THE BLADDER IN PARAPLEGIA

By HUGH DONOVAN, F.R.C.S.

Consulting Surgeon, the United Birmingham Hospitals

This article is a review of present methods of management of the paraplegic bladder. The patient, at first sight so helpless and hopeless a person, can be aided to a remarkable degree by painstaking and skilful surgical care. There may well be entirely new methods of treating the bladder yet to be discovered.

Physiology

There is little difference of opinion on the main physiological points. The micturition centre in the sacral cord, opposite the twelfth dorsal and first lumbar vertebral bodies, controls the normal filling of the bladder, reacts to a stretch in the muscle and empties the bladder, though perhaps not quite completely, in one sustained contraction. The afferent and efferent impulses pass through the nervi-erigentes of the second, third and fourth sacral nerves. The sympathetic nerves have no significant part in micturition, and their section in the paralysed patient merely removes a minor sensation of tightness in the bladder region and perhaps pain, but has no effect on the motor side of the act. The voluntary control of micturition descends from the cortex in the lateral columns. Unilateral interruption does not affect control. This control is partly inhibitory and partly an ill-understood mechanism to initiate micturition, which is thought to occur as a result of an initial voluntary relaxation of the perineal muscles, with the exception of the external sphincter of the urethra which can be voluntarily contracted but not voluntarily relaxed.

The Results of Injury

The result of injury to cord is to produce (below the lesion) a state of complete flaccid paralysis, which in the frog lasts a few minutes but in the human being may last three to six weeks. If the bladder centre remains intact below a transverse lesion of the cord, the bladder begins about this time to act automatically and involuntarily, though it may not empty completely and there may be very marked frequency. If the cauda equina or the bladder centre in the cord is destroyed, the time taken for recovery of detrusor function in the bladder is a matter of difference of opinion. According to Nissen (1942) automatic micturition may appear in four to 18 months after injury

to two, three and four sacral roots. Bumpus (1947) states that after four to five months the majority of paraplegic patients develop automatic micturition, while Thompson *et al.* (1947) state that lesions of the cauda do not as a rule permit of development of an automatic bladder. The M.R.C. report of injuries on the spinal cord and cauda equina (1924) states that when two, three and four sacral roots are injured, automatic micturition may appear in four to 18 months, even when there is no reason to believe nervous continuity has been restored. It also states that though at first imperfect, micturition ultimately results in complete evacuation.

Watkins (1936), in an extremely important paper in which he clearly differentiated between the two main types of bladder lesion (see below, types 2 and 3), seems to have brought forward good evidence, on the study of three cases of cauda equina lesion, that after several months the bladder in this condition can sometimes, possibly more usually when defaecation is simultaneous, empty a large part of its contents without the help of abdominal strain. It is evident that the existence of the autonomous bladder is an unexpected and indeed perhaps an inconstant occurrence, and there seems no physiological reason why shock should have such a long delayed effect in the case of the lower injury.

Insufficient attention has been paid to the state of the external sphincter in cauda equina injuries, and there appears to be no absolute evidence that this muscle is relaxed in this condition. This point is controversial. Emmett *et al.* (1948) have commenced the examination of the external sphincter in paraplegia, and have demonstrated a good method of study. But their paper is insufficient to throw light on the kernel of the problem—namely an almost constant obstruction in the region of the external sphincter, which withstands a pressure of about 100 cm. of water when the cauda equina has been destroyed, with the production of a lower motor neurone lesion involving the nervi-erigentes and pudendal nerves.

The possibility of recovery of the cauda equina after division is accepted, but the writer is unaware of an authentic case. No doubt recovery will only take place in the efferent nerves because the afferent nerves are root fibres running to the cord.

from the posterior ganglia. This might explain the return of motor power in the bladder what time saddle anaesthesia persisted, and could explain some rather puzzling cases of recovery of bladder function in cauda equina lesions. This concept also requires critical study.

The classification of the types of bladder met with has been attempted by various writers and it might be reasonable to agree on such a classification as follows:—

1. The atonic paralysed bladder or atonic neurogenic bladder (this is the bladder in the initial phase wherever the injury).

