

## Section of Urology

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### The Musculature of the Bladder-neck of the Male in Health and Disease

#### PRESIDENT'S ADDRESS

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**ABSTRACT.**—Two muscles, one voluntary the other involuntary, and an inch or more apart, exist at the bladder-neck, both functioning as sphincters. This dual musculature is explained by the emergence of the ejaculatory ducts between them. If both these muscles are open when semen is discharged, secretion may escape into the bladder or to the exterior; also any urine in the bladder would flow out. The internal sphincter is usually tightly contracted during ejaculation. Instances are given in which the internal sphincter is paralysed or injured, e.g. after operation, in prostatic hypertrophy, and in certain nervous diseases. Two instances are reported of direct injury to this localized area, with the result, in all cases, that ejaculation failed. In prostatic hypertrophy the internal sphincter is dilated by the growing adenoma, and at operation it is further stretched and perhaps cut across. Continence then depends on the external sphincter. Two cases are reported in which the external sphincter had previously been paralysed, total incontinence resulting.

Recent work on the trigonal muscle; its function in opening the internal sphincter. Influence of this muscle on prostatic enlargement.

In central nervous disease the dilatation of the internal sphincter resulting in funnel-neck is very common. Series of cases of nervous disease examined in order to determine the frequency of this sign are reported. Other cases occurring apart from nervous disease are also reported.

The part played by the sphincters in ejaculation is discussed and illustrated by reports of further cases of paralysis of the sphincter. It is shown that in the normal way the external sphincter weakens during coitus, and especially during ejaculation, but when the internal sphincter is paralysed no weakening is evident. Penile erection is associated with spasm of the internal sphincter, and spasm of the internal sphincter is produced by irritation, e.g. vesical stone may produce priapism.

The varying types of adenoma bear different relationship to the internal sphincter. The view that submucosal glands give rise to prostatic enlargement is supported. The influence of prostatic enlargement on the internal sphincter is discussed.

**RÉSUMÉ.**—Il existe deux muscles, l'un strié et l'autre lisse, séparés d'un pouce, au col de la vessie; tous deux fonctionnent comme sphincters. Cette double musculature s'explique par l'ouverture du canal éjaculatoire entre les deux muscles. Si les deux sphincters sont ouverts au moment de l'éjaculation du sémen, la sécrétion peut s'échapper dans la vessie ou à l'extérieur, et l'urine dans la vessie s'écoule. Le sphincter interne est d'habitude fortement

contracté pendant l'éjaculation. Il existe des cas où le sphincter interne est paralysé, par exemple après une opération, dans l'hypertrophie prostatique, et dans certaines maladies nerveuses. L'auteur décrit deux cas de traumatisme direct de cette région, tous deux suivis d'éjaculation manquée. Dans l'hypertrophie prostatique le sphincter interne est dilaté par l'adénome croissant, et il est encore plus détiré, et peut-être sectionné, à l'opération. La continence dépend alors du sphincter externe. Description de deux cas où le sphincter externe était déjà paralysé avant l'opération, résultant en incontinence absolue.

Travaux récents sur le muscle trigonal, sa fonction dans l'ouverture du sphincter interne. Influence de ce muscle sur l'hypertrophie prostatique.

Dans certaines maladies nerveuses la dilatation du sphincter interne, menant à la condition de col en entonnoir, est très fréquente. Rapport d'une série de cas examinés pour déterminer la fréquence de ce signe. D'autres cas survenant en dehors des maladies nerveuses sont aussi décrits.

Le rôle des sphincters dans l'éjaculation est discuté et illustré par d'autres cas de paralysie du sphincter. Il est démontré que normalement le sphincter externe s'affaiblit pendant le coït et surtout pendant l'éjaculation, mais si le sphincter interne est paralysé cet affaiblissement ne se produit pas. L'érection du pénis est accompagnée de spasme du sphincter interne, et le spasme du sphincter interne est produit par l'irritation. Par exemple, la calculose vésicale peut produire un priapisme.

Les différents types d'adénome ont des rapports différents avec le sphincter interne.

La théorie que les glandes sous-muqueuses produisent l'hypertrophie de la prostate est soutenue. L'effet de l'hypertrophie prostatique sur le sphincter interne est discuté.

**ZUSAMMENFASSUNG.**—Es gibt zwei Muskeln, am Blasen Hals, ein willkürlicher und ein unwillkürlicher; beide sind Sphinktermuskeln. Diese doppelte Muskulatur ist dadurch erklärt, dass der Ductus ejakulatorius zwischen diesen zwei Muskeln ausmündet. Wenn beide Muskeln offen sind während der Ejakulation kann das Sekret in die Blase oder auswärts entgehen, und der Harn in der Blase fliesst hinaus. Der innere Sphinkter ist gewöhnlich während der Ejakulation fest geschlossen. Verf. gibt Beispiele von Lähmung oder Schädigung des inneren Sphinkters, wie nach einer Operation, bei Prostatahypertrophie, und bei gewissen Nervenkrankheiten. Zwei Fälle von direktem Trauma in dieser Gegend werden besprochen, mit Misslingen der Ejakulation in beiden Fällen. Bei Prostatahypertrophie wird der innere Sphinkter durch das wachsende Adenom gedehnt, und wird bei der Operation noch weiter gestreckt, und vielleicht durchgeschnitten. Die Kontinenz hängt dann von dem äusseren Sphinkter ab. Verf. beschreibt zwei Fälle vorausgegangener Lähmung des äusseren Sphinkters, bei denen totale Inkontinenz erfolgte.

Neuere Arbeiten über den Trigonalmuskel; seine Funktion in der Öffnung des inneren Sphinkters. Einfluss dieses Muskels auf der Prostatahypertrophie.

Bei Erkrankungen des Zentralnervensystems ist der trichtersförmige Blasen Hals infolge Erweiterung des inneren Sphinkters sehr häufig. Eine Reihe von Fällen wurde untersucht um die Häufigkeit dieses Zeichens festzustellen. Andere Fälle, ohne Nervenkrankung vorkommend, werden auch beschrieben.

Die Rolle der Sphinkteren in der Ejakulation wird beschrieben und durch weitere Fälle illustriert. Verf. zeigt dass der äussere Sphinkter während dem Koitus normalerweise geschwächt ist, doch kommt diese Schwächung bei Lähmung des inneren Sphinkters nicht vor. Erektion ist mit Spasmus des inneren Sphinkters verbunden, und Spasmus des inneren Sphinkters ist durch Reizung bedingt. Es kann, zum Beispiel, Blasen Stein Priapismus bedingen.

Die verschiedenen Typen von Adenom haben verschiedene Beziehungen zu dem inneren Sphinkter. Die Annahme dass submikrose Drüsen Prostatahypertrophie bedingen ist bestätigt. Der Einfluss der Vergrösserung der Prostata auf dem inneren Sphinkter ist erörtert.

