THE MANAGEMENT OF THE NEUROGENIC BLADDER

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Patients with non-traumatic cord lesions are, with minor exceptions, similar to those suffering from spinal cord injury. Bors[1] covered the entire field of the neurogenic bladder and included both traumatic and non-traumatic patients. I would agree with this view that the practical urological management of such cases is essentially similar, and that both groups of patients with spinal cord lesions, traumatic or non-traumatic, require the same specialist care from every angle, whether it be neurological, orthopaedic, urological, or in the immense field of rehabilitation. The importance of rehabilitation can never be overstressed because, from the beginning, a patient with a spinal cord lesion (whether it be traumatic, as in a fracture of the spine, or non-traumatic, as in transverse myelitis) must be made to realize that this major catastrophe is not the end of everything, but may be the beginning of a new life with quite remarkable prospects. Apart altogether from the respective roles of physician and surgeon, nursing staff, etc., the daily attentions or encouragement of the physiotherapist, the occupational therapist, and the rehabilitation officer, are of profound importance. The problem is all the more stimulating in the younger groups of patients where re-education and re-adaptation of physical properties may indeed open up a new way of life for the paraplegic — and this particularly applies to those who suffer from congenital anomalies, such as myelomeningocele, or traumatic lesions of the spinal cord in youth or young adult life. In the elderly, both traumatic and non-traumatic lesions offer much graver problems in rehabilitation, and almost everything will depend on the intelligence of the individual patient and his cooperation in the programme of rehabilitation and re-education in the paraplegic state. Accordingly, I agree with Damanski and Gibbon[2] that patients cannot derive full benefit from treatment in special spinal centres unless delay in admission is reduced to a minimum and a regular follow-up is carefully carried out in the centres themselves.

In recent years it has been possible for us in Edinburgh to study the benefits of treatment in a special spinal injuries unit, where the services of a neurologist, neurological surgeon, urologist and orthopaedic surgeon are combined with all the various ancillary services. Patients admitted to this unit have stated quite categorically that they have appreciated that all the energies of the staff in its various branches have been directed towards their recovery. In fact, they have realized that a programme towards rehabilitation has been drawn up for them from the moment of their admission. The patients have a full and busy day when every effort is directed towards an optimum degree of recovery and the prospect of rehabilitation. In this programme of day-to-day care, conservatism must be the key-note. It is agreed that urological care is of paramount importance, because the life-span of this type of patient is directly proportional to the renal involvement. All urological therapy must be aimed at the preservation of renal function. Nevertheless, the prevention of pressure sores, and when they occur, their treatment, will entail the services of a plastic surgeon.

The early mobilization of the patient is of primary importance, and to achieve that there must be the willing cooperation of the orthopaedic surgeon. Over the years, the presence or absence of spinal manometric block has been the basic criterion as to whether laminectomy may or may not be required. It is generally believed that, in the absence of block, neural structures are not being continuously and seriously compressed; that a maximum destruction has already occurred, and that nothing is to be gained by laminectomy. Even with the presence of manometric block, decompression intervention has not necessarily led to neurological improvement. When there is a progressive deterioration in the neurological state, laminectomy may be of value. With improvement in neurological recovery, laminectomy would appear to be contra-indicated. Delayed laminectomy after many months is valueless.

CLASSIFICATION

Classification depends essentially on the site of the lesion, i.e. whether it is in the spinal cord above the conus medullaris, or whether the lesion is at or below the conus medullaris, affecting this structure and the cauda equina. If the lesion is above the conus medullaris the autonomic innervation of the bladder through the pelvic nerves and the internal pudendal (somatic) nerve remains intact, the stretch reflex of the bladder is maintained, and an automatic or spinal reflex bladder function should be achieved. This is sometimes called the upper motor neurone bladder. If, however, the conus and the cauda equina are damaged, there is no autonomic or somatic innervation of the bladder, and the bladder musculature is deprived of reflex spinal activity. The bladder becomes autonomous and functions as a lower motor neurone bladder. In a third group there may be a mixed motor neurone bladder when reflex activity is present *via* the pudendal innervation, but absent *via* the pelvic innervation or *vice versa*.

