).

One can imagine similar contractions occurring during normal bladder filling, inadequate to empty it, but enough to produce frequent urination. This type of curve probably indicates an involvement of the anterior roots.

CASE III.—*Stress incontinence:* A sailor of 41 who was blown up on convoy duty two years earlier by bombs exploding in the sea on both the port and starboard side. He was knocked flat but not hit and continued to serve his gun for three hours. On going off watch he found his trousers wet through, and thought it might be from the sea but was disillusioned later when he found that he passed urine involuntarily on any sudden strain or fright. He was invalided from the Navy and now in civilian life finds that he is incontinent at any unexpected noise like a car back-firing. He gets up two or three times in the night to pass urine but does not wet the bed. If he goes out for any length of time he wears a bag. Examination of the nervous system was negative. The urine was not infected but after passing one pint he still had a residual of half a pint. Cystoscopy showed a clean bladder with fine trabeculation and a funnel-neck deformity. An X-ray revealed a defect of the sacral laminæ, ossification being poor in the first piece and decreasing progressively from the third to the fifth neural arch, with a wider canal than normal. Cystometry showed an atonic curve with few and feeble detrusor contractions. There was some sensation of distension at 500 c.c. and thereafter the pressure rose a little more steeply but only reached 20 cm. at a fill of 700 c.c. when he felt uncomfortable.

This is the type of curve obtained when the nerve involvement is mainly of the posterior roots.

CASE IV.—*Overflow incontinence*: A man of 59 who had been operated upon for spina bifida in infancy; there was a protrusion of skin over the sacrum. After a period of increasing frequency of micturition he became incontinent and this had persisted for the past year. He had no desire to pass urine, but tried every two hours and passed a fair stream with little difficulty. The bladder was distended, the prostate not enlarged, blood urea 33 mg. per 100 c.c. and Wassermann reaction negative in blood and C.S.F. He had over a pint of residual urine which was not infected, and cystoscopy showed a finely trabeculated bladder with a funnel-neck deformity. In this case there was a patulous anal sphincter and a relative anæsthesia over the third, fourth and fifth sacral segments; X-ray showed a deficiency of the sacral laminæ. He declined suprapubic cystotomy but consented to a further exploration of the sacral swelling. The scar was excised and a band of fibrous tissue extending into the spinal canal removed; this was reported as the remains of a meningocele. Two and a half years later the incontinence was unchanged and he continued to wear a rubber urinal. Irreversible changes had been produced in the affected nerves.

These four cases give some indication of the varying types of urinary symptoms encountered in spinal fusion defects and show the transition from frequent micturition and enuresis through stress incontinence to overflow incontinence. Loss of control is commoner than acute retention although this may occur; the type of disturbance appears to depend not only on the degree of nerve injury and the relative involvement of anterior and posterior nerve roots but also on the age of the patient; in the earlier stages the phenomena are those of nerve irritation, but as growth proceeds and the nerves are further stretched or pressed upon paralytic effects supervene. Some cases have no symptoms and are only discovered on the occurrence of infection or quite by chance as in the treatment of a papilloma of the bladder. These are likely candidates for the delayed onset of symptoms after some additional strain or shock such as was seen in Case III.

Treatment.—The surgical principle of treating the cause should be followed, and more of these cases should be submitted to an exploratory operation at the site of the spinal defect at an early stage. The nerve involvement is sometimes due to pressure of a lipoma or traction by fibrous tissue and is capable of relief; even if a cure cannot be promised in all cases there is some hope of preventing the progressive damage which is otherwise likely. Successful results have been reported by Mertz and Smith (1930); Ingraham and Swan (1943) explored 26 cases in children; the commonest finding was a lipoma, either extra- or intra-dural or both, and good results were claimed in 13, or 50%. Where the main involvement is of motor fibres ephedrine or belladonna may help to check the frequency; where sensory fibres are chiefly affected drugs of the acetylcholine type should be tried. For incontinent cases gracilis muscle transplants have been advocated; for the rare cases with retention a high suprapubic catheterization is probably the best solution

and urethral catheterization should be avoided as it is the surest means of producing urinary infection.