For some time past the surgery of the bladder-neck has enjoyed a fair share of the centre of the stage, but the subject of this paper is a phase of bladder-neck surgery which has enjoyed no such publicity.

In the first place I wish to draw attention to an arresting fact, namely that two muscles, separated from each other by an inch or more, exist at the bladder-neck, both functioning as sphincters, the one an unstriated, involuntary muscle, receiving its

nerve-supply from the sympathetic and parasympathetic, the other a striped muscle under the control of the will and innervated by the internal pudic, a spinal nerve. Do these two strangely different muscles play an identical part in the economy of the organism, and if so, why are they so strangely dissimilar? Do they merely support and understudy each other in their functions?

It is to a study of this problem that my paper is in the main devoted. The dual musculature of the bladder-neck is, of course, explained by the emergence of the ejaculatory ducts between the two sphincters. The posterior urethra is the point of meeting between the urinary and the genital streams, and it is to this confluence that we owe the complication of a dual musculature. It is obvious that if both these muscles were open at the time when semen was being discharged from the ejaculatory ducts, that secretion would be at liberty to escape, not only to the exterior, but also into the bladder, whilst any urine which happened to be in the bladder would flow out with the semen. If, on the other hand, both sphincters were closed, sperm would be imprisoned between them. It seems that in health, with the onset of penile erection, the internal sphincter, relatively weak muscle though it is, goes into spasm and in this way cuts off the urinary tract at the bladder-neck from the genital tract, thus imprisoning the bladder contents and forbidding their interference with the sexual act. The nervous centres for erection of the penis and for closure of the internal sphincter appear to be closely related, as will be attested more than once during the present paper.

I shall now proceed to the discussion of several conditions in which the bladder-neck musculature undergoes change, commencing with that source of never-failing interest, prostatic hypertrophy.

#### PROSTATIC HYPERTROPHY

The influence of prostatic enlargement on the musculature of the vesical neck is an important one, two muscles being principally involved—the internal sphincter and the trigonal muscle.

*The internal sphincter.*—The relationship of prostatic hypertrophy to the internal sphincter is a variable one. It is also an important one—so important that the anatomical type of the enlargement is determined thereby. The characteristic thing, of course, is for the internal sphincter to be displaced, so that it comes to lie half an inch or more down the dorsal aspect of the middle lobe. The growing adenoma appears to worm itself through the muscle ring so that a large proportion of the gland projects within the vesical cavity. The enlargement therefore consists of an intravesical and an extravesical portion. The encroachment of the prostate on the bladder cavity and its relationship to the vesical sphincter was difficult or impossible to explain so long as it was believed that prostatic enlargements sprang from the main body of the prostate gland. It is now a widely held opinion that the point of origin of most prostatic hypertrophies is in certain glands situated below the mucosa of the trigone and urethra (fig. 1, p. 4). Though they form a practically continuous chain it is found convenient to classify these glands into three groups according to their anatomical position. They are known, therefore, as subtrigonal, subcervical, and prostatic glands. The "subcervical" group, which is the largest and most important collection, lies at the level of the uvula vesicæ. It is also called "Albarran's" group because to this French surgeon falls the credit of having first demonstrated its rôle in the production of the so-called middle lobe of prostatic hypertrophy. Glands placed along the urethra are found all round that tube but are largest and most numerous on its floor. They are accommodated in the sub-mucosal layer and are therefore internal to the muscular coat, though a few of them penetrate between the surrounding muscular fasciculi. If an enlargement starts in a structure occupying this situation there is no difficulty about explaining the relationship of the adenoma to the internal sphincter and how that muscle comes to

be displaced. It originates actually within the circle of the muscle and by its growth it expands the latter. According to which sub-group of glands is primarily or mainly affected will work out the relationship of the new growth to the internal sphincter

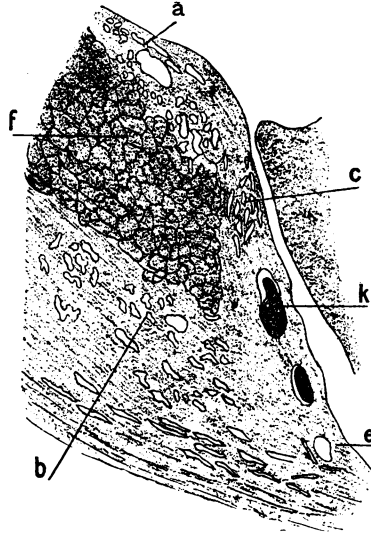


FIG. 1.—Sagittal section of the urethra and vesical neck in the earliest stage of prostatic hypertrophy (Jores), showing : (a) Submucous glands, subcervical group ; (b) submucous glands, intermediate group ; (c) submucous glands, urethral group ; (e) urethral mucosa ; (f) sphincter ; (k) glands in process of cystic transformation.

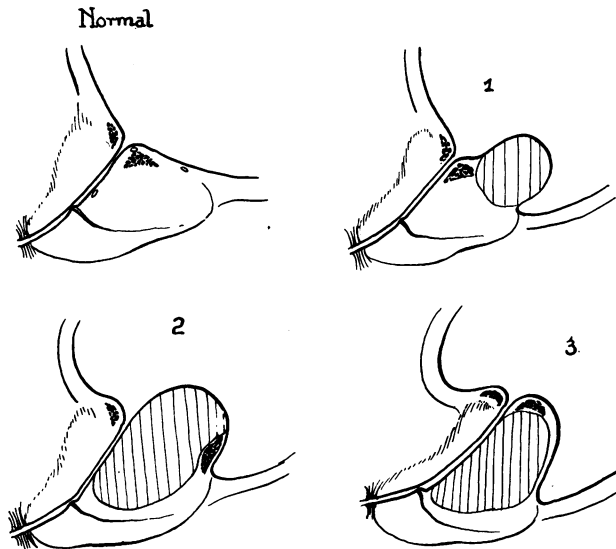


FIG. 2.—Illustrating the relationship of the various anatomical types to the sphincter. In the drawing of the normal, three small circles show diagrammatically the position of the subtrigonal, subcervical and urethral groups of submucous glands.