Management of the bladder in paraplegia must always be directed towards the achievement of a balanced bladder function, and this is concerned with the residual-capacity relationship. Fortunately, the upper motor neurone neurogenic bladder is nearly always balanced in that the residual urine, after voiding, is negligible. In the strictly autonomous

bladder of the lower motor neurone type, the residual urine after straining is apt to be high, and with a high-filling intravesical pressure residual urine of over 10% capacity renders such bladders in imbalance. When the cauda equina is grossly involved and the bladder is atonic and the intravesical filling pressure low, a residual urine of over 20% may be permissible, after voiding by Credé or straining methods. In the initial phase of paraplegia urological management must be directed towards the stabilization of the neurogenic bladder in one of these 3 categories: (*a*) the spinal reflex automatic bladder, (*b*) the autonomous bladder, or (*c*) the mixed upper and lower motor neurone lesion, provided that the neurogenic bladder remains in balance with an appropriately low residual urine.

For over a century, the term 'spinal shock' has been used to describe the loss of segmental reflex cord activity below the level of injury, and many workers have reported that during this stage the urinary bladder is in an atonic state.[3-7] However, the experimental work of Kolb[8] indicated that section of the spinal cord or of the sacral nerve roots did not produce an immediate stretching of the bladder detrusor muscle, and from the pharmacological and clinical studies of Nesbit and Lapides[9] it seems doubtful whether flaccidity or atonicity of the bladder in the stage of spinal shock can be directly attributed to its dissociation from extrinsic nerves or spinal reflexes. It is probable that bladder atony under these circumstances is more frequently the direct result of over-distension of the denervated viscus immediately after cord injury.

Denny-Brown and Robertson[10] obtained evidence that in the human subject the opening and closing of the internal sphincter were related to the ascent and decline of waves of vesical detrusor contraction; they noted that strong, passive pressure on the lower abdomen did not secure wide opening of the sphincter or produce an adequate urinary stream unless the rise in bladder pressure was sustained by detrusor contraction after the manual compression had been released. It thus follows that in the stage of spinal shock manual compression of the bladder could not be expected to produce adequate emptying of the organ, even if it be admitted that the complete loss of intrinsic bladder tonus is due to over-distension rather than to sudden denervation of the viscus. It is reasonably certain that manual expression of the bladder is not effective in most cases of spinal shock,[5] and this method is too hazardous and uncertain to be advised for general use.[7]

This was particularly brought to our notice when a 39-year-old man, who had sustained a wedge compression fracture of the 12th dorsal vertebra, suffered from flaccid paraplegia with complete sensory loss below the D10 dermatomes. He had urinary retention, but with manual expression of the bladder carried out every two hours a good urinary stream was obtained, and variable quantities of up to 300 ml. were expressed on each occasion. Nevertheless, an X-ray of the renal tract taken immediately after manual expression of the bladder during ascending cystography showed a gross residual urine in the bladder with bilateral ureteric reflux. The cystometrogram at this stage showed that bladder filling produced a definite detrusor response which was tonic, and the hazards of manual expression of the bladder in the initial phase of traumatic paraplegia were thus clearly demonstrated. Similarly, from a limited experience of suprapubic cystostomy in such cases, we have found that extensive structural changes developed in the urinary tract at an early stage, and these were contracture of the bladder without complete emptying, uretero-vesical reflux, and hydro-ureter.

For these reasons, it was considered that the simplest and most generally applicable method of avoiding over-distension of the bladder through the initial phase of traumatic paraplegia, is by urethral catheter drainage.

