THE PROSTATE GLAND IN OLD AGE

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This report concerns the anatomical structure of the prostate gland in old age. Seventy-one specimens varying in age from sixty-two to seventy-nine years have been studied. Observations of the gross specimens have been carefully made. Sections taken from various parts of the gland have been cut and stained in the usual manner and studies have also been made of complete serial sections of the entire organ from its apex to the base and also include the vesical sphincter and the entire trigonum vesicæ. In staining these sections various dyes have been used. Most of them have been stained with hæmatoxylin and eosin. In a large number of instances Van Giesen's stain for the differentiation between smooth muscle and connective-tissue cells has been utilized as well as Weigert's elastic tissue stain.

It seems appropriate to review very briefly the embryology and anatomical changes in earlier years before taking up the discussion of structural changes in old age. As has been pointed out in a previous communication, the prostate originates from five independent groups of tubules which begin to develop in the wall of the posterior urethra at about the twelfth week of intra-uterine life. (*a*) The middle lobe is usually made up of about nine or ten tubules originating on the floor of the urethra between the bladder and orifices of the ejaculatory ducts. There may be an absence of the middle lobe, in which case there is an ingrowth of tubules from the lateral lobes. (*b*) The posterior lobe is an independent structure, being made up of twelve tubules which originate from the floor of the prostatic urethra below the orifices of the ejaculatory ducts. They grow posteriorly behind the latter structures and are in no sense a glandular commissure, as they are definitely separated from the other parts of the gland by a lamella of connective tissue. (*c*) The anterior lobe is fairly large until the sixteenth intra-uterine week, after which it seems to decrease in size and importance. At birth it is very small.

The so-called accessory or contiguous structures are interesting, and as their development and later changes are quite important they will be briefly mentioned.

The subtrigonal mucous glands are noted as early as the twenty-

second week of intra-uterine life and are comparatively few in number, the average in all embryological specimens studied being six.

The subcervical glands of Albarran occur in all specimens older than the fifteenth week of intra-uterine life. They average twelve in number during this period.

The seminal vesicles originate at the thirteenth week and appear at first as an evagination lateralward from each vas deferens. They grow backward and laterally, consisting of a main part which is convoluted and from which rather numerous, short, convoluted branches grow out, as described by Pallin.

The vasa deferentia and ejaculatory ducts are at first exceedingly large, comparatively speaking. Later on, as the embryo becomes more mature, they are outgrown by surrounding tissues and hence are comparatively smaller. As these structures approach the lumen of the urethra its floor is pushed up into a mound, converting it into a semilunar-shaped passage and forming the verumontanum.

Before the fifth month the utricle in nearly every instance extends to the base of the prostate. After that age it is usually found in the tip of the verumontanum.

In the wall of the urethra just at the apex and a little below it there are found in the older specimens delicate tubules with a few branches. They are not connected with the prostate and extend only slightly into the muscular walls of the urethra. They disappear lower down in the urethra.

In early embryonic life the peritoneum covers the posterior surface of the prostate and seminal vesicles, extending as far as the apex of the former. Later on this peritoneal sac becomes pinched off, as is beautifully shown by several of Dr. Franklin P. Mall's specimens, and has been described by a French writer, Denonvilliers, whose name the resulting fascia bears.

In old age the prostate lies behind the second portion of the rectum at the neck of the bladder, which it surrounds posteriorly and laterally. It is firmly attached to the vesical orifice and urethra and is encircled by the prostatic fascia. It is held in position by several structures. Its apex is suspended superiorly by the puboprostatic ligament which connects it with the pubic bone on either side. The anterior surface is separated from the symphysis pubis by a space 1.5 cm. to 1.1 cm. in size and gradually increasing from above downward, filled chiefly with a fatty cellular substance and a dense venous plexus. Inferiorly it is joined to the rectum by the recto-urethralis muscle, which is a reflection of the anterior portion of the levator ani muscle. The deep layer of the

triangular ligament aids in fixing the apex because it invests the membranous urethra and is attached to the prostate. The lateral borders of the gland are embraced by portions of the levator ani muscle, which are separated from direct contact with it by a plexus of veins.

