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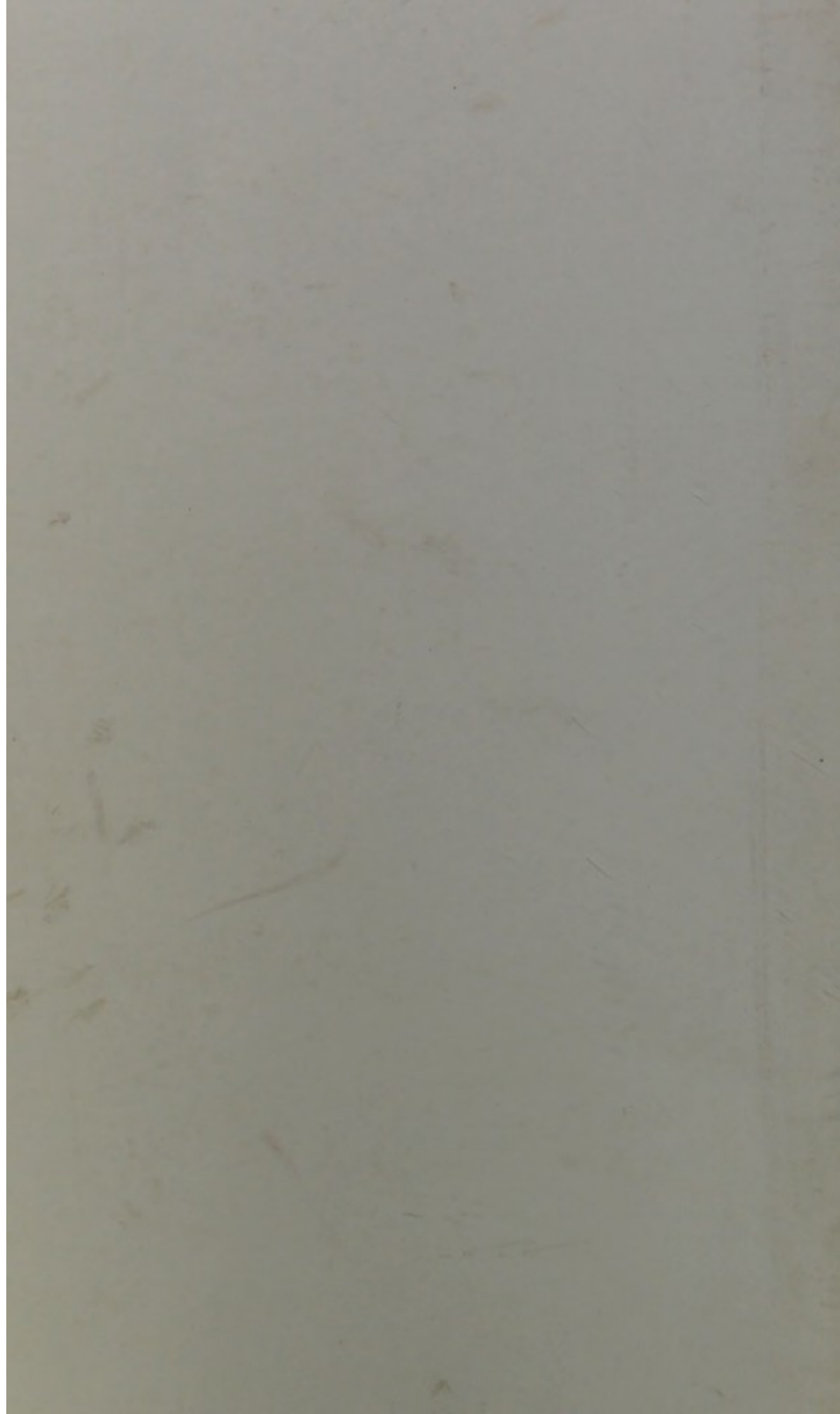
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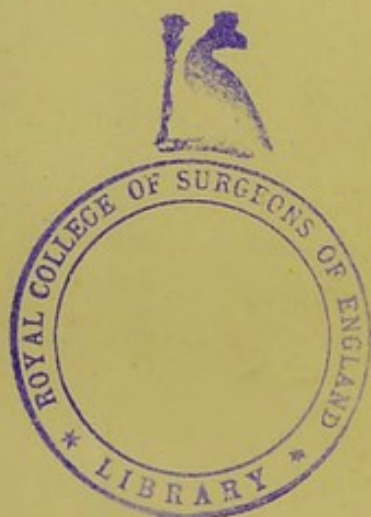
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OBSERVATIONS ON THE ANATOMY OF THE PROSTATE. By JOSEPH GRIFFITHS, M.B., C.M. Edin., *Assistant to the Professor of Surgery in the University of Cambridge.* (PLATE XV.)