(fig. 2). The subtrigonal group lies above the sphincter and if it bears the chief brunt of the enlargement, the intravesical part will be disproportionately large ; if the subcervical group, which lies within the circle of the muscle, is principally affected, the

internal sphincter will be much dilated and the growth will be equally distributed within and without the sphincter, that is its intra- and extra-vesical components will be approximately equal. Should the prostatic group of glands, which lies some distance down the urethra and entirely below the sphincter, alone be affected, the hypertrophy never gets within the sphincter and that muscle remains undilated, the only displacement which it suffers being one of elevation, due to increasing size of the underlying prostate. Of these three types the second is by far the most common. The first and third are very rare in the pure form, though either type, or both together, are frequently found in association with Type 2. If Type 1 occurs alone—a great rarity—you enucleate a middle lobe without any lateral lobes and the whole hypertrophy occurs above the sphincter. If Type 3 occurs alone dilatation of the sphincter is absent and the enlargement is entirely subsphincteric. Returning to the more common type, which arises in the subcervical glands of Albarran, we find that in front of the meatus the sphincter is relatively little, sometimes not at all, disturbed; it often continues to abut on the meatus. As we trace the muscle from before backwards on the lateral aspect of the hypertrophied prostate we find that its displacement steadily increases, the lateral lobes of the gland gradually emerging through the sphincter, though in less measure than the middle lobe. In favourable

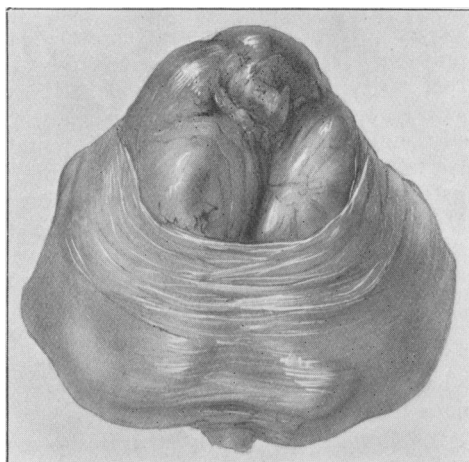


FIG. 3.—Anterior view of enucleated adenoma to show relationship of gland to internal sphincter. Note that sphincter is but little displaced anteriorly but recedes posteriorly. Also observe the groove which it makes on the adenoma.

circumstances when the bladder is fully displayed at operation the position of the sphincter may be traced as an oblique line marking off the mucosa behind, which properly belongs to the bladder, from that in front which overlies the encroaching gland and which is derived from the urethra.

At operation the enucleating finger passes between the adenoma and the sphincter. Often, however, a ribbon of muscle fibres tears away and adheres to the growth (fig. 3). These adhering fibres are scanty in number and constitute but a small part of the total muscle, though they are sufficient to determine its relationship to the gland. The site of the sphincter is always discernible, if a careful examination is made, as a shallow groove on the surface of the removed adenoma but in numerous instances there is a quite well-marked furrow which clearly shows that the pressure of the muscle is not a negligible force and that it evidently plays a material rôle in pressing together the various lobes of the abnormal gland and probably thus helps to obstruct

the outflow of urine. Is it a revolt of this misused muscle which determines that final acute retention which may set in so dramatically? And if so, would a simple division of this muscle band at one or more sites be enough to relieve the patient's symptoms? I have no answer to these questions. I have often thought of experimenting with this limited operation but have not had the courage to face the risk of failure.

The bladder mucosa proper extends forward only as far as the new position of the internal sphincter. In front of this is mucosa drawn up from the urethra overlying the invading prostate. But little submucosal tissue separates the adenoma and mucosa at this site and the mucosa is thin and fragile. It was on these facts that Freyer relied when he recommended the surgeon to scratch through the mucosa just behind the urethral orifice. But, as we have seen, a certain number of glands do not displace the sphincter and when this is the case the finger encounters firm muscle. Under these circumstances it becomes a bad method of approach. Great difficulty will be encountered in effecting an entrance and when an entrance is effected it will not lead the surgeon's finger to the outer surface of the adenoma where a welcome line of cleavage awaits it. It is many years since I forsook Freyer's method of approach in favour of the intra-urethral access which I find very much more expeditious, more certain and easier. I expect that most other surgeons have likewise adopted this route, but I sometimes wonder if ignorance of this elementary fact may not account for the considerable number of cases of non-adenomatous bladder-neck obstruction which seems to occur in the practice of some writers, a condition which is a great rarity in my own experience. I may be quite wrong but I hazard the view that with some operators the extravescical, that is the subsphincteric, type of adenoma swells the numbers of cases of "prostatisme sans prostate." I am not alone in suspecting that "prostatisme sans prostate" is a rare disease, for other surgeons—amongst whom I may quote Marion of Paris and Zuckerkandl of Vienna—have expressed similar opinions. These writers, whilst they do not entirely deny the possibility of the occurrence of such conditions, have each insisted on their rarity, and consider that the diagnosis should be made only after a most exhaustive attempt to exclude other conditions.

In the operation which I favour a horseshoe incision is traced by an electric needle and circles posteriorly behind the meatus. From the centre of this a second incision passes directly backwards for half an inch. The last incision is a deep one and divides many, perhaps most, of the fibres of the muscle. I believe there is no danger in going deeply at this point for if you examine a sagittal section of the bladder-neck from a patient with prostatic disease you will find a great depth of tissue in this situation. The object of this last incision is, of course, to prevent stricture formation at the bladder-neck and the principle was introduced by Sir John Thomsor-Walker, with this intention in view, though he made his incision at a later stage in the operation. Its object is to lay into one, the cavity previously occupied by the adenoma and the bladder cavity, and in doing this the continuity and function of the internal sphincter are necessarily, in greater or less measure, destroyed. If you examine a prostatectomized patient some time after healing is complete, using a cystoscope or urethroscope, you will find the adenoma cavity shrunk to the size of a marble and communicating freely through a moderately wide aperture with the bladder. The internal sphincter is no longer competent and bladder continence depends entirely on the external. The importance of the external sphincter is illustrated by two cases in my practice in which continence failed.

Mr. — was referred to me by Dr. Halsall of Colwyn Bay, suffering from hæmaturia and retention of urine. Ten years previously a rectal carcinoma the size of a shilling had been treated by the removal of the rectum and a colostomy functioned in the left iliac fossa. Prostatectomy was performed and convalescence was smooth in spite of the colostomy opening, but total incontinence was the unfortunate outcome of an otherwise

successful operation. It appears to me certain that, during the operation on the rectum, damage to the external sphincter or its nerve supply had resulted in its permanent damage or paralysis. Between the time of the rectal operation and the prostatectomy the patient had relied on the internal sphincter only, and that muscle was destroyed by the prostatectomy.

I wonder if other members have knowledge of a prostatectomy undertaken after a Kraske and what the result was. Bladder function is, as is well known, very liable to be interfered with for a time after the removal of the rectum and I remember on more than one occasion being pressed to remove a prostate to rectify this trouble. In each instance, however, micturition has been re-established after an interval of waiting and the case just reported is the only one within my experience in which the dual operation has been performed, the interval between the two operations in this case being ten years.