URETHRAL CATHETERIZATION IN THE INITIAL PHASE OF MANAGEMENT

We consider that the catheter designed by Gibbon[11] in 1958 is the nearest approach to the ideal instrument currently available, and we have used this catheter in the initial stages wherever possible. It provides for a closed, continuous and aseptic urinary drainage and can be used without interference with forced diuresis, acidification of the urine, a full diet, correction of anaemia, two-hourly turning, and physiotherapy. Until a year ago, the Gibbon catheter with closed drainage was changed at weekly intervals. Collecting bottles were autoclaved and were individual to the patient. During the changing of bottles, every effort was made to avoid the ascent of bubbles within the lumen of the catheter to the bladder. The recent work of Slade and Linton[12] has drawn our attention to the importance of ascending infection from the urethra, male or female, to the bladder during the passage of the catheter, or to air bubble ascending infection through the lumen of the catheter, and to ascending infection along the outer wall of the catheter from organisms lying within the urethra and its crypts. We have for long used a phenoxytol antiseptic in the lubricating jelly before the passage of a catheter. Slade and Linton[12] have suggested that 'hibitane' should be incorporated in the lubricating base and injected into the urethra, male or female, before the passage of the catheter. Before the withdrawal of any catheter when it is to be changed, they have suggested that hibitane solution should be instilled into the bladder through the catheter. In obstetrical and gynaecological practice such techniques have produced remarkable results in the control of urinary tract infection. In the past several months in treating paraplegic patients in Edinburgh, the Gibbon catheter has been changed daily.

The technique employed is as follows:

A. Procedure used for New Patients or those with Sterile Urine on Admission, and carried out each 24 hours

1. Withdraw previous catheter if one in place.
2. Clean (merthiolate solution) and towel external genitalia.
3. Spray external meatus with polybactrin.
4. Pass a simple Jacques catheter, only as far as the external sphincter.
5. Inject along this catheter 2 or 3 ml. of an aqueous solution of bacitracin, 1%; neomycin, 1%; polymyxin, 0·4%. Soframycin, 1%, can be substituted for bacitracin or neomycin.
6. Withdraw the Jacques catheter.
7. Leave for 1 hour.
8. Spray external meatus with polybactrin, and then insert new Foley or Gibbon catheter into the bladder on continuous closed drainage.

Comments

1. The solution used is bactericidal in 1% of the concentration that affects white-cell activity.

2. The level of concentration of hibitane that is bactericidal is very close to the level of concentration that inhibits white-cell activity.

3. Gels are inferior to solutions, since they tend to remain in the urethra and retain debris.

4. In the last 3 months 3 cases have been managed in this way and have remained with sterile urine, except for a few colonies of staphylococci and yeasts, which have been easily eradicated.

5. There are about 30 new admissions *per annum*, but of these only about 10 or 12 will have sterile urine, since the remainder were infected during their initial management elsewhere.

B. Procedure used for Patients with Infected Urine on Admission

The procedure outlined under *A* is of value solely as a prophylaxis and has little place in the management of the patient with established urinary infection. In these cases the usual catheter regime has been used.

The local antibiotic, soframycin (1%), is of value as a solution for bladder washouts for *P. pyocyaneus*, but tends to allow *B. proteus* to grow.

It remains to be seen on balance whether this daily changing of the Gibbon catheter technique with urethral instillation of an antibiotic is worth the labour and the expense, but the fact that our attention has been drawn to the potential danger of organisms lying within the urethra being attracted up to the bladder along the outer wall of the catheter is of the greatest importance, and will ensure that in the future catheterization of any patient, male or female, will be carried out by a proved technique, and with instruments and materials from a specially prepared and autoclaved catheter packet.

The duration of the period of catheter drainage is not prescribed and fixed, but is a matter for careful consideration in the individual patient. When there is early evidence of neurological recovery, the catheter is clipped and the bladder allowed to fill slowly. If it is then obvious that bladder sensation has returned, the catheter can be removed for a trial period of 2 hours. Recently, we have been following the advice of Comarr,[13] and have used the ice-water test, when, in anticipation of neurological recovery and the return of reflex bladder activity, 2 - 3 oz. of ice-cold saline solution are introduced through the catheter into the bladder. If the solution is immediately ejected, the test is positive. Alternatively, if the catheter is withdrawn, and the ice-water solution is ejected within half a minute, the test is again considered a positive indication of a return of reflex bladder activity. From now onwards tests must be made as to the efficiency of reflex bladder activity, and trial periods of about 2 hours must be instituted after the withdrawal of the catheter. Should there be a bizarre sensation of filling of the bladder after removal of the catheter, a comparison of the volumes of urine voided spontaneously, or after an injection of moryl, will decide whether the bladder is compensated and in balance when the catheter is replaced and the residuum measured. The first trial with the catheter is usually postponed until the orthopaedic condition is sufficiently stable for patients to be nursed in an ordinary bed, and are thus able to exert a greater voiding force by abdominal straining. It is unsafe to discard the catheter suddenly, but continued trials may be made from day to day until, after a 24-hour trial period with or without injections of moryl, the residuum in the bladder has become less than 10% of the bladder capacity.