(Read at the Meeting of the Anatomical Society, Feb. 6, 1889.)

BEFORE the discovery of the "third lobe" of the prostate, announced to the Royal Society by Sir Everard Home in the year 1806, there was no explanation of the occurrence of an enlargement of this part of the prostate, which had been observed and found to be the cause of considerable difficulties in micturition in old men.

Home's discovery was accepted by most anatomists and surgeons of this country; but amongst the French there were many who did not regard the "third lobe" as an extra lobe, and who considered it as a part of the gland placed in the middle line, posteriorly, between the vasa deferentia so constituting a "middle part."

However it was not until Sir Henry Thompson took up the study of the prostate, from an anatomical and pathological point of view, that any real doubt was thrown upon Sir Everard Home's discovery.

After considerable investigation into the literature, I came to the conclusion that the subject is in a very unsatisfactory state, and determined to enter upon an inquiry for myself.

Before proceeding further, I may here quote what Sir Everard Home said in his communication to the Royal Society:—

"On turning back the vasa deferentia and the vesicula seminales, we came down upon a rounded prominent body, exactly in the sulcus, between the lateral lobes of the prostate; it was embedded under their rounded termination, and adhered to the coats of the bladder; its circumference could not be distinctly seen till the ends of the lateral lobes were detached, and when this was done the continuity of the glandular structure could be readily shown on the side next the bladder; the ducts passed directly through the membrane of the bladder. This lobe completes the circular ring through which the tube of the urethra passes" (*Phil. Trans.*, 1806).

Although much has been written on this subject since, the only observations of importance are those of Sir Henry Thompson, who conducted a series of investigations into the normal as well as the pathological conditions found in this gland. His results were fully brought together and published in the *Jacksonian Prize Essay* for 1859, in which I find the following conclusion:¹—

“I cannot find in healthy bodies, below fifty years of age, any formation in the situation described capable of being recognised as a distinct ‘third’ or ‘middle lobe,’ and am compelled to conclude that any marked prominence there, which appears to possess independent characters (as regards size or form), must be considered abnormal or morbid.”

I gather from the preceding remarks that Sir Henry Thompson could not confirm the observations made by Sir Everard Home. He, however, endeavours to explain the existence of a “third lobe” by referring it to the pathological field, as Morgagni and others had previously done.

For the purpose of clearing the anatomical ground, I investigated all normal human prostates that came in my way; and, although the number is limited, still the observations are, I think, worthy of notice. I have followed in my investigations two plans—(1) to observe, after opening the urethra from the front, the position of the orifices of the prostatic ducts; and (2) to make median longitudinal sections of the gland after hardening in spirit, as I find that method gives more reliable and satisfactory results than section of the fresh gland.

I find that in a certain number of individuals, of whatever age, there are numerous orifices of prostatic ducts in the part of the urethra between the posterior end of the verumontanum and the vesical orifice in addition to the usual linear series, on either side, in the prostatic sinuses. In some instances the duct-orifices in this first part of the urethra are numerous (ten or twelve), easily detected, and arranged more or less in a concentric form, as diagrammatically represented in the accompanying figure. The secretion may be seen oozing from these orifices when the median part of the prostate behind the verumontanum is pressed. I judged that ducts opening in this situation would

¹ In his later writings the same views are held.

probably be derived from the portion of the gland called the "third" or "middle lobe."

To corroborate this view, I made median longitudinal sections in the specimens in which these orifices existed, and found, in each case, a portion of prostatic tissue of variable size occupying the situation assigned to the "third lobe."

All the cases which I allude to as presenting these appearances were in young and middle-aged persons: one was a boy twelve years of age. The presence of the "third lobe" cannot, therefore, be regarded as pathological; and I repeat, that it only exists in a certain number of individuals.¹ The relative frequency of its occurrence I have not been able to determine, as my material is limited; but, from my opportunities, I am inclined to think that a certain amount of gland tissue exists in this situation in most instances.