The only other case in which I have encountered incontinence after prostatectomy was that of a patient whose perineum and ischiorectal fossæ had, at an earlier date, been the site of severe tuberculous disease. The reason for this patient's lack of control is not so evident as it was in the former case but presumably is related to involvement, by the preceding tuberculous disease, of some part of the neuromuscular mechanism of the external sphincter, on which we mainly rely for continence after suprapubic prostatectomy.

A period of years elapsed between the time when each of these men lost the use of his external sphincter and the time when they started to suffer from prostatic obstruction. During these years neither was conscious of any alteration in the act of micturition, which remained fully under the direction of the will. In other words two patients whose external sphincters were known to be paralysed had complete voluntary control by means of their internal sphincters—muscles composed of plain fibres, innervated by the sympathetic and parasympathetic—muscles, the voluntary control of which is often questioned. In view of this observation the discovery by McCrea of considerable amounts of striated muscle in the internal sphincter is significant. Now we have already seen that the prostatectomized patient, who has lost his internal sphincter, similarly has complete vesical control, so that it would appear to be a matter of indifference, so far as micturition is concerned, to have either of the sphincters out of action, so long as the other retains its normal capacity.

In a large number of prostatectomies these are the only two cases in which I have had the misfortune to render the patient incontinent, and in each of them an extraneous cause was responsible. Such an experience speaks volumes for the reliability of the external sphincter after the suprapubic operation and incidentally demonstrates how far it is removed from the operative danger zone. It is the external sphincter alone on which we can depend for post-operative continence and at all costs it should be safeguarded from injury. I have no personal experience of the perineal approach to the prostate and ought therefore to be hesitant in speaking upon this operation, but to my mind it carries the fundamental objection that it endangers the compressor urethræ or its nerve supply. The internal sphincter has suffered pre-operative change and dilatation in the way which I have described. It may be true that further damage is not inflicted upon it by surgical division, but even so there is no guarantee that it will recover its tone and will once more function as a sphincter. An American speaking in London last year remarked that he "understood the mortality rate for perineal prostatectomy to be lower than that for the suprapubic operation, but many of those who lived wished devoutly that they hadn't."

How does prostatectomy affect sexual potency? Leaving out of consideration the integrity of the ducts and the sufficiency of prostatic tissue—both of them questions which are surely finally settled—I shall confine my remarks to the function of ejaculation. It is obvious that the injury to the internal sphincter will destroy

bladder closure in many cases and will allow sperm to regurgitate into that viscus instead of diverting it to the exterior. With most prostatic patients sexual life is a thing of the past, but to a few, especially the younger ones, it is still interesting.

A man, aged 50, who was referred to me with complete prostatic retention, had recently married for the second time. He was concerned to know the effect of operation on his sexual capacity. I attempted to explain the position to him and asked him to keep in touch with me after his discharge from the home and to report on his experiences. During the operation I was at some pains to avoid injury to his internal sphincter. Several months after he left the home he reported to me that in the first period coitus was accompanied by an orgasm but by no emission. At a slightly later time, however, the act became completely normal and was accompanied by normal ejaculation.

It can scarcely be doubted that these two phases in this patient's recovery correspond to stages in the recovery of his internal sphincter. When circumstances have been suitable, I have taken the opportunity to seek information on this subject and have made a few similar observations, but taking into account the large number of prostatic patients upon whom one operates, it is astonishing how infrequently the chance to study this question presents itself. The reasons are to be found, I suppose, in the age of the patients and in their indifference or perhaps reticence. Of those from whom I have obtained a precise answer the majority appear capable of coitus and experience an orgasm, but they remain incapable of ejaculation, though some of them realize that semen has been shed internally. Only a minority exhibit a return to full sexual capacity.

It would appear from this that, following prostatectomy, two conditions of the internal sphincter may occur: the one in which the sphincter is intact, when it remains capable of performing its sexual function and probably also its function as a sphincter of the bladder; the other in which the muscle has been permanently injured. Each of these conditions can be verified time and again at cystoscopy or urethroscopy. The second state must certainly be more common with the modern operation, in which the sphincter is intentionally sacrificed, than it was with the more limited technique previously employed. Yet, more than twenty years ago, presumably therefore in cases in which the old technique had been used, Thomson-Walker, approaching the question from the view-point of the capacity of the muscle to retain urine in the bladder, showed that the internal sphincter became active and competent in considerably less than 50% of cases.

*The trigonal muscle.*—This is a muscle about which fresh ideas have been advanced recently, and if they prove acceptable our views regarding the physiology of micturition must be modified. It is interesting to note that in his report at the International Congress of Urology last year Kenneth Walker was able to provide certain new facts in support of this theory.

Till recently it has been taught that at the onset of urination the internal sphincter undergoes an "inhibitory dilatation," comparable to that seen at the anal sphincter, but according to Young and Wesson the trigonal muscle, superficially placed in reference to the other muscles of the bladder-neck, passes downwards and forwards through the internal urethral orifice to receive an insertion near the verumontanum (fig. 4). Its course between these two points is not in one plane, the vesical and urethral sections being set at an angle, which angle is situated at the internal meatus of the bladder and corresponds to the uvula vesicæ. In contracting, the trigonal muscle straightens out this angle and drags back the lower lip of the orifice of the bladder. The internal sphincter is dragged open and micturition commences.

McCrea has shown that the trigonal muscle is a thin sheet whilst the internal sphincter is a very definite structure. If, therefore, the trigonal muscle has the action which Young and Wesson attribute to it, a relaxation of the internal sphincter



must accompany the contraction of the trigone. There are many elastic fibres helping to close the bladder-neck in the neighbourhood of the internal sphincter. It is possible that the sphincter muscle itself relaxes but that the trigonal muscle is responsible for the holding open of these elastic fibres.

Young and Wesson describe the downward action of the trigonal muscle in straightening out the angle formed at the uvula vesicæ but scarcely mention the

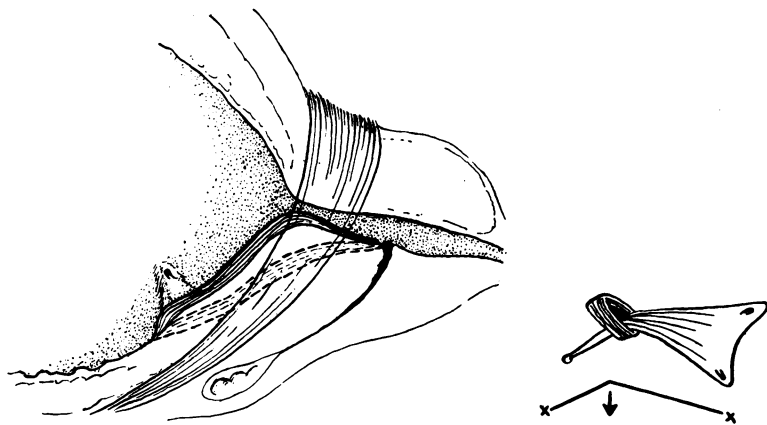


FIG. 4.—Sagittal section of bladder to show trigonal muscle at rest and (dotted lines) in action. (Modified from Young.)

importance of its triangular shape. The two bars of Bell converge on the urethral meatus and as they enter this opening alter their course and run side by side down the urethra. When contracting these two divergent limbs must become straightened out and thus exert an outward as well as a downward traction on the internal meatus, in this way opening the meatus transversely as well as vertically (fig. 5).