B. *Tabes*

In tabes there is no interference with the motor side of the reflex arc, but the gradual sensory loss leads eventually to chronic overdistension with permanent loss of tone of the detrusor so that its contractions are not sufficiently strong to empty the bladder. Residual urine collects and if it becomes infected the consequences may be most serious. Tabetics are often in the prostatic age-group when first seen, but the differential diagnosis is usually obvious on cystoscopy; the two conditions may co-exist.

CASE V.—A man of 71, a tabetic, was admitted for retention with overflow; for years he had complained of difficulty of micturition, and he passed urine four or five times at night. The bladder was drained by a urethral catheter and this led to urinary infection which was not formerly present. Cystoscopy showed a large trabeculated bladder with a false diverticulum at the fundus and a funnel-neck deformity; both lateral lobes of the prostate were enlarged into the urethra. A cystogram confirmed the irregularities and showed the funnel neck. Cystometry showed an atonic bladder with no feeling of distension until its content was 700 c.c. when the pressure was still only 10 cm. On further filling there were some poorly sustained detrusor contractions, and the pressure rose to 35 cm. at 1,000 c.c. fill. There was no return of bladder function after seven weeks' treatment by catheter, and in view of the cystometric evidence of some motor activity I decided to resect the lateral prostatic lobes. He passed urine when the catheter was removed and after a month another curve was done which showed a voiding pressure at a fill of only 400 c.c. Residual urine after six weeks was only 1 oz. and eighteen months later it remained the same. He was then quite symptom-free and did not have to get up at night at all. The bladder picture was unchanged save for the absence of the lateral lobes, but its capacity was still 18 oz.

Other such cases have been reported by Emmett and Beare (1941). It is when retention develops that the treatment of the tabetic bladder becomes difficult. In the earlier stages catheterization and infection may be postponed by the use of acetylcholine derivatives.

C. *Paralysis after a Spinal Anæsthetic*

In these unfortunate cases the usual immediate sequel is retention of urine with an atonic bladder as in cauda equina lesions but later incontinence may develop if the bladder is allowed to become contracted.

CASE VI.—A man of 67 whose prostate had been resected under stovaine spinal anæsthesia one year before I saw him; he now had constant incontinence. There was anæsthesia over the second, third and fourth sacral cutaneous segments and absent anal and bulbo-cavernosus reflexes. The bladder held only 3½ oz. of infected urine and had a funnel neck; its capacity was increased by weekly lavage and distension to 9 oz. Cystography then showed a ragged outline, a wide funnel neck and a reflux up a distended left ureter. Cystometry was difficult owing to the contracted musculature but gave a steeply ascending curve with no power of adaptation and no detrusor contractions. He refused suprapubic cystotomy and was still incontinent two years after the spinal anæsthetic.

This hypertrophy of the detrusor is seen at a late stage after parasympathetic lesions and has been produced in experimental animals by Langworthy and his associates after section of preganglionic parasympathetic fibres in the sacral roots. Whatever the disadvantages of a paralysed atonic bladder they are small compared with those of a contracted one which leaks constantly. The best treatment of these unfortunate cases is probably early high suprapubic catheterization which prevents this complication and does not interfere with any recovery which may ultimately take place.

D. *Cauda Equina and Conus Lesions*

Periodic reflex micturition will follow lesions of the cauda equina and I have seen it after a proved lesion of the conus, but it takes longer to develop than does the automatic bladder of a cord lesion. The problem in treatment is to prevent either over-distension in the early stages or contraction later on, whilst guarding against ascending infection. I will mention two cases in only one of which has this problem been successfully dealt with.