In the management of urinary infection, as has been indicated above, prevention of infection has been directed towards a strict catheter technique, and more particularly towards the sterilization of the urethra by the instillation of antiseptics or antibiotics in the lubricating solutions. If, however, established urinary infection occurs, appropriate antibiotic and chemotherapeutic agents are prescribed in full dosage. If the narrow Gibbon catheter becomes blocked by debris in the presence of active infection, freer drainage can be obtained by replacing the Gibbon catheter by a 14 or 16 gauge Foley catheter. It is important, however, to restrict the amount of fluid in the retaining bag to 5 ml. Foley bag catheters have a tendency to encrustation round the bag, and when the bag is emptied a film of phosphatic encrustation may remain within the bladder and form the nucleus of a calculus. Accordingly, with the wider calibre of the Foley catheter debris and collections of mucus within the bladder can be removed by intermittent irrigation with sterile normal saline or weak aqueous solutions of sodium bicarbonate. After litholapaxy, twice daily irrigations with 1% aqueous solutions of acetic acid may be employed.

Tidal irrigation of the bladder has been abolished, but irrigation of the bladder through a two-channel Foley catheter may still be of value when there is phosphatic encrustation. The irrigating agent has been renacidin.

Bladder training. When the indwelling urethral catheter has been removed because of the early recovery of bladder function, each patient must already have been instructed to concentrate on any vague sensation, however bizarre, which might have accompanied the filling of the bladder to a physiological degree when the catheter has been clipped. The individual patient must now learn to regularize any reflex bladder activity by controlling his fluid intake so that with a given rate of urinary excretion at a certain stage of filling the normal stretch stimulus to the bladder detrusor muscle will occur. The individual patient, therefore, must keep account of the amount of fluid ingested, and by the clock anticipate when, the bladder having filled, a normal stretch stimulus will become apparent to him. These sensations of fulness of the bladder may be localized to the abdomen and are presumably transmitted through afferent sympathetic fibres reaching the level of cord above the level of section as described by Nathan[14] in 1956. Otherwise, sensation may be due to associated autonomic activity with a feeling of uneasiness, flushing and sweating, and sometimes headache. In the majority of fully cooperative patients during the development of micturition by the clock, bladder control is most satisfactory when the associated bizarre sensation of fulness of the bladder is anticipated or ignored and when by their training routine of a balanced fluid intake and regular micturition habit they become educated to locate and to use trigger spots to initiate reflex voiding. It is more difficult to initiate reflex voiding after atypical sensations of fulness are experienced. Such reflex micturition may be anticipated, by the clock, by straining or by suprapubic percussion. Reflex voiding initiated by abdominal straining is most satisfactory if abdominal straining is discontinued imme-

diately after reflex voiding has been begun. Otherwise, if straining is continued, the urinary stream may become intermittent.

General tests. Day-to-day neurological assessment is absolutely essential in paraplegic patients, and from time to time, apart from the assessment of sensory and motor loss, various reflexes such as the bulbo-cavernosus or the anal reflex should be observed. The ice-water test has also been mentioned. From the orthopaedic point of view stabilization may be expected some 6 weeks or so after the injury.

Excretory urography. At the stage of stabilization of the skeletal system a scout intravenous pyelogram should be made, and this may be repeated at yearly intervals to check the anatomical and functional condition of the kidney.

Cysto-urethrography. Similarly, when the catheter has been withdrawn the cysto-urethrogram will serve to demonstrate vesico-ureteral reflux. This examination, again, should be repeated annually, particularly when renal pain accompanying voiding, renal tenderness, or recurring chills suggest that vesico-ureteral reflux has occurred.