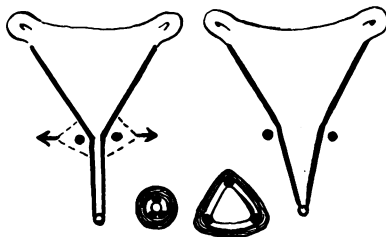


FIG. 5.—In contracting the divergent limbs of the trigone exert an outward traction on the meatus.

In prostatic enlargement the trigonal muscle hypertrophies to overcome obstruction. But what is its relationship to the growing adenoma? The insertion of this muscle we have seen to be in the neighbourhood of the verumontanum. Is its urethral component displaced back as is the internal sphincter, or does it run through, or over, the neoplasm? The two muscles of Bell normally converge on the uvula vesicæ, and it is underneath this eminence that Albarran's glands are situated. When hypertrophy affects these glands they push up between, beneath, and around

the Y-shaped convergence of the two muscles of Bell (fig. 6). If you cut sections in this area you will find that the cleft between the middle and lateral lobes is occupied by a layer of longitudinally running muscle, the like of which you will not find over the rest of the gland surface, and this bundle is continuous all the way down the cleft to where it meets its fellow. This muscle is the direct continuation of the bundle which lies in the bar of Bell, and is, I believe, the self-same muscle which, in the normal condition opens the internal sphincter, as described by Young and Wesson. These muscles, therefore, lie in the vallecule between the middle and lateral lobes, and almost certainly the resistance they put up to the growth of the

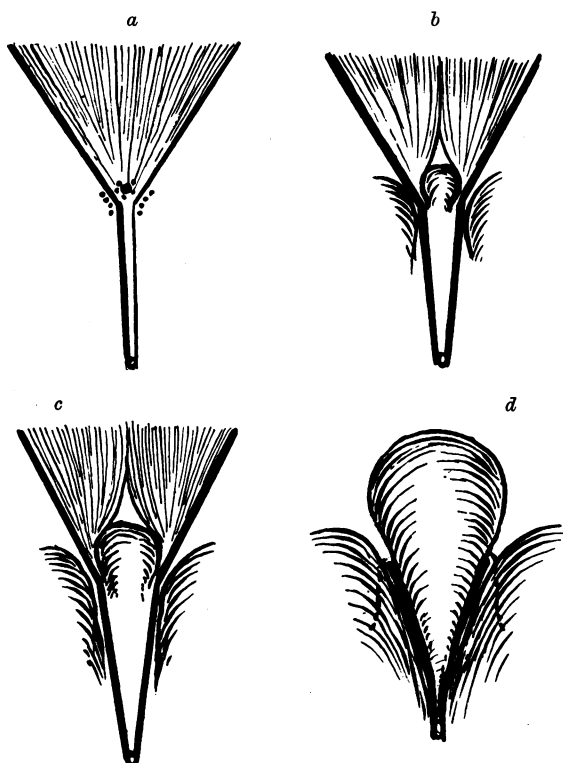


FIG. 6.—Shows the glands of Albarran in the normal and in varying grades of hypertrophy. In fig. *d* a retroprosthetic pouch has formed and the trigonal muscle doubles back acutely into it. (Cf. fig. 7.)

adenoma is the cause of the furrows which they occupy, and therefore the cause also of the prostatic division into the lateral and middle lobes. The subdivision of the prostate into lobes has never been satisfactorily explained but the presence of muscle bundles within the clefts seems sufficient to account for it, and is, so far as I am aware, a new observation.

In health the internal sphincter and the trigonal muscle cross each other at the internal meatus, and here they are placed in close contact. In prostatic hypertrophy the internal sphincter is dislocated downwards and backwards by the adenoma, but the relationship of the two muscles is still maintained, for the sphincter lies at the point where the interlobular cleft emerges into the bladder cavity and the contained

muscle of Bell is bent over it in crossing (fig. 7.) The deeper the retroprostatic recess, the more acute the angle formed. Perhaps the hypertrophied trigonal muscle even plays a part in the dislocation of the internal sphincter. These muscular strands are torn across during the enucleation. The torn ends, in healing, probably acquire further attachments in the neighbourhood of the internal sphincter, but as that muscle is usually incompetent after prostatectomy, they are no longer required to play a part in micturition.

#### NERVOUS DISEASE.

Disease of the central nervous system frequently causes derangement of bladder function, and it has been common knowledge ever since the days of Romberg that dysuria may be the first symptom to show itself as a result of various spinal conditions, and particularly in *tabes dorsalis*. When it occurs thus as an isolated symptom it is elusive and is likely to be diagnosed only after exclusion of other conditions. It is true that trabeculation of the bladder is a recognized sign of nervous disorder and that it has certain characteristics which distinguish it from other types of trabeculation, yet this trabeculation is inconstant and easily overlooked and its diagnostic significance is not completely reliable.

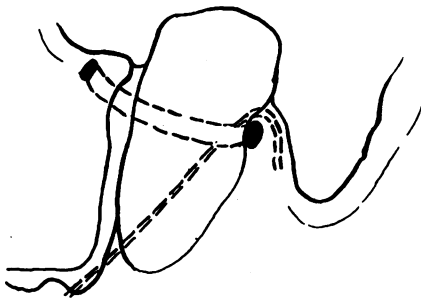


FIG. 7.—The urethral component of the trigonal muscle passes up between middle and lateral lobes and doubles back into the trigone. Note relationship to the internal sphincter, which, perhaps it helps to displace.

An early sign, of at least equal importance, is to be found at the bladder-neck. It results from weakness or paralysis of the internal sphincter, producing a funnel-shaped posterior urethra which can be seen cystoscopically. This phenomenon was apparently unknown clinically until 1917, when Burns of Baltimore described twenty-one cases of spinal syphilis (mostly *tabes*) in which he had observed the change. Prior to that, Barrington had demonstrated similar phenomena resulting from transection of the cord in the cat. From the time that Burns described this cystoscopic appearance, onwards, the English and American press is almost completely silent, a single reference by my own colleague, D'Arcy McCrea, being all that I can find on the subject. On the European continent, six examples of funnel-neck bladder were reported in 1920 by Schramm, and the Germans, conveniently ignoring the priority of Burns' article, have christened the condition "Schramm's phenomenon."