CASE VII.—*Conus lesion:* A girl of 20 who was thrown out of a car and sustained a fracture dislocation of the first lumbar vertebra with paraplegia. Retention with overflow developed and suprapubic catheterization was done under local anæsthesia nearly forty-eight hours after the accident. After decompression for two days tidal drainage was instituted via the suprapubic catheter and was continued for five months. The neurological signs were those of a lesion of the conus and epiconus. Cystometry two weeks after the injury showed an atonic bladder with no detrusor contractions; the curve after

twenty weeks is also shown when there were moderate detrusor contractions but no reflex micturition (fig. 4). A cystogram at this time showed that the bladder was still somewhat atonic, but distension was felt at 300 c.c., the outline was regular and there was no ureteric reflux. Cystoscopy showed a clean mucous membrane with some trabeculation, and after the cystoscope was withdrawn she was able to pass through the urethra fluid introduced by the catheter. It is now nearly six months since the injury; there has been a mild bladder infection since the third week but she has been afebrile throughout and has had no suggestion of renal infection. Excretion urography shows an apparently normal urinary tract. Her general state has been good throughout in great contrast with the frequent toxæmic course followed by such cases. The only urethral instrumentation was the cystoscopy five months after the injury.

CASE VIII.—*Fibrous stricture of cauda equina:* A man of 39 who had suffered from a sudden urinary incontinence five years previously. He had been treated at various hospitals by dilatation and lavage during the intervening period until in 1939 he had pain in his back which came on two weeks afer a fall. His back was manipulated twice without relief and nine months later the fifth lumbar spine was excised. Following this operation he had retention of urine and incontinence of fæces. I saw him nine days later when he had been catheterized intermittently. Cystoscopy showed an infected bladder holding 21 oz. with a funnel-neck deformity. There was anæsthesia over the sacral area and a patulous anal sphincter. Neurological opinion confirmed a lesion of the lower roots of the cauda equina. Automatic tidal drainage was started but failed to control the urinary infection. He was sent to a neurosurgical centre where after thorough investi-

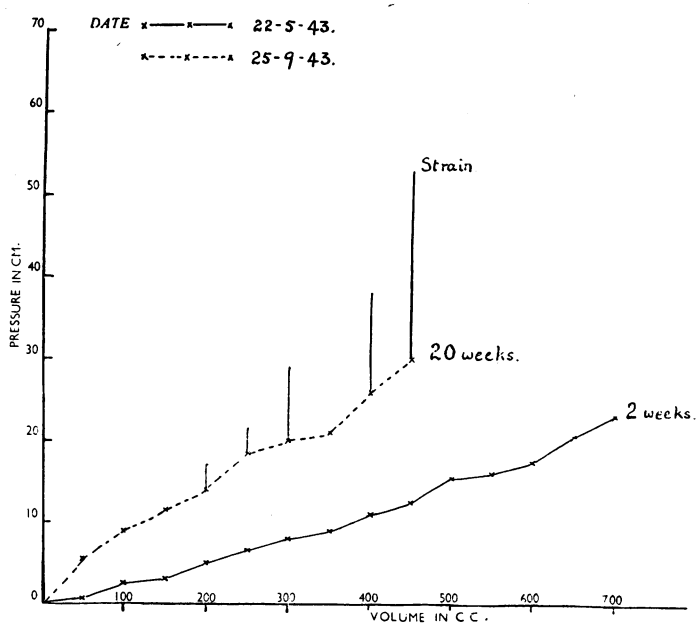

FIG. 4 (*Case VII*).—Conus lesion. Cystometrograms two weeks and twenty weeks after injury, showing the improvement in tone and return of detrusor contractions after suprapubic catheterization and tidal drainage.

gation laminectomy was performed; an extremely dense fibrous structure was found adherent to the dura and compressing the nerves of the cauda equina, and it proved impossible to separate the constrictive ring from the nerve roots. Three months later a suprapubic cystotomy was done; it was very low, the tube emerging immediately above the symphysis; it leaked, and he passed urine incontinently from the urethra. He put up with this for two years but was unable to work on account of it, and early this year I agreed to close the fistula. The bladder had now contracted down to about 2 oz. capacity (fig. 5) and showed gross cystitis, a funnel neck, and a reflux up the right ureter. The fistula was closed after two months and the bladder capacity was then increased by tidal irrigation and intermittent distension until it was 4 oz., at which point it remains ten months later. He wears an incontinence bag, but can pass a good stream by straining, leaving an ounce of residual urine. He is working and is glad that the fistula was closed. I believe that if the cystotomy had been early and high instead of late and low he would have developed a useful automatic bladder.

