type of ending has already been described in this lecture as being sympathetic efferent in character. The intrafusal fibres seem, therefore, to have a single efferent innervation which is sympathetic in origin. This is in itself a point of great importance, for it suggests that other fibres may be similarly innervated.

I suggest, therefore, that the skeletal muscle of vertebrates consists of two sets of muscle fibres disposed in groups each with its own specific innervation, and, consequently, its own specific function, the experimental investigation of which will be discussed in the next lecture. I shall then endeavour to establish the proof of the following claims. The fibres receiving somatic nerve endings are concerned in shortening as the result of voluntary and of reflex activity, and in isometric contraction during the continuation of the stimulation. These fibres are responsible, therefore, for voluntary movement and for what Langelan¹⁰ calls "contractile tone." They are comparable to what Sherrington calls the "movement muscles" of invertebrates. Other fibres, innervated by the sympathetic system, are first inhibited and then lengthened and shortened during these processes, and remain at the new length passively imposed upon them. In other words, these fibres exhibit what Sherrington has called "plastic tone." They are comparable to the "fixing muscles" of invertebrates. During movement these fibres aid in supporting the weight of the moving part. At the termination of movement they take part in maintaining the position attained as the result of the movement.

Further, some of the "fixing muscle" fibres appear to be included within a sheath to form the special sense organs (muscle spindles) which transmit afferent impulses to the central nervous system by means of somatic sensory fibres. The degree of lengthening and shortening imposed upon these intrafusal fibres is maintained by the influence of their sympathetic innervation. Epilemmal sympathetic endings found on other fibres that receive also a sympathetic motor innervation probably constitute in a similar way sympathetic proprioceptor organs.

All the evidence related above in regard to the exact mode and the function of the double innervation of skeletal muscle indicates that the differentiation of muscles into "movement" and "fixing muscles," which is so apparent in some invertebrates, is not lost in vertebrates. These two muscle systems of invertebrates are represented as small muscle groups which mingle together to constitute the skeletal muscles of vertebrates.

From the standpoint of physiology the existence of such an arrangement would readily account for the marked similarity in the behaviour of the "catch" mechanism of invertebrates and the activities of skeletal muscle in maintaining posture. In reviewing the points of comparison between the two processes, Bayliss recalls the suggestion of A. V. Hill that a more efficient mechanism of maintaining a weight must be exhibited under natural conditions than that displayed by the sartorius muscle of the frog when its nerve is stimulated by induction shocks. He compares also the process of inhibition of the "catch" mechanism (von Uexküll) with that of the tonic contraction of skeletal muscle during decerebrate rigidity (Sherrington); and he calls attention to the existence of an extremely low rate of metabolism during the activity of the "catch" mechanism (Parnas, Bethe) and of skeletal muscle in the state of decerebrate rigidity (Roaf, Lovatt Evans). If separate muscle fibres exist in vertebrate skeletal muscle for the fixation of posture and for active and reflex shortening and for isometric contractions of the muscle, the differences in metabolism and in the nature of inhibition during the manifestations of these activities of the two different muscle groups will be readily comprehended.

From the pathological standpoint this view introduces a line of attack to relate the symptomatology and pathology of such diseases as myotonia atrophica, the muscular dystrophies, and myasthenia gravis. In poliomyelitis it has long been known that sometimes the sympathetic ganglia partake of the degeneration found in the lower somatic motor neurone system. Such cases are, no doubt, those in which the tone of the muscle affected is completely lost. In other cases, in which there develop rapidly structural deformities due to the tendency for the limb to remain fixed in posi-

tions imposed upon it, the sympathetic innervation probably remains intact. Further, according to this conception, the operation of sympathetic ramisection for spastic paralysis consists in removing the nerve supply to the fixing muscle fibres only. All the movement fibres remain entirely unaffected. This, no doubt, accounts for the efficiency of the partly denervated muscles after long periods of time—for example, twelve months. On the other hand, according to the prevailing theory of the existence of the double innervation of each individual muscle fibre, the operation would entail partial loss of the nerve supply of each fibre of the muscle; or, more precisely, that the sarcoplasm of each muscle fibre is deprived of its nerve supply. This is unlikely in view of the unimpaired activities of reflex and of active shortening of the muscles which remain for long periods after the operation.