In the healthy male it is impossible to see the walls of the posterior urethra when the cystoscope is withdrawn down the tube, because in so narrow a channel the prism and lamp are both in contact with the mucosa. In certain circumstances, however, the upper and lower walls of the channel are more widely separated, so that if the ocular end of the cystoscope is depressed and the window is turned downwards, the lower wall of the tube, together with the colliculus, can be clearly

seen (fig. 8). The anatomical basis of this condition is a widening of the proximal urethra, due to relaxation of the internal sphincter, the whole posterior urethra coming to form a funnel-shaped passage having its base directed towards the bladder and its

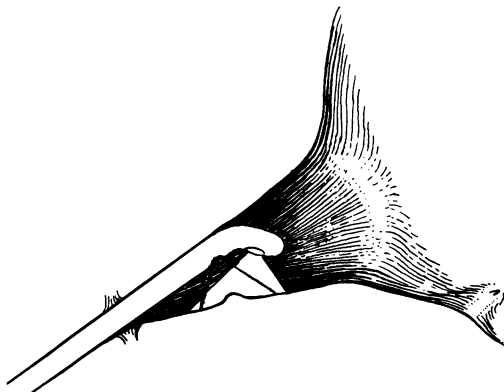


FIG. 8.—Cystoscopic examination of colliculus in “funnel-neck” bladder—type No. 4.

apex near the triangular ligament. This condition is variable in development, according to the degree to which the internal sphincter gapes, and Moro has described four grades (fig. 9) which are useful to keep in mind, as they form a good working basis:—

(1) In the first of these there is radial streaking in the neighbourhood of the bladder-neck, and the transition between the bladder and the urethra is more rounded and gradual than it is in the normal state.

(2) The canal shows early widening, and its lower wall, together with the colliculus, can be dimly discerned in the imperfectly lit channel.

(3) The field is at first dark, but as the cystoscope is further withdrawn it enters a relatively spacious chamber, where the lighting is good. On the floor of this chamber the colliculus is clearly visible.

(4) The condition is fully developed. The bladder orifice gapes widely, and the normal angulation at the transition of the bladder into the urethra fails. The posterior urethra can be visualized in its whole length.

Recently, Mr. Poole Wilson and I have examined a series of twenty-one patients suffering from nervous lesions, for the most part tabetics or general paralytics. It was originally my intention to discuss our findings at some length, but I unfortunately shall not have the time to do so. We propose to publish them in extenso shortly.

Disease	Number of patients	Principal symptoms	Grading (Moro)
Tabes dorsalis	15	Dribbling	7 4; 4; 2 → 4; 3; 3; 3 or 4 → 4; 1 or 2
		Enuresis	
		Automatic micturition	
		Difficulty	
		No symptoms	
		Copious evacuation of urine	3 4; 0; 1 or 2
			2 4; 0 → 4
			3 2 → 4; 4; 2 → 4
G.P.I.	4	Incontinence	2 3 → 4;
		No symptom	2 3; 4
? Tabes; ? G.P.I.	1	Sensation of distension without residual urine	0
Disseminated sclerosis	3		0; 0; 3
Spastic paraplegia	1		0

Suffice it to say that amongst twenty-one tabetics and general paralytics the phenomenon was positive in all except two, whilst an odd example turned up in a

case of disseminated sclerosis. Following Moro's gradings, we found ourselves very sceptical about Types 1 and 2 and only accepted the findings when Types 3 or 4 appeared. Repeatedly we observed that a minor degree of funnel-neck would develop into a major if the bladder was more fully distended, and this is indicated in column 3 of the table, where, not infrequently, two figures may be seen attached to one case. To obtain a good view of the colliculus is the best test of the sign and to do so the ocular end of the cystoscope must be sharply depressed. Otherwise the condition will be overlooked.

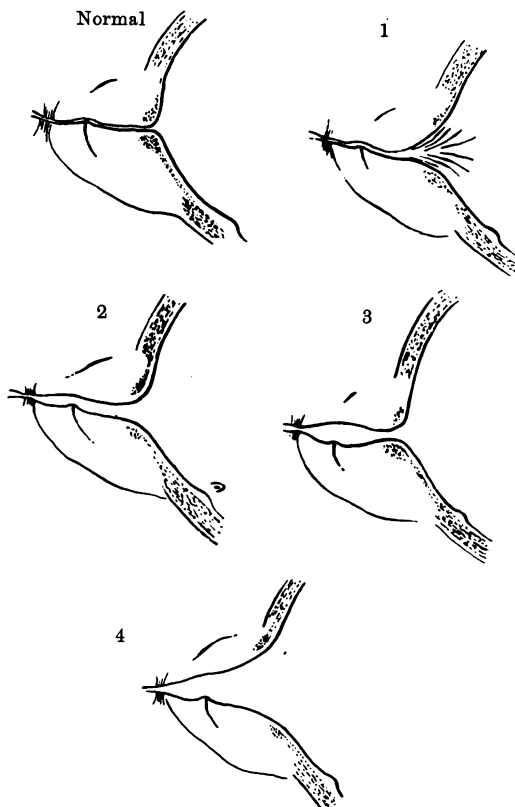


FIG. 9.—Illustrates Moro's gradings. (See text.)

In addition to these twenty-one patients who were known sufferers from central nervous disease, a watch has been kept upon our ordinary cystoscopic material. One hundred consecutive males examined during the present summer produced twelve examples of a funnel-neck. It is relatively easy to account for the phenomenon when discovered in a known paralytic, but when encountered unexpectedly it presents greater difficulties in interpretation and cannot then be explained in every case similarly.

Some of the cases are accounted for by straining to urinate—but then the condition is transitory—some, by the fatigue of prolonged cystoscopy. A few are due to spinal or sacral anæsthesia, but most of these have been checked by subsequent cystoscopy without anæsthesia. One or two may be cases of incipient nervous disease. Some of them are unexplained, so that the question must arise whether the sign is sometimes to be found in the completely healthy man.

This work shows how the internal sphincter bears the brunt of the paralysis in

nervous dysuria and appears to indicate that the external sphincter retains its function comparatively well.

In passing, it is worthy of remark that the internal sphincter, an involuntary muscle, is probably mainly responsible, in health, for continence during sleep, the external sphincter relaxing like other voluntary muscles. The paralysis of the internal sphincter, therefore, may play a part in the nocturnal incontinence which is so characteristic of tabes, though it must be admitted that this is not the whole truth, for the two patients whose war wounds I shall shortly describe are not incontinent at night, nor are those patients incontinent who have had their prostates removed and whose internal sphincter is out of action. We must postulate, therefore, the capacity of the external sphincter to take over this function in the absence of the internal sphincter, under favourable circumstances. That the circumstances are not favourable in tabes is obvious.