The shape of the prostate changes markedly during various stages in its development. At the very first appearance during the latter portion of the third intra-uterine month it exists as a cylindrical mass surrounding the posterior urethra, the mass being a little more pronounced on its posterior aspect. About the seventh month the lateral borders near the base become quite bulging in character, due to the fact that the lateral lobe tubules grow more extensively than do those of other portions of the gland. At the time of birth the gland is slightly more flattened than during the seventh month and also a little larger. Between the time of birth and the beginning of puberty there is very slight change in the shape of the organ. During the adolescent period the prostate changes markedly. It loses most of its rounded appearance and rapidly assumes the appearance of the adult organ. The length of the prostate in every instance is greater than its thickness and always less than its width.

In shape the adult prostate has often been likened to a horse-chestnut flattened on one side, but this comparison seems to be insufficient. Its posterior surface is triangular and flattened. It usually has a depression extending longitudinally in its midline which is most prominent towards the base of the gland and rarely, if ever, exists at the anterior one-third. Its upper border or base bulges on each side as do the lateral borders. The anterior surface is rounded and most of the vessels of the prostate occur here and at the lateral borders, very few being found on the posterior surface or at the base. The base receives the ejaculatory ducts after the junction of the vasa deferentia with the seminal vesicles in an elliptical funnel-shaped depression. Geometrically the prostate has been called an oblate conoid or truncated cone.

The size of the prostate shows marked changes at various stages in its development, as is shown in the accompanying table. The development from the actual period of origination until the time of puberty seems to be upon the whole a fairly regular and gradual increase in size. At five years of age the gland is surprisingly little larger than it is at birth. The average length during the first half of the first decade is 1.2 cm. The width is 1.5 cm. and height 0.9 cm. Cuthbert S. Wallace states " at the eighth year the prostate has increased somewhat in size, and taken on more or less the adult form. In regard to its

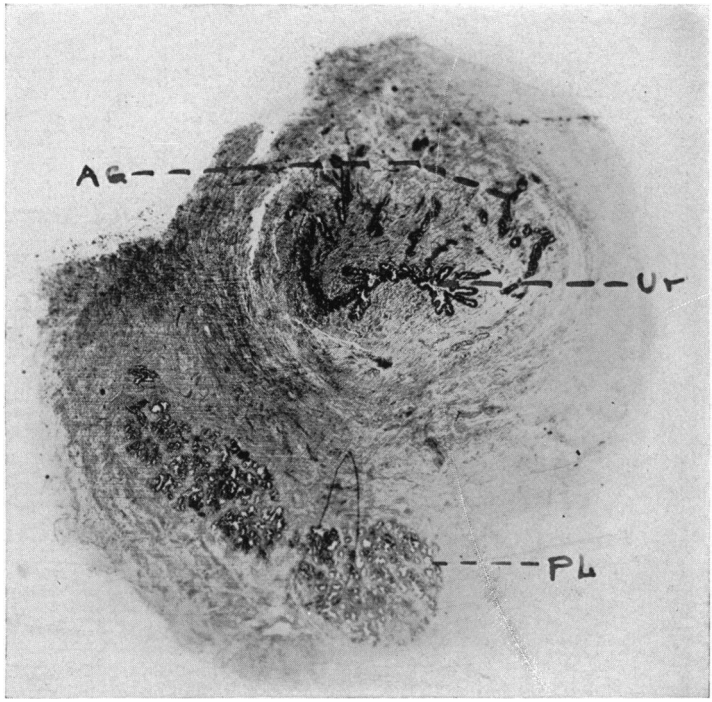

FIG. 1.—Cross-section through urethra at apex of prostate. showing tubules of the apex group. *PL*, forward branches of the posterior lobe of prostate; *Ur*, urethra; *AG*, tubules of apex group of glands. Specimen seventeen years of age.