2. The reflex bladder or automatic bladder. This is the bladder some weeks after injury which cannot be inhibited by the patient and which evacuates some ounces of its contents, in some cases all its contents, at intervals varying from a few minutes to an hour or two. It occurs when the cord is interrupted above a surviving bladder centre.

3. The bladder in cauda injuries or injuries where its centre is destroyed, which many have called the autonomous bladder, and which may sometimes evacuate an ounce or two of its contents in a continuous stream, and which sometimes with the help of considerable strain will evacuate nearly all its contents. This condition is usually associated with dribbling by night and by day with residual urine and with back pressure dilatation of the ureters.

Diagnosis

We are not concerned here with measures to diagnose between a mechanical obstruction, an hysterical paralysis and an organic nervous disorder of the bladder, though the surgeon should always be prepared, when confronted with retention apparently due to chronic nervous disease, especially tabes, to find in fact that the cause is a bladder neck obstruction.

The diagnosis of the initial stage, especially when this is due to trauma or to the ictus of grave spinal cord disease, is usually self evident. It is when the patient is seen suffering from some variety of incontinence at a later stage, or when the patient has been drained suprapubically or by catheter for several weeks that steps have to be taken to classify the type of bladder palsy in the interest of good treatment. An exact neurological diagnosis comes first. This means not merely such a statement as that there is a transverse lesion of the cord at the level of say D.10, but also information as to whether the reflex activity of the cord is present below this level, for in the experience of the writer (Donovan, 1947) in not a few patients with cord injuries the cord below the lesion ceases to function and the bladder in such

cases is in category 3, i.e. atonic or autonomous. The response to Faradism of the muscles below the level of the lesion is of value when investigating the state of the cord. The next step in the diagnosis is the estimation of the presence and quantity of residual urine. If, however, the bladder is already drained, this information is not available. Incidental information which influences the care of the urinary tract is provided by X-ray evidence of stones, presence of dilatation of kidneys and ureters (excretory urograms) and some knowledge of the infecting organisms present. The wisdom of carrying out cystoscopy has been questioned. Some very interesting information has been obtained by those who have cystoscoped great numbers of these patients. The bladder often shows an increased tone, and most American authors describe trabeculation. The writer has very frequently noticed bullous oedema of the base, making recognition of the ureteric orifices difficult. The internal urethral orifice varies: in some cases it is seen to be widely open so that the veru can be readily seen with a Ringloeb cystoscope, and the internal sphincter looks like an open ring or diaphragm. In other cases the bladder neck is closed. This relaxed internal urethral orifice is probably more common in the autonomous bladder (type 3), but from time to time may or may not be present in the same patient. As was said by Emmett (1947), it may be difficult to visualize a definite obstruction at the vesical neck. Perhaps the chief value of cystoscopy, apart from its use to exclude a mechanical bladder neck obstruction, is to study the rate of excretion of methylene blue in a pyrexial patient, to exclude an obstructive lesion in a ureter. The cystometrogram seems to be falling into disuse, as it does not differentiate clearly between the two types of bladder. The writer plotted many curves from different patients, and while it was true that those of the type 2 bladder tended to be more vertical than those of type 3, there were individual exceptions, and moreover the reflex bladder frequently fails to empty itself even at a considerable height of pressure, thereby leading to the wrong conclusion that co-ordinated reflex micturition had not yet been established. This unfavourable view of cystometrography is shared by Emmett (1945).

If a patient whose bladder has been drained following a spinal injury is regularly reviewed once or twice a week, it will be noted, if there is neurological evidence that his spinal centre is intact, that when his bladder is being washed out he will begin to micturate as it is filled (bladder type 2). This piece of evidence should be specially sought for a few weeks after the injury, and as soon as neurological evidence warrants it. The simple distention of the

bladder through the suprapubic tube with antiseptic lotion at a pressure of not exceeding 3 ft. is likely to be an adequate test, and the character of the micturition which follows this, if it is a sharp vigorous flow, is confirmatory evidence that such a bladder is now ready for closure.