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PER-URETHRAL OPERATIONS FOR PROSTATIC OBSTRUCTION.

BY

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THE introduction of suprapubic prostatectomy in 1901 led almost immediately to the abandonment of the various palliative methods of treatment that had previously been tried with indifferent success. Since that time prostatectomy has grown in popularity, so that nowadays it is regarded by many surgeons as a routine method of treatment to be carried out in all cases of enlargement, except where some special contraindication exists. With improved technique the mortality of the operation has steadily diminished, so that patients who thirty years ago would certainly have been condemned to catheter life are now subjected to operation. But great as has been its success, prostatectomy must still be regarded as a serious operation and one that, even in the hands of the most competent, is attended by a comparatively high mortality rate. In view of this and of the fact that there must exist cases in which prostatectomy is unjustifiable, it may not be out of place to describe certain less drastic procedures which, in suitable cases, give excellent results.

Objections to Partial Removal of the Prostate.

Three criticisms are usually levelled against any operation that fails to effect a complete removal of an enlarged prostate: first, that the treatment is likely to fail in its object; second, that even when it succeeds the results are temporary; and third, that as an apparently innocent prostate may microscopically show malignant changes it is unwise not to remove it. The first two of these objections will be discussed more fully later. Suffice it for the moment to state that the whole success of partial operations on the prostate depends on a judicious selection of cases, and that failures are generally due to an ill advised attempt to tinker with a large prostate that is amenable only to total enucleation.

With regard to the third objection, as long ago as 1900 Albarran and Hallé called attention to the fact that a certain number of prostates which clinically appeared to be examples of innocent enlargement showed malignant changes when examined microscopically. This observation has since been confirmed and a figure approximating to 14 given as the percentage of cases in which these changes are found. From this it has been argued that as it is impossible to be sure that an enlarged prostate is pathologically innocent the wisest procedure in all cases is to carry out total prostatectomy. This argument for the wholesale removal of enlarged prostates would be unanswerable but for two facts—the first, that total prostatectomy itself has

a very high mortality rate; the second, that even if a prostate showing malignant changes be enucleated the patient runs a very considerable risk of a recurrence at some future date.

In balancing risks, therefore, it is necessary to remember that the diminished likelihood of future malignant trouble may in certain cases be more than neutralized by the immediate risk of prostatectomy. Exactly what that risk is depends on a great many factors, but at a large general London hospital I find that the mortality rate of prostatectomy for simple enlargement during the years 1914 to 1923 works out at 22 per cent. This is undoubtedly high when compared with the figures given by genito-urinary experts, but even the more favourable figures show that the death rate is above 5 per cent. It is therefore impossible to lose sight of the fact that prostatectomy must even nowadays be considered a dangerous operation. It is still more difficult to estimate the amount of protection from future malignant trouble afforded by total removal of the gland, but in this connexion it is interesting to note that of the five clinically innocent but pathologically malignant prostates recently removed by R. H. J. Swan two recurred in spite of the complete prostatectomy. It would therefore seem probable that too much emphasis has been laid on the argument that it is wise to remove all enlarged prostates simply on account of the risk of their being malignant, and, that being so, it is illogical to condemn offhand all partial prostatectomies.

Since failure to obtain satisfactory results from partial operations is generally due to faulty selection of cases, it is important to consider what forms of prostatic obstruction are suitable for such treatment. First amongst these suitable cases is that which is generally known as the prostatic bar.

Prostatic Bars.

It has long been recognized that there are patients who have all the symptoms commonly associated with prostatic obstruction and yet in whom rectal and even cystoscopic examination fails to reveal any enlargement. This condition has been termed variously, sclerosis of the internal sphincter, contracture of the vesical neck, atrophy of the prostate, atony of the senile bladder, or, in French, "prostatisme sans prostate," but the mechanism underlying the obstruction is the same. The symptoms resemble closely those due to prostatic enlargement—namely, frequency and urgency in micturition, difficulty or delay in starting, progressive diminution in the force and calibre of the stream, and an increasing amount of residual urine, but not infrequently these begin earlier in life than is usual with general enlargement of the prostate.