In the cases in which the "third lobe" is pronounced it forms a rounded mass, possessing a capsule, derived from and continuous with that of the rest of the gland; and leading from it into the vesical end of the prostatic urethra, as I have just said, are ducts similar to the other prostatic ducts. These form the excretory channels of this portion of the gland.

It is indeed clear that this part of the prostate, with its separate ducts, is in some instances in normal conditions developed to such an extent as to render it quite worthy to be called a "third or median lobe."

My observations thus to some extent confirm those of Sir Everard Home, but I find that in some individuals it is absent, and that there is every gradation up to the size which he represents.

It has, as we have already seen, been suggested that the "third lobe" consists of an extension of the lateral lobes backwards to the space between the vasa deferentia; but that it is as real a part as either of the lateral lobes is proved by the exist-

¹ I especially wish to draw attention to this point, and to remark in passing, that it follows that enlargement of the third or median lobe of the prostate does not and cannot take place in those individuals in whom the gland tissue in that situation is absent. Indeed, it is the presence or absence of gland tissue in the situation assigned to the third lobe that determines the presence or absence of enlargement in that position, in cases of general enlargement of the gland; this is also true of the part of the gland in front of the urethra. See further on.

ence of ducts belonging to it, and by the fact that the position of outlet of its ducts is different from those of the lateral lobes.

Reference will be made in a subsequent paper on the enlargement of the prostate, to the existence of the ducts from the "third lobe"; and their importance in the pathology of the gland will be then discussed.

In examining the prostates of man and the lower animals, I have been struck with the regularity with which numerous venous channels, almost amounting to a plexus, are found in the anterior wall of the prostatic urethra. These venous channels are more numerous towards the middle of the prostate, and they are placed immediately subjacent to the mucous membrane in the somewhat dense submucous tissue, being only covered by the epithelium. Cases in which the veins become full previous to or during the death of the individual, show these venous channels very well, and they then form dark lines running more or less parallel to one another in the direction of the urethra. I have not yet been able to investigate them any further, and here merely wish to draw attention to the existence and very superficial position of these venous channels. These, in addition to similar, though less numerous and less prominent, veins in the hinder wall, and which are in like manner situated immediately beneath the epithelium near to the neck of the bladder, explain the easily excited and considerable hæmorrhage from the prostatic urethra, of not unfrequent occurrence, after the passage of instruments.

Minute Anatomy.

The general anatomy of the prostate is so well known, that all I propose is to briefly describe the main features in the histology of the gland.

The normal histology of the prostate was carefully studied and described by Kölliker; and a very clear description is given in Klein and Noble Smith's *Atlas of Histology*, and indeed by many other writers.

A *transverse section* near the middle shows it to consist mainly of a mass of gland tubules surrounded by a distinct strong fibrous capsule, which is connected on its inner aspect with trabeculæ separating and supporting the glandular divi-

sions. Near the middle of the section is seen the crescentic urethra, and below or behind it is a dense mass, consisting of connective tissue, with a few non-striped muscle fibres, traversed by gland "ducts." There exist very few, if any, gland "tubules" in this situation. From this central mass of tissue strong trabeculæ, similar to those just mentioned, pass outwards towards the periphery to join the capsule; they in their turn give off smaller trabeculæ of similar structure, which invest the terminations of the gland tubules. The trabeculæ thus all radiate from the dense tissue behind the urethra; and with reference to this it may be remarked that, as I show later on, the prostate in man originally develops at this hinder part, and subsequently, up to the period of adolescence, extends laterally and forwards round the sides of the urethra, to meet ultimately in the middle line anteriorly. The gland is of the usual compound tubular type, and the tubules, which open by means of short ducts upon the floor of the urethra, branch and reach to near the periphery. In favourable sections they may be seen in their entire extent.

The "ducts" do not possess any special coats of their own beyond the columnar epithelium which lines them; and they constitute mere channels embedded in the supporting structure at the back of the urethra already referred to.