Writers are, generally speaking, somewhat silent as to the time at which an attempt should be made to close bladder type 3, the autonomous, atonic or cauda bladder. Those who believe in cystometrography certainly describe the development of waves of contraction of greater strength or perhaps different character, appearing in such bladders after months of drainage, and draw the conclusion from this that the time has come for closure, etc. In three cases of Watkins (1936) the patient was drained by catheter for short periods, and over some months the bladder function improved. There do not seem to be any established principles to guide us in the choice of the time to close the autonomous bladder.

Treatment

In the initial phase (atonic neurogenic bladder) early suprapubic cystostomy is beyond doubt the wisest plan. The opening into the bladder must lie at least 2 in. above the pubis, and to ensure this the lower end of the incision should stop at this point. It is best to make a sufficient incision to expose the bladder, and the tube inserted, a self-retaining one, should have a good bore—not less than 26 Ch. The bladder should be drained directly into a Kilner, or similar bottle, and should be washed out with a suitable antiseptic twice a day. Tidal drainage is apt to be followed by pyrexial attacks, and the urine is not so clean as when drainage is direct. The suprapubic tube should be changed at weekly intervals when the track is well established. It must not be allowed to piston in and out. The best oral urinary antiseptic is water, and an attempt should be made to make the patient to excrete 120 oz. or more a day. It is not practicable to give the sulphonamides, penicillin or other antibiotics as a preventative of infection in these cases, for the bladder flora rapidly become resistant. It is of the greatest importance that the drainage tube should not become blocked, for this is frequently followed by a severe pyelonephritis which may last for weeks. Undue emphasis has been laid upon the danger of a severely contracted bladder following prolonged drainage in these cases.

With regard to the use of a catheter, it may be that opposition to its use in the first 24 hours is not well founded. Infection can rarely be prevented in these cases. The chief disadvantage of a catheter, apart from the inadequacy of the drainage, is the damage to the urethra which frequently

results, so that the patient may get a severe stricture, or the floor of his urethra may slough out opposite the suspensory ligament. These are common complications, rendering difficult the restoration of normal micturition and making it impossible for the patient to wear an incontinence bag.

If a patient has a type 2 (reflex) bladder, in due course, perhaps in a few weeks, closure of the bladder can be carried out. The indications for this have been mentioned already. The suprapubic tube is removed and a catheter inserted for three or four days under cover, on this occasion, of penicillin, sulphonamides and streptomycin. As a rule the patient will reflexly empty his bladder without leak when the catheter is removed, but if suprapubic drainage has existed for many months it may be necessary to excise the skin-lined track and to free and suture the bladder. Some hours after the catheter is removed, unless it is clear that vigorous micturition is taking place, the residual urine should be estimated as a control. The patient is then fitted with an incontinence bag and encouraged to develop awareness of imminence of micturition, of which, as has been said by Thompson *et al.* (1947), they often appear to have an uncanny knowledge. Watkins (1936) regarded patients with reflex bladders as being more inconvenienced than those with a cauda equina injury, but patients leading a sheltered institutional life appear to have few accidents and to be virtually continent in many cases. When good reflex micturition exists the patient no longer suffers from constant reinfection, attacks of pyelonephritis become rarer, and it may now be possible to eradicate organisms from the urinary tract.

The autonomous bladder, as has been indicated above, is a more troublesome problem. In the writer's experience attempts to close this type of bladder were almost without exception followed by severe pyelonephritis necessitating reopening of the bladder. Emmett (1947) appears to have intervened at about the third or fourth month after onset of paralysis. Guttman (1946) has not stated the time he chooses. There are essentially three methods of treatment described (1) After bladder closure to allow nature to take her course when, as Watkins (1936) described so well in three cases, a fair measure of continence may be established, or (2) following Guttman (1946) to prepare the patient for closure by vigorous abdominal exercises so that he greatly develops his abdominal muscles and can empty his bladder by strain or (3) to follow the plan described by Emmett (1945) and to resect the bladder neck.