The periodic reflex micturition of a cauda equina lesion is subject to some control as there is a warning of distension and detrusor contractions can then be initiated by abdominal straining. In a man the resistance of the tissues around the membranous

and bulbous urethra prevents a leak unless overdistension is allowed to occur; in a woman there is more likely to be some leakage and a permanent suprapubic catheter is often of better service.

E. *Cord Lesions*

After complete supralumbar lesions periodic reflex micturition is quite automatic and uncontrollable and as the tendency towards a contracted bladder appears to be greater in these cases they are usually best served by permanent cystotomy.

CASE IX.—*Carcinoma of bronchus with spinal secondaries:* A man of 61, admitted to hospital for pneumonia; after seven weeks he complained of numbness below the umbilicus and inability to micturate properly. Catheterization gave a residual of 14 oz. and was continued thrice daily for eight days when it was replaced by an indwelling catheter to which tidal irrigation was subsequently added. He had absolute paralysis below the tenth dorsal segment; the urine was mildly infected. I saw him after a month when the bladder showed a funnel-neck deformity with a capacity of 24 oz. At a little more distension he passed a forcible stream reflexly. I did a high suprapubic catheterization and thereafter he was much more comfortable and was able to sleep through the night for the first time. Cystometry showed the hypertonic type of curve associated with cord lesions, overflow occurring at 300 c.c. fill and a pressure of 50 cm. He returned to his former hospital and died eight weeks later; autopsy showed a bronchial carcinoma with secondaries in the spine. The kidneys were free from infection and the bladder clean. The suprapubic catheter had worked perfectly throughout.

FIG. 5 (*Case VIII*).—Cauda equina lesion with low suprapubic cystotomy. Cystogram. Contracted bladder with funnel neck and ureteric reflux.

CASE X.—*Complete transverse lesion of the dorsal cord:* A soldier of 23 wounded in action in North Africa in March 1943; he received a shrapnel wound in the spine resulting in complete paraplegia below the sixth dorsal segment. He had retention of urine and was catheterized once and urine was expressed manually once. Within twenty-four hours of the injury suprapubic cystotomy was performed in a mobile neurosurgical unit; the opening was made low, immediately above the symphysis. He was evacuated by air and reached a base hospital six days after being wounded. He was pyrexial for some weeks owing to urinary infection but after a month was well enough to undergo laminectomy; a metal splinter was removed which had transected the cord at the sixth dorsal segmental level, leaving possibly a few normal fibres only. He developed a streptococcal septicæmia and multiple abscesses requiring drainage, but he was so well cared for that he survived and was evacuated to England five months after his injury. He has a very low suprapubic cystotomy which leaks sometimes (fig. 6); the bladder is contracted, holding less than 2 oz. and there is a reflux up the right ureter (fig. 7). There is a wide funnel-neck deformity with hypertrophy of the bladder mucosa; the urine is alkaline and contains gross pus; when the bladder is washed out from above the lotion comes through the urethra almost at once, and he passes urine incontinently by this route as well as by the suprapubic tube so that he must keep a bottle in the bed.

This deplorable state is due to the extreme contraction of the bladder following a very low suprapubic opening, and the condition appears beyond remedy after this lapse of time. It suggests also that the position of the opening is of even more importance than the time at which it is made.