The diagnosis rests chiefly on an examination of the posterior urethra and vesical neck, the cause of the trouble being found in a bar formation which affects either the

FIG. 1. — Sagittal section through a prostate showing a common type of fibrous bar, with thickening of the posterior lip, increase in the distance between the vesical orifice and the perivesical tissues, and a diminution in that between the orifice and the verumontanum. The dotted line marks off the area removed by operation.

sagittal section there is a diminution in the distance between the vesical orifice and the verumontanum, and an increase in that between the vesical lip and the perivesical tissue. It is undoubtedly due to an increase in fibrous tissue following some old-standing inflammatory process such as a chronic prostatitis. The second type described by Randall is similar to the first, except for the fact that the bar projects upwards so as to encroach

on the trigone rather than forwards towards the prostatic urethra. In the third and fourth types the bar is glandular, being due to hypertrophy of the submucous glands of the posterior commissure in the one case, and of the glands of Albarran in the other. In none of these cases is the enlargement other than local, and yet the presence of hypertrophy of the bladder, trabeculation, etc., as associated conditions shows that a definite degree of obstruction exists.

However, it may be urged that even if prostatic bars of this nature exist they are so rare that, from the point of view of the practical surgeon, their importance is negligible. I cannot agree with this criticism. It has been my experience that the more careful the preliminary investigations of patients presenting themselves for prostatic obstruction, the more important does this type of case appear. How frequently has one seen a bladder opened in the expectation that a prostate suitable for enucleation would be found, and in place of this a small fibrous gland discovered which could only be removed piecemeal by scissors and forceps! Most surgeons have memories of struggles with the "small fibrous type of prostate," and not a few of their patients have been returned to bed unrelieved of their obstruction. It is difficult to find figures that will give an accurate idea of the commonness of such cases, but probably the most comprehensive are those obtained from Randall's *post-mortem* room investigation. Out of 158 subjects showing prostatic abnormalities after death, 33.5 per cent. were examples of bar formation. As Randall's findings are very instructive in showing the relative frequency of other forms of prostatic enlargement his figures are appended:

Relative Frequency of Various Forms of Prostatic Enlargement (Randall).

800 Necropsies.	158 Prostatic Abnormalities.	
	Number.	Per cent.
Lateral lobe hypertrophies alone	29	18.4
Median lobe hypertrophies alone	42	26.7
General trilobar hypertrophies	22	14.0
Anterior lobe	3	1.9
Carcinoma	8	5.0
Sarcoma	1	0.6
Median bar—fibrous	8	5.0
" " glandular	13	8.2
" " not classified	18	11.4
" " small and non-obstructive ...	14	8.9
	158	

But the proof that bar formations are of frequent occurrence does not rest on *post-mortem* findings alone. J. R. Caulk, who has made a special study of this condition, reported in 1921 that of the cases consulting him for obstructive symptoms, 20 per cent. were examples of bars, and since that time, with a better understanding of the condition and improved methods of examination, he has found a considerably higher rate of incidence. My own observations, so far as they go, are in harmony with Caulk's.

Young's Punch Operation.

In 1909 H. H. Young devised an endoscopic tube by means of which prostatic bars could be removed through the urethra under local anaesthesia. Although the early instrument was in the form of a urethroscope, it was soon found that the operation of punching out an obstructing bar could be carried out efficiently without visual observation, and the original apparatus was abandoned in favour of one of simpler design (Fig. 2), consisting of an outer sheath with a window and an inner tube with a sharp cutting edge. It is employed as follows.

The bladder is distended with fluid and the instrument introduced with the inner tube pushed home so as to close the opening in the sheath. The instrument is then withdrawn with the opening uncovered so that on reaching the urethra it engages the prostatic bar, an event that is signalled by the sudden stoppage of the fluid escaping from the bladder. The operator then pushes home the inner cutting tube and excises a small fragment of

tissue. As a rule more than one cut is necessary, the foregoing proceeding being repeated, and two or three fragments removed in turn.

Since the introduction of this instrument various modifications have been made by different workers. The chief criticism levelled at Young's punch operation has been that it is liable to be followed by haemorrhage. However, although this is usually fairly brisk for a short time after operation, it does not often occasion any real anxiety. Personally I have not encountered difficulties in this direction, and my reason for abandoning Young's operation in favour of other procedures is that I have been dissatisfied with the small amount of tissue that can be conveniently removed by this method.