With most male tabetics, as is well-known, the capacity for sexual intercourse deteriorates. It remains intact, however, with a proportion. Fessler and Fuchs investigated fourteen cases of tabes who were still potent, and they obtained a clear history from three of them that intercourse and orgasm were normal but that there was complete absence of ejaculation, the flow of semen undoubtedly taking place into the patient's own bladder as a consequence of the breakdown of nature's barrier, the internal sphincter. These writers also state that where there was a severe lesion of the internal sphincter it became impossible to express the prostatic secretions by means of massage, in such a way that they would present at the external meatus, for the whole of the fluid regurgitated into the bladder.

We did not ourselves question all our patients about their sexual functions. Sometimes we were working in public-assistance hospitals with the nursing staff present, whilst not a few of the patients were of low intelligence. Two of the tabetics, however, were quite definite that orgasm without emission occurred routinely in their recent experience. On the other hand, two patients with funnel-necks of No. 4 grade quite unexpectedly reported normal ejaculation.

I propose now to tell you of two unusual and interesting patients who suffered gun-shot wounds of their bladder-necks.

(1) Lieut. ——— was referred to me by Dr. McBain (Crumpsall). In September 1916, he was wounded in Delville Wood on the Somme. When walking near the front-line trenches about 5.30 in the evening he was hit by a rifle bullet which entered just behind the trochanter of the right femur. Three months later the bullet was removed from a site behind the left femoral trochanter, which fact probably serves to indicate accurately the line taken by the missile. He states that his bladder was full at the time and he experienced "extreme pain in trying to get rid of the water." Efforts at micturition proved unavailing, but some faeces were passed and these were noted to be blood-stained. His legs appeared to be paralysed, but he dragged himself back by his arms after dusk (8 o'clock). Catheterization was undertaken at an advanced dressing station and was repeated later. On the third day a suprapubic cystostomy was performed at a casualty clearing station (? 38th). He says that "there were no broken bones and the paralysis of the legs passed off after a few hours." There was no more blood from the rectum. The bladder healing was slow, and early in 1918, when still in hospital at Stratford-on-Avon, he developed a "septic kidney on the right side." After that he had intermittent febrile trouble and pyuria, and in 1928, his symptoms becoming more pronounced, I removed a pyonephrosis of the right kidney. After that the pyuria disappeared and the urine became quite normal. The febrile disturbances also ceased, and (seen within the last few weeks) he reports that he is in excellent health.

Prior to his operation (1928) he had discussed with me the fact that since he was wounded he had never experienced an ejaculation of semen, even though periodically sexual excitement led to a normal orgasm. As he was engaged to be married this circumstance gained additional importance. In view of this the endoscopy of his bladder and urethra, which I performed on three occasions, is of interest. I shall omit that part of the examination which concerns his pyonephrosis and urinary sepsis, as this is merely incidental,

and shall describe only the condition of the bladder neck. I think you will agree with me that the bladder shows wonderful powers of recovery from injury and that frequently it is difficult even to recognize the site where one has oneself operated. In this case I find it difficult to describe my findings. There was a loss of tissue affecting the posterior half of the meatus, such that the bladder cavity and the proximal portion of the prostatic urethra were laid into one, the trigone appearing to run flatly into the posterior urethra. An attempt to bring the colliculus into view was not successful. A posterior urethroscope of the Joly type confirmed this observation, the patent opening into the bladder being conspicuous and the prominence of the uvula vesicæ being absent. The urethral orifice appeared rigid and was roughly triangular in shape, the base of the triangle being placed postero-inferiorly. There is therefore little doubt that the bullet had crossed the neck of the bladder somewhere behind its mid-point and had destroyed the internal sphincter.

This patient has now been married for six years and states that coitus and orgasm appear to be completely normal, but that he has never had an emission. Asked whether coitus could occur when the bladder was full he replied in the affirmative. There has been no nocturnal incontinence.

(2) . . . aged 34 was referred to me on August 16, 1931, by Dr. W. Fletcher Shaw, Professor of Gynæcology at Manchester University, who had been consulted by the patient's wife because she had been married for nine years and the marriage was childless. Inquiry showed the male partner to be at fault and the latter was advised to consult me.

In July 1917 this patient had been wounded at Ypres. During an attack he was emerging from a shell hole when he was struck by a rifle bullet. Apparently his thigh was in full flexion and the bullet entered above the knee on the inner and anterior aspect, traversed the subcutaneous structures for several inches, when it emerged, to re-enter over the right pubic bone and again emerge immediately to the right side of the coccyx. The right testicle and scrotum were destroyed in transit. After lying out for seven hours he lost consciousness. He states that his legs were not paralysed but he had no desire to get home as he was convinced that he was dying. He knows that his bladder was full before the attack began and after being wounded he experienced the greatest desire to urinate. He put his hand to the position of the coccygeal wound of exit and realized that a mixture of blood, fæces, and urine was exuding freely.

A catheter was passed at the casualty clearing station and a little blood-stained urine was withdrawn. Subsequently a suprapubic cystostomy was performed. From that time until the beginning of December, urine and fæces both came from the suprapubic wound. The bowel was then closed by operation. Shortly after this a piece of bone was removed from the bladder, after which progress was rapid. He was able to walk on Christmas Day. About midsummer he passed urine naturally. From this point convalescence was satisfactory until 1919, when he had what appears to have been a sharp attack of cystitis.

He married in 1922. Coitus proved to be normal in every way except that ejaculation was absent. His condition remained unchanged during the subsequent nine years, when he visited me. The patient says that spermatic fluid is unmistakable in the urine when it is next passed. He also states definitely that coitus can be undertaken when the bladder contains urine though it is never indulged in when the bladder is distended.

*On examination.*—He was a well-developed man. The entrance wound of the thigh was small and lay over Hunter's canal. The wound of emergence higher up the limb was several inches long and one to one and a half inches wide. It was covered with thin atrophic skin. There was considerable superficial scarring to the right side of the penis. The right testicle and the corresponding side of the scrotum were missing and there was a depressed area of scar,  $2\frac{1}{2}$  in.  $\times$  2 in., over the position of the right os pubis, which bone had been carried away. The thickened end of the ascending ischial ramus was easily felt in the groin. The wound of exit lay immediately to the right side of the coccyx and that bone was present, though apparently thickened owing to injury. There was a single rather wide suprapubic scar.

The urine was passed into two glasses and proved to be free from pus, albumen, or other abnormal constituent. There was no difficulty in micturition nor in commencing or controlling the act. He never wet the bed at night.