Resection of the Bladder Neck

This is possibly the most important advance

of the decade in the treatment of paralysed bladders, but it will take some years to settle how often repeated resections have to be done, and whether dilatation of the ureters results from back pressure. It would seem to have been an empirical discovery for, as Emmett (1947) has admitted, the look of the bladder neck does not suggest obstruction and resection should be carried out regardless of its appearance. The explanation of the effect of resection offered by Emmett (1945) is that the internal sphincter is the edge of the detrusor, and that it contracts with the detrusor and interferes with evacuation. There is another possibility, however, namely that in the course of resection the external sphincter becomes dilated by the drag of the resectoscope and that this weakening facilitates evacuation.

There is one essential requirement where the autonomous bladder is concerned, i.e. the patient must have good voluntary abdominal muscle power. The best results seem to occur when there is a considerable amount of residual urine. The technique is as follows:—Resect the entire circumference of the internal urethral orifice; cut well out to the veru; remove on the average about 5 gm. of tissue but remember that there is not much thickness of tissue between the urethra and the prostatic capsule, and be prepared to repeat rather than to be radical.

If the patient has a cystotomy this can be closed in a week or two and then an attempt should be made to train the patient to empty his bladder completely at suitable intervals, and any urinary infection should be very actively treated.

There are a number of very favourable reports on this procedure from the U.S.A. In this country first impressions have also been favourable (personal communications from D. Band, A. Jacobs, T. J. D. Lane and E. W. Riches). My experience as yet is very limited but has been encouraging. The following is an example of what may be expected:—

D.R. 1944, G.S.W., cauda equina, S.P. drainage of bladder. Bladder stones formed during tidal drainage and were crushed; eventually discharged home with permanent S.P. tube. Several subsequent admissions for the treatment of stones in bladder and right kidney. Admitted for resection in September, 1948. I.V.P.s were normal and the ureters were not dilated. Blood urea, 43 mgm. per cent.; urea concentration test max., 3 per cent.; bladder pressure when 180 ml. of fluid was instilled was 20 cm. and 50 cm. of water on separate occasions. At 120 cm. of water pressure there was some slight leak from the penis. Operation, October 4, 1948; perurethral resection with McCarthy resectoscope. The I.U.O. was a little relaxed, so that it was possible

to see over the posterior lip from the veru. Eleven strips totalling 3 cc. were cut away from 3 o'clock to 11 o'clock. A Foley's bag was inserted with slight traction for one to two hours and was removed on the second day. Operation, October 27, 1948; excision of suprapubic tract. This ran down behind the peritoneum, was cut away and the bladder closed with chromic gut. Examination of the I.U.O. from within showed it to be sufficiently dilated to admit the thumb. There was a bulge anteriorly at 12 o'clock. Following the operation streptomycin was given for five days, a total of 9 gm. The urine before closure contained *Ps. pyocyanea*. On November 1 it was sterile, but on November 8 contained a moderate growth of *Morgan bacillus*. Convalescence was very smooth. On November 6 the patient could pass about 180 cc. of urine at a time with considerable effort, but on defaecation as faeces descended and dilated the sphincter, urine was passed in a virtually normal manner. There was no incontinence. Attempts to facilitate micturition by anal dilatation did not help. There was no residual urine. I.V.P.s one month after closure showed no dilatation of upper urinary tract. He was reviewed on May 2, 1949. His micturition was then as on discharge; he had 135 cc. of residual urine.

Whether resection is necessary for the No. 2 type of bladder is uncertain. Here also it has been claimed that it abolishes residual urine and may render the patient continent.

Complications

The most important of these are severe ascending urinary infection leading to prolonged pyrexia, stone formation in kidney or bladder, and where the urethra has been instrumented, urethritis with stricture, sloughing of the floor of the urethra and epididymitis.