The Cautery Punch.

Four years ago J. R. Caulk introduced a punch in which the inner cutting tube acted at the same time as an electro-cautery, thereby reducing the risk of haemorrhage and increasing the amount of tissue removed by the operation.

In his instrument the cutting is done by a circular platinum-iridium knife, carefully insulated from the rest of the instrument and heated to a dull red heat by a suitable electric current. It has been found unnecessary to provide water cooling for the outer tube since the whole of the burning operation can be carried out within the space of five or six seconds, and very little general heating occurs. In dividing the bar the inner tube is given a rotatory motion, and should it be considered advisable to increase the action of the cautery the tissue may be resected by pulling backwards the blade at half heat.

It is of the greatest importance in using Caulk's instrument to employ the right form of current, and reliable results can only be obtained by using an alternating current of about 10 volts and 150 amperes. This unfortunately limits the utility of the instrument, for the current available in different localities varies considerably, and will have to be modified in certain cases by the use of cumbersome and costly transformers. At any rate, after having made various efforts to overcome these electrical difficulties in London, I came to the conclusion that they constituted a serious objection to what was otherwise an excellent weapon, and I discarded Caulk's cautery punch in favour of the instrument described in the next paragraph.

The Diathermy Punch.

The instrument described below has been constructed for me by Mr. Schranz of the Genito-Urinary Manufacturing Company, to whose ingenuity in design I give full credit.

In external form it resembles the Young punch, but the sheath is constructed of bakelite—an excellent insulating material allied to vulcanite—with a metallic lining. This lining only comes to the surface at the edge of the window situated below the beak; elsewhere it is insulated from the urethra by the bakelite covering. (See Fig. 2.)

FIG. 2.—(1) Sheath with attachments—(6) for current to lamp, (7) diathermy apparatus; (2) bougie guide screwed to sheath; (3) obturator; (4) punch.

into a posterior urethroscope of the Gueringé type. Under guidance of the eye the punch is now withdrawn until the bar is seen to engage the window. Once it is in position the instrument is held firmly and pressure exerted on the bar by slightly raising the proximal end. Connexion is then made with the source of diathermy current. Immediately the current is turned on the inner metallic layer of the sheath becomes a urethral electrode, but owing to the insulation conferred by the bakelite covering the only point of contact with the urethra is the edge of the window engaging the bar. From this edge can be observed to spread a line of coagulation which within ten or fifteen seconds whitens the whole area of prostate engaged. By maintaining continuous irrigation the process of diathermy can be carried out under complete ocular control, the current being turned

off when it is judged that a sufficient depth of tissue has been destroyed.

In order to remove the wedge of destroyed tissue and thus obtain immediate benefit without waiting for the separation of sloughs, the telescope and lighting system is withdrawn and an inner tube, resembling that used in the Young punch, inserted. By pushing this home and giving it at the same time a slight rotatory movement, a core of destroyed tissue about 2 cm. in length and 0.5 cm. in diameter may be removed. This does not, however, constitute the whole amount of prostatic tissue destroyed by the operation, the full benefit of which will only be obtained at a later period when the sloughs have separated. The telescope and lighting system may then be reintroduced, the area of operation inspected, and a decision arrived at as to whether any further fulguration is required. If the operator is satisfied with the amount of tissue dealt with, the bladder is emptied, the obturator inserted, and the instrument withdrawn.

It is obvious that the diathermy punch briefly described above offers many advantages over both Hampton Young's and J. R. Caulk's instruments, the chief of these being the avoidance of all possibility of haemorrhage by the use of diathermy, and the fact that the whole operation is conducted from beginning to end under the guidance of the eye. The use of the inner punching tube gives the same immediate advantages conferred by Young's instrument, and besides this there is the diathermy action, which adds so much to the efficacy of the operation, and which is absent in Young's procedure. It is, indeed, not unusual for a patient with complete retention to empty his bladder a few hours after treatment with the diathermy punch and for his stream to improve still further with the subsequent separation of sloughs. Minor improvements are still being made in the instrument.

Fulguration of the Prostate.