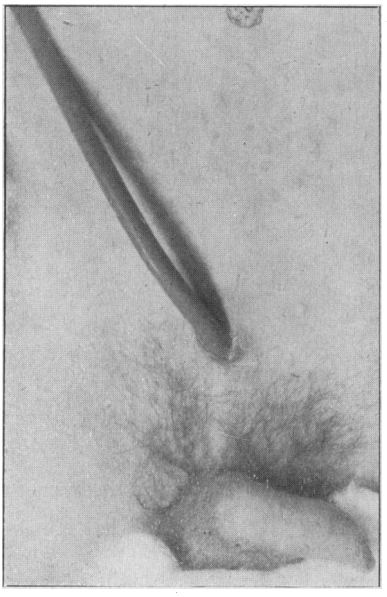

FIG. 6 (*Case X*).—Wound of dorsal cord. Low suprapubic cystotomy.

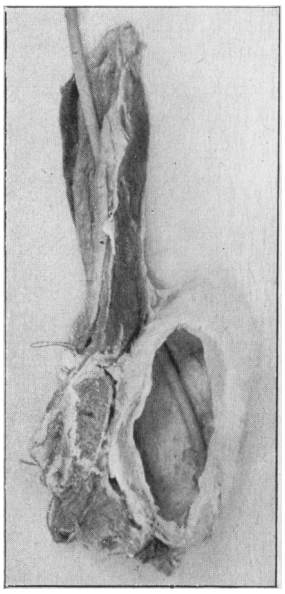

FIG. 8.—From a case of carcinoma of bronchus with spinal secondaries. Specimen sixteen days after suprapubic catheterization.

FIG. 7 (*Case X*).—Wound of dorsal cord. Cystogram. Contracted bladder (50 c.c.) with wide funnel neck and ureteric reflux. Low suprapubic cystotomy.

These cases are but a few I have chosen to illustrate how far we are from perfection in our knowledge and treatment of the paralysed bladder. We are almost unanimous in this country in condemning the urethral catheter but it is dying a lingering death, like the unfortunate patient for whom it is used. Early suprapubic cystotomy is a better

alternative at least in theory, but in practice it leads too often to a low fistula which leaks and allows the bladder to contract. This is usually due to an incision immediately above the symphysis, but even if the tube is brought out at the top of the incision the wound may give way, especially in a paralysed abdominal wall, and the final result is the same; I prefer a short transverse incision half-way up to the umbilicus. It is because of these results that I have suggested the method of suprapubic catheterization which I have described elsewhere (1943*a*). The high point of entry appears to prevent the extreme degree of bladder contraction seen in some of these cases, and the technique is simple.

(The operation was shown in a film.)

Tidal drainage is not an essential part of the treatment and it may be a danger unless everyone, down to the most junior probationer, understands what it is for. I think its main value may prove to be in the maintenance of an adequate capacity in the hypertonic bladder of high spinal lesions; overdistension is a greater danger in cauda equina lesions, but of the two evils overcontraction is the worse in its effect on the ultimate well-being of the patient. Ascending infection leading to pyelonephritis is the worst evil of all as it will kill him or make him a chronic invalid from urinary sepsis.

There is no danger of injuring the peritoneum if the bladder is distended and the catheter inserted obliquely. The specimen illustrated in fig. 8, p. 7, shows the track taken by the catheter. This patient died from carcinoma of the bronchus with spinal secondaries sixteen days after suprapubic catheterization for paralytic retention; the bladder is neither contracted nor overdistended and it is clean. The peritoneal reflexion is an inch away from the track and was a good deal more when the catheter was put into the distended bladder. The length and obliquity of the track and its small size prevent leakage and make it the best substitute for the natural urethra which is, at least temporarily, out of action. The operation is easy and rapid; it should not be done until the bladder is distended but it does not require the perfect surgical surroundings needed for an open operation or for urethral catheterization. Incidentally it is the best way of decompressing the bladder in cases of long-standing chronic retention from prostatic obstruction.

In conclusion, although there are still many gaps in our knowledge of the paralysed bladder we should be quite clear on the aims of our treatment. They are not only to prevent serious infection but to leave the patient continent, with a bladder which will hold an adequate quantity of urine whether it is passed voluntarily or automatically or through a suprapubic tube.

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