Cystometry in the early management of paraplegia. We have always regarded cystometry as an important guide to:

1. Classification of the type of neurogenic bladder, e.g. (*a*) spinal reflex or automatic, (*b*) autonomous with a high intravesical pressure and residual urine, or (*c*) atonic with a low intravesical pressure and a high residual urine.
2. As a means of assessing the progress of an atonic or autonomous neurogenic bladder with residual urine to an automatic or spinal reflex bladder with residual urine reduced to a minimum.

During cystometry a note is made of the intravesical pressure during the filling stage, the time of onset of a feeling of fulness, however bizarre, and the time of onset of reflex bladder contraction. The end-point in recovery is to restore the reflex bladder contraction which is compensated and leads to voiding with minimal residual urine. A hypotonic decompensated recovery phase bladder indicates the need for a return to the indwelling urethral catheter until reflex bladder contractions on filling are restored. Sometimes many months may elapse before the hypotonic bladder has progressed to a compensated reflex bladder function, again fully demonstrated by the cystometrogram.

Urethroscopy and cystoscopy. These are routine examinations to be made at regular intervals following or accompanying urethro-cystography. In other words, evidence of contracture of the bladder neck or spasm of the external sphincteric mechanism as demonstrated by cystography requires confirmation by endoscopic examination. The radiological demonstration of calculi in the bladder would indicate the need for endoscopic assessment of any obstruction at the vesical outlet and naturally be followed up by lithotrity, and possibly by a transurethral resection.

Ascending urethrography. This is a useful adjunct to cystometry because, by estimating the voiding intravesical pressure and balancing that against the resistance of the external sphincteric mechanism, an indication may be obtained as to whether treatment may be directed towards the bladder neck or the striated sphincter. The shelf of the contracted bladder neck is readily demonstrated in the oblique view of the cystogram and, if the contracture of the bladder neck is confirmed by cystoscopy, a small transurethral resection may restore bladder balance. Similarly, spasm of the external sphincteric mechanism as demonstrated by ascending urethrography may be abolished by pudendal nerve block. Sometimes a simple pudendal nerve block by 1% lignocaine or novocaine may be all that is required to restore balance, but a temporary improvement after pudendal nerve block would suggest that, for a more permanent effect, pudendal crush is indicated.[15]

COMPLICATIONS

Urological complications. It must be stressed that every effort has been made to make each patient catheter-free, and that a spontaneous and balanced vesical function has been achieved. Eighteen out of 23 of our patients who received their main urological management in the spinal injuries unit were catheter-free and had passed their 4th year of follow-up. These patients have been able to avoid the use of a portable urinal during the day. They had no dribbling or soiling of clothing, because they anticipated micturition by the clock and initiated spontaneous voiding by pressure or stimulus of the lower abdomen. The portable urinal, however, may be used for social occasions, but its over-use encourages balanitis and peno-scrotal sores. At night a glass or plastic urinal bottle is used, in preference to the rubber bag.

Peri-urethral abscess. Should a Foley catheter be employed for urethral drainage it must be strapped to the lower abdominal wall so that the curvature of the urethra is preserved and angling and pressure to the peno-scrotal junction avoided. The peno-scrotal lesion leading to abrasion of the urethra by the catheter, peri-urethritis, and perineal abscess, may be followed by fistula. After incision of a peri-urethral abscess, the fistula usually closes spontaneously when a suitable catheter is reintroduced.

Diverticulum of the urethra. This complication may follow peri-urethritis and abscess formation, or if by some chance a penile clamp has been used to occlude the urethra and prevent dribbling. Both extra-urethral and intra-urethral causes of diverticulum, whether from urethritis or from extra-urethral pressure, can be avoided by a proper nursing regime. The treatment of a urethral diverticulum may be conservative or expectant, in which the patient himself empties the contents of the diverticulum by compressing it after voiding. A surgical excision may be difficult because of the risk of perineal fistula or stricture. In many cases 2 or 3 operations may be required.[16]

Bladder-calculi. Both disc-shaped and bi-convex calculi may develop during the bed-fast period. The shell-like calculus or deposit which occurs round the back of the Foley catheter is avoidable if the Foley bag is not distended with more than a few ml. of water. The Foley catheter should be changed every few days if there is a tendency towards phosphaturia. The need for avoidance of infection is apparent if catarrhal debris, which will form the nucleus for calculus formation, can be prevented. Hibitane

vesical lavage through a wider-bored catheter is probably the most effective prophylactic treatment. No vesical calculi should be permitted to grow beyond the size suitable for per-urethral lithotrity.