As an alternative to the punch operation prostatic bars may be dealt with through a posterior urethroscope carrying a diathermy electrode. This form of treatment has been championed in France by Luys, and in suitable cases gives good results. In England the method has on the whole been neglected, and for this reason no apology will be offered for dealing with it at some length.

Any good operating posterior urethroscope may be used for the purpose of fulguration. My own practice is to employ two instruments—a direct-vision endoscope of the Gueringé or Joly type and the new prismatic operating cysto-urethroscope made by Wolfe. With the former I map out my field of operation, since it gives a clearer idea of the topography of the posterior urethra and of the mechanics of the obstruction than does the prismatic instrument. Having achieved this, I discard the direct-view urethroscope in favour of the Wolfe cysto-urethroscope, which has the great advantage of permitting the use of a larger electrode (No. 8) than the Gueringé instrument, and of thus shortening the time consumed by the operation. A current of from 500 to 2,000 milliampères is used, and throughout the whole operation a copious stream of fluid is kept circulating through the instrument in order that a clear field of vision may be maintained. The position of the patient, the general arrangements of the theatre, and the preliminary stages of the operation are the same as for a cystoscopy. A general anaesthetic is as a rule required, but in certain cases where this has been inadvisable I have operated under local anaesthesia, the prostate being infiltrated with novocain through a needle mounted on the end of a ureteric catheter. In any case, once the instrument has been introduced and fulguration started only light anaesthesia will be required. Special arrangements must be made to allow of continuous irrigation throughout the operation, and for this purpose a large-sized irrigator should be used and kept filled. In those cases in which a preliminary suprapubic drainage has been carried out there is, of course, no danger of overdistension of the bladder, and all that is necessary is to attach a length of rubber tubing by means of a glass connecting piece to the suprapubic drain and to lead the irrigating fluid into a bath placed beneath the operating table. In all other cases, however, the operator will have to keep an eye on the condition of the bladder throughout the operation, and at intervals evacuate.

FIG. 3.—Fulguration in a case of obstruction due to bar formation. In addition to the bar there exists a minor degree of enlargement of the right lobe.

It is usually more convenient to start fulguration at the bladder neck and to work towards the urethra. The method

is the same as in dealing with bladder growths, and the chief difficulties likely to be encountered are those associated with keeping a clear field and with recognizing the exact position of the operating electrode. Obscuring of the visual field may be due to blood, debris from the destroyed tissue, and bubbles of hydrogen given off at the electrode. The first two obstacles to clear vision are removed by irrigation, and the third by rotating the instrument so that the bubbles may escape to the upper part of the field. The time required to complete the operation depends on the amount of prostate requiring removal, the strength of current, and the calibre of the electrode; it may be as much as an hour where a large amount of tissue has to be dealt with. In the simplest type of prostatic bar all that is necessary is to cut a channel through the ridge so that the level of the bladder neck is flush with that of the urethra, and to widen and deepen the channel sufficiently to provide a free exit for the urine. When some lateral enlargement is associated with the bar formation it will be necessary to deal with this as well (see Fig. 3). As in the case of the bar, the portion of the lateral lobes nearest the bladder should be attacked first, the optical end of the instrument being raised so that the electrode lies in the lower part of the cleft between the enlarged lateral lobes. Energetic treatment of the adenomatous masses will be necessary if the result is to be satisfactory. Both sides should be attacked at the same sitting, each portion of the obstructing lobes being brought in turn under treatment from the level of the bladder neck outwards towards the verumontanum. Where more than a slight degree of enlargement exists several sittings may be required.

Very little after-treatment is necessary, and it is not my practice to tie in a catheter. A most remarkable point is the complete absence of pain or haemorrhage, or indeed of any other complication, after this operation. What little bleeding there is at this early period is usually due to the trauma of instrumentation, and ceases within a few hours. Most patients are able to get up and, if necessary, to leave hospital or nursing home the day following the operation, and their discomfort is certainly not greater than that commonly experienced after a cystoscopy. An alteration in the stream is not usually noted for four or six days, but as sloughs begin to come away an improvement occurs. The separation of these sloughs may be encouraged by posterior irrigation according to Janet's method. In those cases in which more than one sitting is required an interval of three to four weeks should be allowed between operations so as to allow time for the separation of the sloughs and the subsidence of the reaction. The procedure at the second or third operation is exactly similar to that of the first, and as a rule it will be found that the work is considerably easier than on the previous occasions. In the majority of my own cases two sittings have been sufficient.