There is nothing which can give rise to more anxiety than the severe persistent fever from which a paraplegic patient so often suffers, and it may be impossible to settle whether this is due to a deep bed sore perhaps involving a bone or a joint, or whether it is due to pyelonephritis. A high dorsal injury will denervate the kidney, which is therefore painless. If there is no obstructive condition present, however, in the ureter or kidney pelvis, no active surgical intervention is required. It is therefore desirable in such cases, when pyrexia persists for more than three or four days, to examine the upper urinary tract by X-rays and chromo-cystoscopy or by excretory urography. Obstruction can be due to a non-radiopaque stone. If there is no obstruction there should be no hesitation in rendering the urine alkaline for a day or two, and if the active urinary antiseptics have not been used in a routine way they can be now

used with some hope of having sensitive organisms to deal with. Prevention of ascending infection depends upon :—(1) unobstructed drainage, (2) a very active urinary excretion, e.g. 120 oz. a day, and (3) particular care of the patient's health. It should be remembered that pyelitis very rapidly causes marked secondary anaemia.

Stone Formation

When this occurs in the bladder it is a comparatively minor matter ; such stones should be crushed and never removed by suprapubic operation. Crushing is easy and usually causes permanent cure. Stones in the kidney can be prevented by adequate fluid output, frequent movement of the patient, and early ambulation ; possibly acidification of the urine by diet and ammonium chloride reduces the incidence. The stone shadow may be due to a definite calculus or to a muddy precipitate, and it is generally worth while attempting acidification of the urine to Ph. 5.0 when a shadow is present, in the hopes of aiding solution and spontaneous passage.

The question of when to operate on renal stones is a difficult one and it is not easy to lay down any definite rules. At any rate it can be said that, if possible, operation should be deferred until the patient has been ambulatory, or up in a chair, for several weeks. Another important principle is that renal tissue must be conserved. After pyelolithotomy, aided by renal X-ray at the time of operation, continuous renal lavage for two weeks or so with two litres of Solution G. a day has given good results.

Miscellaneous Comments

In the female, experience of the paraplegic bladder is lacking. In the stage of shock the urethral catheter is less objectionable than in the male because drainage is good and epididymitis and urethral complications do not arise. Later on the patient may be more comfortable drained permanently by the suprapubic route, especially if she has a type 2 (reflex) bladder. The incontinence apparatus for the female is not very efficient. Emmett (1947) describes resection of the bladder neck in the female as a helpful procedure.

Anterior rhizotomy, done to arrest violent muscle spasms, will affect the bladder, usually producing a type 3 bladder, and this should be borne in mind when the operation is contemplated for it may be necessary to reinstitute suprapubic drainage at the time of the spinal operation.

It is an over-simplification of the problem to say that resection of the bladder neck is the panacea, for the patient with a type 3 bladder and

a paralysed abdominal wall will almost certainly need a permanent suprapubic tube.

Chiefly in patients with spina bifida there occurs an incontinent bladder continuously dribbling without residual urine. The treatment of this condition is still experimental. Emmett (1947) has recorded restoration of continence by a combination of resection of the bladder neck and a Kelly repair. This was done in the case of two adult females. Hamilton Bailey (1938-39) described a successful case of restoration of continence in a female tabetic patient by the use of a gracilis graft drawn around the urethra.

A number of theoretical procedures have been described such as—Rose, quoted by Rex van Duren (1945)—destruction of the sphincteric mechanism by resection and then control by a penile clamp. Van Duren refers to the use of an Aldridge type of sling operation ; possibly there may be some place for a fascial sling operation if the recti are under voluntary control and the external sphincter is destroyed. The tabetic bladder is in a special class in that its motor supply is intact. The defect is on the afferent side and probably retention is due in part to incoordination. In many cases the patient can be re-educated to empty his bladder by taking thought and by regular effort, and he will be aided by the administration of pharmacopoeial doses of pilocarpine nitrate. The posterior urethra and bladder neck are usually widely open in these cases, nevertheless Emmett advocates resection ! It must be borne in mind that a patient with tabes may have prostatic enlargement or bladder neck obstruction.

The possibility of transplanting the obturator nerves into the pudendal, and similar theoretical procedures, are worthy of exploration. Further, it would be a valuable discovery if we had a urinary antiseptic that was entirely non-toxic and against which the usual invaders of the urinary tract never developed insensitiveness.

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