The "tubules" and their continuations or secreting portions of the gland are lined by long and slender columnar cells, each cell possessing an oval nucleus placed near the attached end. The protoplasm of the cells, towards the lumen of the tubule, is usually found to be very granular, and the cells to have no well-defined free border. Between the attached extremities of these columnar cells small pear-shaped cells¹ are not unfrequently seen, which rest upon the basement membrane of flattened epithelial cells. This basement membrane, which is present throughout in the gland tubules, is separated from the surrounding network of capillaries by a thin homogeneous layer. In some places, where the epithelial cell-lining has fallen away during the manipulation of the section, may be seen the basement membrane of flattened epithelial cells, proliferating and giving rise to the small pear-shaped cells which are ultimately developed into the columnar cells (see Pl. XV. fig. 3).

¹ These small pear-shaped cells were first described by Langhans.

The character of the epithelial lining remains much the same from the extremities of the gland tubules to the beginning of the ducts. In the ducts, which are very short, a gradual change takes place between the epithelium lining the tubules and the transitional epithelium lining the prostatic part of the urethra.

The supporting structure, or stroma, consists of connective tissue, in which there are found many non-striped muscle cells arranged in bundles, and crossing one another in various directions. These muscle-bundles are chiefly disposed around the peripheral parts of the tubules, and their contraction compresses the tubules, forcing the secretion towards the urethra (see Pl. XV. fig. 4). In the stroma there are, besides, the blood-vessels and nerves belonging to the gland.

The Utriculus Masculinus.

In the *utricle masculinus* the mucous membrane is thrown into folds, and bears on its surface columnar cells. The submucous coat consists of somewhat loose connective tissue which supports numerous thin-walled blood channels (spaces lined with a single layer of flattened epithelial cells). Externally is a thin layer of circularly disposed non-striped muscle.

The *utricle* constitutes a separate structure, which is distinct from, and merely becomes surrounded by, the prostate in the course of its growth.

The Arrangement and Origin of the Muscular Element of the Prostate.

The arrangement of the muscular fibres in the prostate, and the relation that exists between them and the muscular coats of the urethra, are subjects surrounded with difficulties, so long as investigations are confined to the adult.

During the development of the prostate gland from birth to adult life, the—originally simple—arrangements become changed and more complex, and so obscured that it ultimately affords no clue to the original source and arrangement of the muscle. With the hope of elucidating these points, I examined microscopically a series of sections taken, at intervals of an $\frac{1}{8}$ of an inch, from the neck of the bladder down to the anterior ex-

tremitry of the prostate in a fœtus nine months old. It would facilitate the description of the muscular fibres if I first give a brief account of the development of the gland.

At the time of birth the prostate forms a small mass, slightly divided into two lateral lobes, situated almost entirely behind the level of the urethra; and it then consists of a number of gland tubules with short branches embedded in a connective tissue stroma rich in non-striped muscle cells. These comparatively simple tubules are derived from outgrowths of the epithelium forming the hinder wall of the urethra, especially from those parts on either side of the *verumontanum*, namely, the prostatic sinuses.

The portion of the urethra from which the tubules originate, it will be remembered, is formed from the part of the wall of the *uro-genital sinus* in the immediate neighbourhood of the orifices of the primitive *genital ducts*, both Müllerian and Wolffian.

Therefore the prostate is in reality derived from outgrowths of the epithelium lining the original *uro-genital sinus* after the manner of other glands, and is not, as has been supposed, and is indeed now very commonly believed, derived from some part of the lining of the *Müllerian ducts*.¹

The gland tubules grow at first backwards, then outwards and forwards into and between the fasciculi of the thickened posterior half of the external circular non-striped muscle-coat of the urethra in this situation presently to be described.

The growing tubules further divide, and become more and more branched, until their full development of the gland is established. And as these gland-tubules grow forwards on each side, they nearly or quite meet in the middle line in front of the urethra. In some instances the gland substance from the two sides fuses together in front, but in others it fails to do this, and an interval between the two sides is left. Hence the amount of prostatic

¹ It would follow, therefore, that any structure in the female homologous with the prostate in the male, must be sought near the fore part of the urethra and in its immediate neighbourhood in the small mucous glands which are there found. Sir J. Y. Simpson expresses the same view in his article on "Hermaproditism" (*Anæsthesia, Hospitalism, and other papers*, p. 509), as follows:—"And if we are to find a true prototype in the female of the prostate gland in the male, we shall probably detect it in the follicular glands and structures that exist so abundantly in the course and at the extremity of the female urethra."

tissue in front of the urethra varies considerably in different individuals.

The third or median lobe develops in like manner when present by extension backwards of the tubules originating behind the *verumontanum*.