Infection. The vast majority of patients have developed urinary infection within 2 or 3 weeks of the initial catheterization. The predominant organisms are *P. pyocyaneus, B. proteus* and *B. coli.* Formerly, the use of systemic antibiotics was virtually the only means of medicinal treatment, accompanied by various acidifying or alkalinizing urinary antiseptics. These mixed urinary infections with organisms which are notoriously difficult to eradicate, may become very persistent. Nevertheless, with the development of spontaneous voiding by the clock, 7 of 18 patients with a mixed organismal infection developed a sterile urine during the early phase of the follow-up within 2 years after injury. During the past year promising results in the control of urinary tract infection have been achieved by local application to the urethra of antiseptics or antibiotics in the lubricant, and by irrigating the bladder with hibitane.

The spastic bladder. Following prolonged catheter drainage the bladder may become small and spastic, with the dangers of ureteric reflux and ascending infection. Topical lignocaine, mucosal anaesthesia of the bladder, and transurethral resection of the bladder neck and bilateral pudendal nerve block have all been used with very varying degrees of success in the treatment of this condition. Sometimes, however, lignocaine infiltration of the 2nd sacral nerve root through the posterior sacral foramina may have a dramatic effect, and the bladder capacity may be increased with delay in the coordinated reflex bladder contraction. When the spastic bladder is accompanied by severe somatic spasticity, subarachnoid alcohol injection may be used. The subarachnoid space is entered between L5 and S1, and 5 ml. of absolute alcohol are injected slowly after the withdrawal of a similar amount of cerebrospinal fluid. Of necessity, the reflex automatic bladder becomes converted to the autonomous type, but the distress of the severely spastic patient with flexor spasms renders the subarachnoid injection worth while, because, in a limited number, reflex voiding may return following alcohol block while the limbs remain flaccid.

SUMMARY

The physiological and clinical basis for the use of continuous urethral catheter drainage in the initial management of traumatic paraplegia is presented, and the application of the method described in detail. Recent developments in the technique of catheter drainage and methods adopted for the prevention of infection are discussed. The value of cystometry as a guide to the correct use of a catheter regime is illustrated, and methods of bladder training to restore reflex bladder activity with spontaneous voiding are discussed.

REFERENCES

1. Bors, E. (1957): Urol. Surv., **7,** 177.
2. Damanski, N. and Gibbon, M. (1956): *Ibid.*, **28,** 24.
3. Fernsides, E. G. (1917): *Ibid.*, **40,** 150.
4. Walker, J. T. (1917): Lancet, **1,** 173.
5. Holmes, G. (1933): Brain, **56,** 383.
6. Munro, D. and Hahn, J. (1935): New Engl. J. Med., **212,** 229.
7. Riches, E. W. (1943): Brit. J. Surg., **31,** 135.
8. Kolb, L. C. *in* Langworthy, O. R., Kolb, L. C. and Lewis, L. G. eds. (1940): *Physiology of Micturition.* Baltimore: Williams & Wilkins.
9. Nesbit, R. M. and Lapides, J. (1948): Arch. Surg., **56,** 139.
10. Denny-Brown, D. and Robertson, E. G. (1933): Brain, **56,** 149.
11. Gibbon, N. (1958): Brit. J. Urol., **30,** 1.
12. Slade, N. and Linton, K. B. (1960): *Ibid.*, **32,** 416.
13. Comarr, E. (1959): *Ibid.*, **31,** 1.
14. Nathan, P. W. (1956): *Ibid.*, **28,** 126.
15. Tasker, J. H. (1961): *Ibid.*, **33,** 397.
16. Griffiths, I. H. and Walsh, J. J. (1961): *Ibid.*, **33,** 374.