SUMMARY AND CONCLUSIONS.

It has already been stated that the methods of treatment described in this paper are only to be regarded as a substitute for prostatectomy in certain types of case, and that diathermy or punch operations, used indiscriminately, are bound to lead to disappointment and failure. The type of case for which these methods are eminently suitable is the prostatic bar, but fulguration may also be used against the lesser degrees of glandular enlargement when for one reason or another prostatectomy is difficult or dangerous. If, however, the prostate be considerably enlarged the results obtained will in all probability be incomplete and transitory. Fulguration may also be employed, but with less certainty of success, in cases of post-operative obstruction, and in cases of malignant disease of the hard sclerotic kind.

For the sake of convenience the conclusions reached in the foregoing paper will be tabulated as follows:

1. Total prostatectomy, in spite of a fall in mortality, must still be regarded as a serious operation and one that in many cases is attended with very considerable risks.
2. The arguments for removing all enlarged prostates as a precautionary measure against malignant disease are not entirely sound, since enucleation of a gland showing malignant changes is no guarantee against recurrence, and

the immediate risk of a prostatectomy may in some cases be greater than the remote risk of malignancy.

3. Treatment by punch operations and by fulguration is of the greatest use in certain types of obstruction. These procedures are particularly suited to cases of prostatic bar, and of minor enlargement where enucleation, owing to the existence of complications, would be difficult or dangerous.

4. Success in the use of these minor operations depends on the exercise of a nice discrimination in the selection of cases. For this reason the very greatest care and thoroughness must be employed in the preliminary investigation. Otherwise the results will be uncertain and short-lived.

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THE SURGICAL TREATMENT OF CHRONIC ULCERATIVE COLITIS.

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THE medical treatment of chronic ulcerative colitis has, in my experience, proved extremely unsatisfactory. The ordinary intestinal antiseptics by the mouth are practically useless, and the great difficulty is to determine when active surgical interference should be decided upon. There is no hard and fast line in determining when cases of colitis reach the chronic stage.

There is no doubt that a large percentage of Indian troops are "carriers" of dysentery, especially of the amoebic form; in peace, when they are comfortably housed in cantonments where they have their normal rations and are not exposed to hardships and fatigues, they suffer little or no inconvenience. The same men under field service conditions, when their rations vary in quality and quantity, usually for the worse, and especially when they are exposed to cold and wet weather, soon manifest symptoms of colitis.

My own experience of these cases has been gained under field service conditions on the north-east frontier of India, 1911-13, and in Mesopotamia during the recent war. During the operations on the north-east frontier *post-mortem* examinations in cases of colitis revealed the intense and extensive ulceration of the large intestine which can occur; the conditions impressed me with the utter hopelessness of medical treatment. It must be remembered that Indian troops are far more susceptible to scurvy than European troops; in my experience of active service, it takes about three months from the beginning of a campaign for the disease to show itself. The presence of scurvy or of a tendency to it is a very serious complication in cases of colitis and seriously aggravates the condition.

During the recent war (1914-18), while acting as surgeon to an improvised hospital for Turkish prisoners in Mesopotamia, and later as civil surgeon of Baghdad, an opportunity arose of observing a large number of cases of colitis; the majority were chronic and were complicated by scurvy. The combination of these two diseases made the colitis extremely intractable, and in consequence large numbers died.

While in Mesopotamia I performed appendicostomy for intractable ulcerative colitis in ten patients—Turks, Arabs, and Indians. They were all extreme cases, and all were complicated with scurvy in its various stages. The operations were performed under chloroform, and owing to the emaciated condition of the subjects the appendix was easily and rapidly approached in all cases. In the first two cases the appendix was not opened for two days, but in the remaining eight it was opened at the time of the operation, and lavage carried out at the same time, the wound being sealed with collodion. After a few irrigations of the large intestine the patients began to show remarkable improvement. The cachectic appearance due to the intestinal auto-intoxication disappeared and the general condition improved