To return to the muscular coats of the urethra. The external or longitudinal coat of the bladder (*detrusor urinæ*) terminates by insertion into the base of the prostate at or near the vesical orifice of the urethra.¹ The circular coat suddenly diminishes in thickness just below the neck of the bladder, at the commencement of the urethra, and may be traced onwards as the *external, circular, non-striped muscle* coat of the urethra. The latter, however, differs from the circular coat of the bladder in having its bundles more closely packed together to form a denser layer. This difference is marked to the naked eye both in the male and female urinary organs.

At the level of the *verumontanum*, in the prostate of a foetus at nine months, this circular coat is seen as a continuous sheet along the anterior wall of the urethra, whereas at the sides and posteriorly it spreads out into slender fasciculi, which invest the developing tubules of the prostate. It undergoes a special thickening in this region behind the *verumontanum*, where the developing tubules of the prostate grow out from the urethra; and the fasciculi derived from this part, and accompanying the tubules in their divisions constitute the muscular element of the prostate. Thus the muscle-fibre and gland-tubules grow on together, the former accompanying the latter in their whole extent, so that the muscle fibres form an investment to the gland-tubules to their very extremities. The gland-tubule-growth, however, exceeds that of the muscle-fibre, so that the glandular constituent forms a relatively and gradually increasing element of the organ. It is further to be observed that the "*ducts*" or excretory parts of the prostatic gland-tubules are devoid of a muscular investment; this results from the fact that these "*ducts*" occupy the situation near the *verumontanum*, between the mucous lining of the urethra and

¹ In the female the external longitudinal muscle-fibres of the bladder are inserted into the external fibrous coat of the urethra, immediately below the neck of the bladder.

the circular coat, in which situation there is, in the early foetal state, a considerable quantity of connective tissue. Hence the developing ducts traverse this tissue before reaching the circular muscle-coat of the urethra and acquiring from it their muscular sheath.

Internal to the above described circular muscle-coat of the urethra, which, as just said, is continuous with the circular coat of the bladder, is an imperfect coat of longitudinal muscle-fibres which run in separate bundles. This is thickest posteriorly in the *verumontanum*, and there encloses the *utricle masculinus*. Internal to it, and separated from it by a thin layer of connective tissue, is a thin compact layer of circular muscle-fibres in the connective tissue immediately subjacent to the epithelium lining the urethra.

There are, therefore, three layers of muscle in the urethra,—an internal, circular, immediately beneath the mucous membrane, or forming its deeper part, and constituting a *muscularis mucosa*; a middle, longitudinal, the bundles of which scarcely form a continuous sheet (it is possible that this is continuous with the obliquely longitudinal inner muscular fibres of the bladder, but I have not been able to satisfy myself that such is the case); thirdly, an outer, circular, coat, which is the continuation of the circular muscle coat of the bladder into the urethra. These three layers, it will be noticed, are quite distinct from the “*external sphincter of Henle*,” which is composed of *striped* muscle (continuous with the striped muscle around the membranous urethra), and covers the fore part of the prostate, and beneath which the prostate in its development extends itself (see Pl. XV. fig. 5).

In the adult, a thin layer of non-striped muscle immediately surrounds the gland, which does not appear to have any direct connection with the circular muscular coat of the bladder, and which is situated beneath the *striped* muscle of *Henle*—in fact, forming a part of the capsule. From it fasciculi pass between the larger divisions of the gland, and these again are continuous with the muscular fibres investing the ultimate groups of tubules, and which are developed from the outer circular layer of the urethra in the manner already described.

If a group of tubules be examined, it will be seen that the

muscular fibres in relation to them are arranged around the tubules in such a manner that their contraction exercises compression on the extremities of the tubules, and so forces out into the urethra the secretion contained in their interior.

These observations regarding the muscle element of the prostate are not in accord with the view put forth originally by Mr Ellis in the *Med. Chir. Trans.*, vol. xxxix., and since adopted by Mr Harrison of Liverpool (*Surgical Diseases and Injuries of the Urinary Organs*).

The following are extracts from Mr Ellis's paper:—

“The prostate is essentially a muscular body, consisting of circular or orbicular involuntary fibres, with one large hole for the passage of the urethra.