The cystoscope passed into the bladder without obstruction. The mucosa was healthy and the bladder normal in every particular with the exception of the region of the neck. On the right-hand side of the bladder outlet there was a deformity which evidently resulted from a loss of tissue. A notch was cut in the circle of the internal sphincter and the corresponding

portion of the right lobe of the prostate extending from 8 to 11 o'clock. This was slightly irregular in shape but was lined with healthy mucosa. The bite continued externally to involve an area of bladder wall which was sunken like a shallow, wide-mouthed diverticulum. On withdrawing the cystoscope into the prostatic urethra, that channel could be inspected only at the position where there was loss of tissue and the veru was not seen.

Attempts at artificial insemination were made by Professor Fletcher Shaw, the semen being recovered following coitus from the patient's bladder by means of an Ultzmann syringe, but these attempts proved unavailing.

This is a remarkable pair of cases, for it must be most unusual to meet instances in which this small but important area has suffered from a gunshot wound. The relative youth of these patients makes them more suitable material for the study of sexual functions than is the elderly prostatic or broken-down tabetic. The interest centres on the effect which the destruction of the internal sphincter has on emission. I would repeat that in each case coitus was normal except that emission failed and in each case intercourse could be safely undertaken, even when it was known that the bladder contained urine.

For purposes of contrast, I wish to cite another pair of cases reported by Brenner.

In these there was a gunshot wound of the spine resulting in an "automatic bladder," much residual urine and a "funnel-neck." Continence here again rested entirely on the external sphincter and though the voluntary control of that muscle had been lost the patients were completely continent both by day and night. Micturition was only possible by the manual expression of the bladder contents. The significant fact in these two cases was that in each the onset of an erection was accompanied by a slight trickling of urine, which continued till the erection subsided or until the normal level of residual urine was reached. Should ejaculation occur, the outflow of urine was more rapid immediately before and during the ejaculation. This phenomenon of micturition during erection, and especially during emission, is explained by Brenner on the assumption that simultaneously with the closure of the internal sphincter which accompanies erection, the external sphincter, which has no urinary function once the internal sphincter is in spasm, relaxes in preparation for emission. In the presence of a paralysed internal sphincter, bladder control was completely lost.

The examples of operative injury and of gunshot wound of the internal sphincter which I have been discussing previously, seem to indicate the behaviour after a simple localized injury of the internal sphincter. Brenner's cases, on the other hand, introduce a partial implication of the external sphincter. Reviewing these groups together, I think that it is fair to conclude:—

(1) That Brenner's cases show that with the onset of erection the external sphincter weakens and that the dilatation becomes more pronounced during emission, events which are not cause for surprise.

(2) On the other hand it is evident, from a study of the behaviour of the bladder sphincters in my own groups of cases, in which the internal sphincter alone was damaged, that the external sphincter does not relax sufficiently to allow sperm to pass unless the internal sphincter is tightly contracted, and it seems justifiable therefore to assume that a certain pressure must be developed in the posterior urethra before the signal is given for the external sphincter to yield and permit emission.

It is interesting in passing to observe that in coitus the relative efficiency of the two sphincters is the exact opposite of that occurring normally. Suppuration in the posterior urethra, when it has overdistended that department of the tube, finds an outlet, not through the external sphincter to the exterior, but through the internal sphincter to the bladder. This is a well-known clinical fact on which two or three glass tests depend in the diagnosis of posterior urethritis. The external sphincter is thus normally the more powerful muscle. But in coitus the position is reversed, the internal sphincter being tightly contracted and the external yielding so soon as



pressure rises in the posterior urethra. If, from any cause, the internal sphincter fails to play its part, regurgitation into the bladder takes place. Moreover it appears that the external sphincter does not in these circumstances open up at all, for, as I have shown, coitus can be effected even in the presence of urine in the bladder, which indicates clearly that the factors causing yielding of the external sphincter were missing.

In further illustration of the association between erection and closure of the internal sphincter may be advanced the observation that certain patients with bladder stones suffer from priapism. Swift Joly says that he has met with this symptom chiefly in youths about the age of puberty and that he has never seen it in adults. I have, however, known priapism prove troublesome in adults, a relevant example being that of a man aged 45, who presented himself with a phosphatic bladder-stone, three-quarters the size of a golf ball. There was a moderate degree of accompanying cystitis and definite frequency of micturition. This patient complained that he had for some months suffered from priapism which was prolonged and might be painful. When it was protracted the call to empty his inflamed bladder became imperative, but he then found micturition to be impossible until the erection subsided. Here again, therefore, we seem to meet the association between spasm of the internal sphincter, provoked presumably by the irritation of the stone, and erection of the penis, an alliance which appears to have its physiological basis in the necessity for bladder closure during coitus.

(3) When the sexual act is effective but no ejaculation eventuates, the patients invariably express the view that the orgasm is completely normal and satisfactory. This fact would seem to suggest that the orgasm is not dependent on the distension of the posterior urethra or the propulsion of spermatic fluids along the urethra. By exclusion, therefore, we are led to the view that it results from stimulation of that sensitive structure, the verumontanum, by the emerging semen.

By some authorities it is stated that in coitus the passage of sperm into the bladder is prevented by the turgescence of the verumontanum. I would submit that the various cases I have cited this evening prove that this is an insufficient barrier, if indeed it is a factor at all. The verumontanum remains unaffected by prostatectomy, it is not involved by tabes, nor was it injured in the two war wounds which I have recorded. Yet in all these conditions ejaculation fails. I doubt whether swelling of the verumontanum is even an accessory factor, for if such had been one of its functions it would have been placed at the upper end of the prostatic urethra and not in the middle or lower reaches. It is, in my opinion, undoubtedly to the internal sphincter that this important office is entrusted. Possibly if per-urethral surgery maintains its present meteoric advance, eugenic sterilization will soon be available by the cystoscopic division of the internal sphincter!

Much experimental work has been done in the past on the bladder and its sphincters and in this work British physiologists and urologists hold a proud position. I have carefully excluded this field from my address to-night. Ultimately the two provinces are one, and must eventually be found in complete harmony. Physiologists themselves would probably be the first to concede that the results of experimental work may gain much by a review of the clinical field, and even that they require checking by clinical observations, with which they are not always in complete accord. Thus, examples may be instanced of nerves carrying fibres to muscles which physiologically antagonize each other, or, at least, do not act simultaneously. The common experiment of stimulating such a nerve may throw into action muscles, or groups of muscles, which are incompatible or antipathetic. An instance of such apparent discordant result may be seen in the *nervi erigentes*, stimulation of which nerves simultaneously causes an erection of the penis and a contraction of the vesical detrusor, two processes which we have, during the present paper, repeatedly recognized to be physiologically opposed. We

as clinicians assume that such a nerve supplies groups of muscles which act separately or perhaps antagonistically.

To spend an hour therefore examining the problem solely from the functional and clinical standpoint has, I trust, not proved profitless.

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