“Its [prostate] circular fibres are directly continuous behind, without any separation, with the circular fibres of the bladder; and in front a thin stratum, about $\frac{1}{30}$ th of an inch thick, is prolonged forwards from it around the membranous part of the urethra, so as to separate this from the surrounding voluntary constrictor. Within, and quite distinct from the circular fibres, lies the tube of the urethra encased by its submucous layer of longitudinal fibres.

“I would propose the name ‘*orbicularis vel sphincter urethræ*’ for both the prostate and the prolongation around the urethra.”

1st. I do not find that the prostate is essentially a *muscular* organ, but essentially a *glandular* organ, and that the muscle-element is secondary in importance.

2nd. I do not find any of the muscular fibres of the prostate are *directly* continuous with the circular coats of the bladder, but that they are the resultant of an outgrowth of the external, circular, muscular fibres of the urethra upon the prostatic glandular tubules, and are, therefore, only *indirectly* continuous with the circular fibres of the bladder. This applies to the enveloping fibres of the prostate as well as to the fibres in the interior of the gland.

3rd. On this view, the term “*orbicularis vel sphincter urethræ*” is hardly applicable.

In the present paper I merely describe the structure and the intrinsic muscle of the prostate, and I have not entered into the consideration of the extrinsic muscles, such as the *external sphincter of Henle* and *levator ani*, which in their contraction compress the prostate forcibly, and so serve

the purpose of ejaculating the urinary, seminal, and prostatic fluids from this capacious tract of the urethra.

It appears to me that the predominance of the muscle-element in the prostate has been much exaggerated. The muscle-cells and fibres are considerably more numerous than in other glands, but they are arranged in the main around the extremities of the tubules, and even there do not by any means preponderate over the glandular parts. The general disposition of the muscle upon the tubules, and the absence of any muscular coat to the excretory ducts, are characteristic features of this gland, and may, I think, be considered to have relation to the function of the gland as an accessory to the sexual organs.

The requirements in relation to that function are not continuous, but very occasional; and the muscular fibres are disposed in such a manner that, by simultaneous action, they may produce a more or less rapid expulsion from the tubules, through the ducts into the urethra, of the secretion formed in the tubules of the gland.

The chief conclusions arrived at in this paper are the following:—

1. The *third or median* lobe exists, in many instances, as a well-defined portion of the gland at the time of puberty and during adult life, *i.e.*, the period before enlargement of the prostate occurs, but in other instances it is very small or entirely absent.
2. This part or lobe possesses ducts of its own, which open upon the parts of the hinder wall of the prostatic urethra, which extends from the vesical orifice to the *verumontanum*.
3. This part or lobe also develops separately from the part of the urethra just mentioned, in the same way as the lateral lobes do from the part of the urethra on each side of the *verumontanum*, and it is not the result of an extension backwards of gland tissue from the lateral lobes into the interval between the vasa deferentia beneath the neck of the bladder.
4. The whole gland is peculiar in this particular, that the "ducts" are short, and form mere channels in the stroma, being destitute of any special coats except a layer of

epithelium lining them, and that the muscle tissue of the prostate is so arranged around the terminations of the "gland tubules" which form the secreting parts, that the muscle, when it contracts, is able to act as an efficient expulsor along the whole course of the tubules.

5. This arrangement of the muscle in the prostate is developed in relation to the function¹ of the gland; and thus it is that the secretion accumulated in the tubules can be completely expelled into the urethra at once, or at least in a short time.
6. The muscle-element of the prostate is derived from the outer, circular, non-striped muscle-coat of the prostatic urethra, this coat being continuous with the circular coat of the bladder; therefore the muscle-element of the prostate is only indirectly continuous with that of the circular coat of the bladder.
7. The *utriculus masculinus* is not, properly speaking, embedded in the prostate. It forms a distinct structure separate from the prostate; and as the growth of the prostate greatly exceeds that of the *utriculus masculinus*, the latter is in time covered in, and appears as if embedded in the former.

DESCRIPTION OF PLATE XV.

Fig. 1. Diagrammatic representation of the hinder wall of the prostatic urethra seen from the front, to show the position of the orifices of the prostatic ducts. (a) Orifices of ducts from the third or median lobe; (b) orifices of ducts from the lateral lobes; (c) verumontanum, with opening of utriculus masculinus.

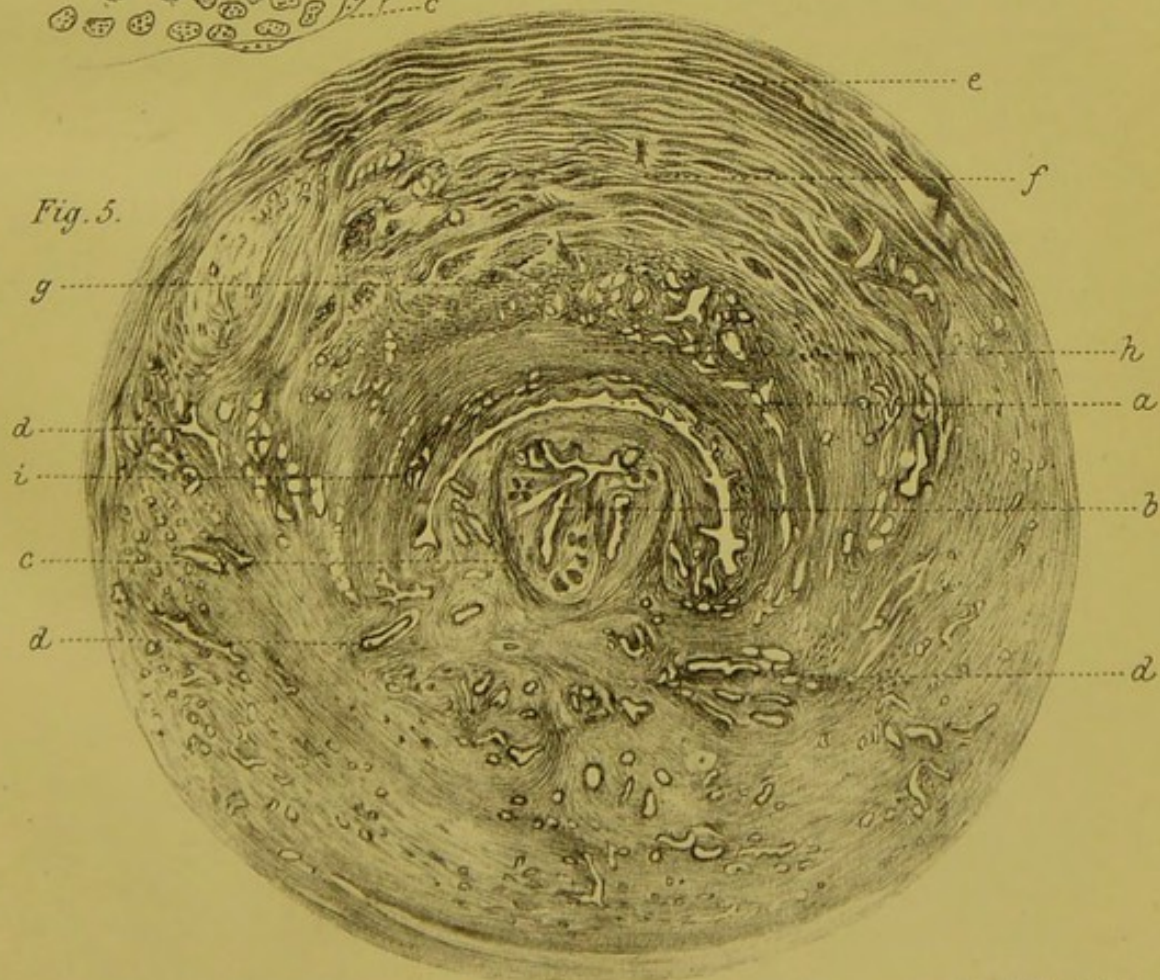
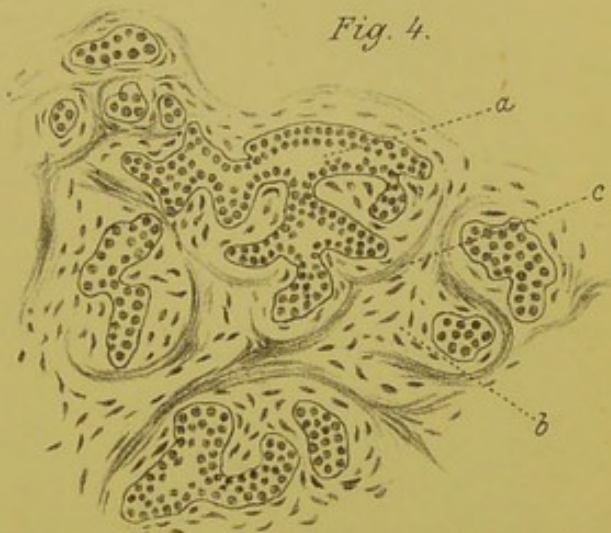
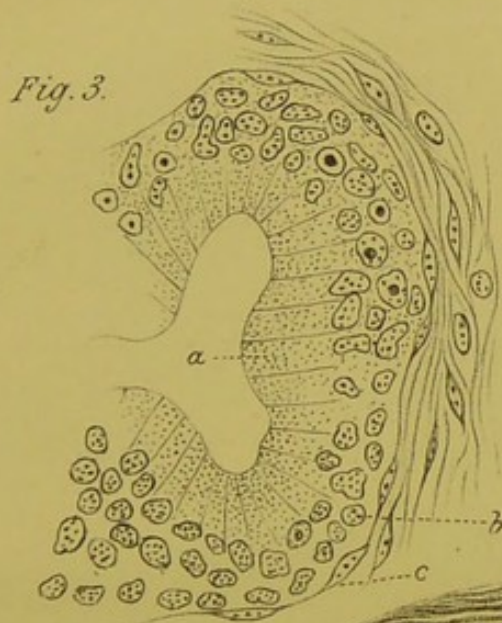
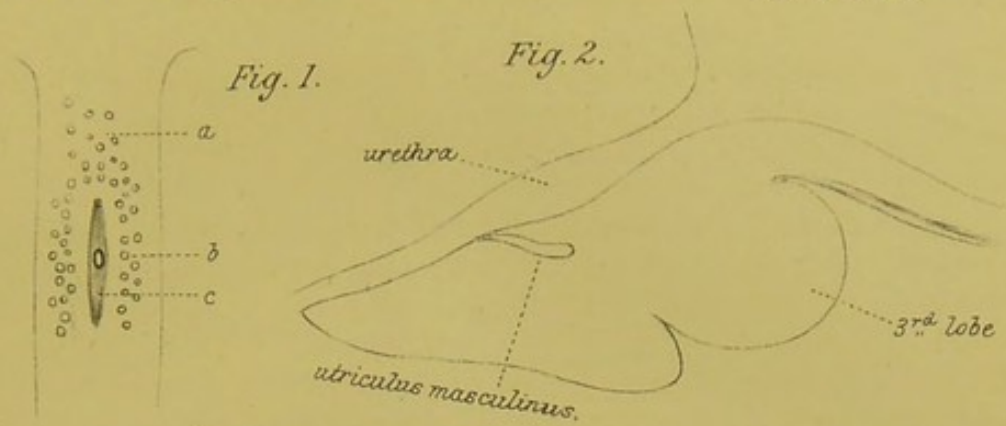
Fig. 2 is from a median section of the prostate of a young adult, and in which the "third lobe" is very prominent.

Fig. 3. Section of the prostate of a man, 30 years; $\times 400$ (Camera Lucida). (a) Columnar epithelial cells, with nuclei near attached ends; (b) nuclei of small pear-shaped cells between attached extremities of columnar cells; (c) flattened layer of epithelial cells, forming a basement membrane, and from which the small pear-shaped cells are formed.

¹ The function of the prostate being glandular, and accessory to the true generative glands.

Fig 4. Section of the prostate of a child five years old, $\times 40$ (Camera Lucida). (*a*) Developing prostatic gland tubules ; (*b*) the connective tissue stroma ; (*c*) muscle fibres disposed around the developing tubules.

Fig. 5. Transverse section through the middle of the prostate and urethra in a foetus æt. 9 months ; $\times 20$ (stained with picrocarmine). (*a*) urethra ; (*b*) utriculus mas. and vasa deferentia ; (*c*) muscle enclosing them ; (*d*) developing prostatic tubules ; (*e*) external sphincter of Henle ; (*f*) external non-striped muscle-coat of the urethra in front, and spreading out to form the muscle of the prostate laterally and posteriorly ; (*g*) bundles of internal longitudinal coat ; (*h*) internal, circular, non-striped muscular coat of urethra ; (*i*) submucous veins in superior and anterior wall of urethra.



F. Huth, Lith. Edin.