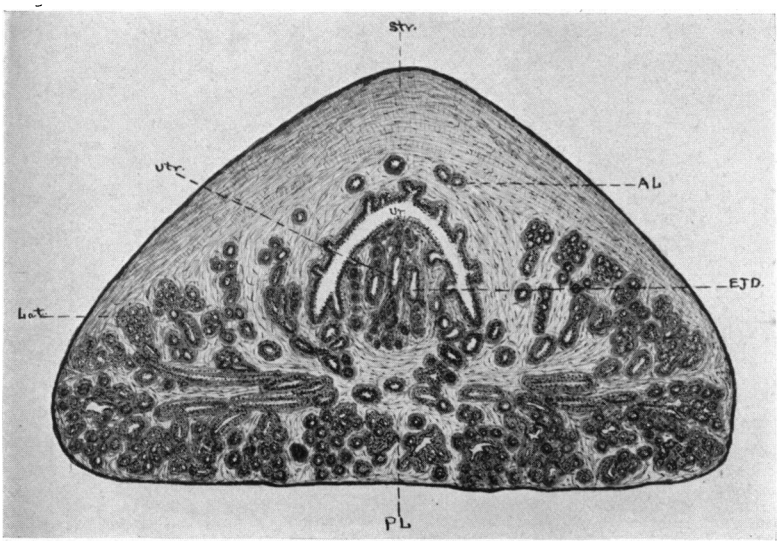

FIG. 2.—Cross-section through middle of verumontanum and prostate of a boy aged four years, stained according to Van Giesen's method. *Ur*, urethra; *Utr*, utricle; *EJD*, ejaculatory ducts; *Str*, striated muscle fibres; *AL*, anterior lobe tubules; *Lat*, lateral lobe tubules; *PL*, posterior lobe tubules.

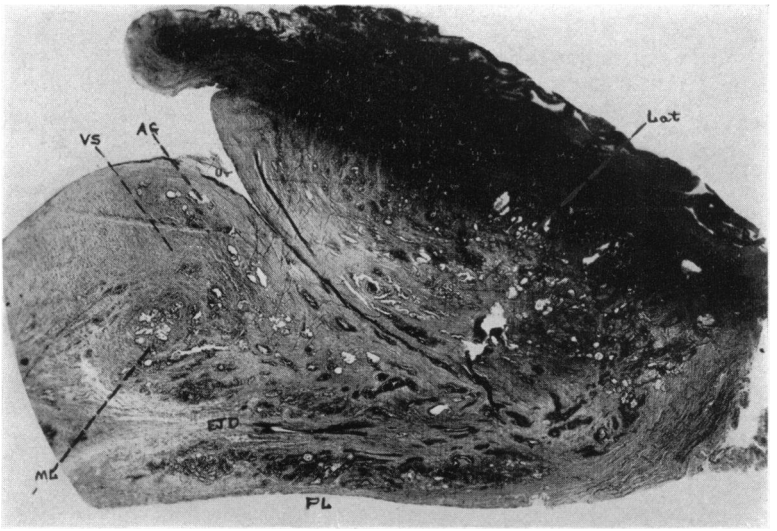

FIG. 3.—Oblique section through the prostate, trigonal region of a man aged seventy-six years. *Ur*, urethra; *AG*, Albarran's subcervical gland tubules; *VS*, vesical sphincter; *ML*, middle lobe tubules; *EJD*, ejaculatory ducts and muscular envelope; *PL*, posterior lobe tubules; *Lat*, lateral lobe tubules.

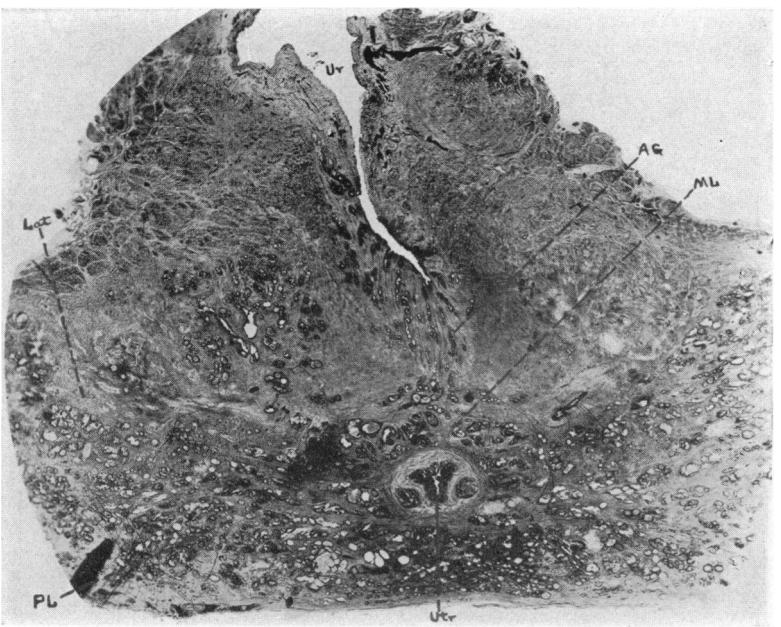

FIG. 4.—Cross-section at the level of the region just above the upper end of the verumontanum of a man thirty-four years of age (section cut slightly obliquely). *Ur*, urethra and portion of bladder lumen; *AG*, Albarran's glandular tubules; *ML*, middle lobe tubules; *Lat.*, lateral lobe tubules; *PL*, posterior lobe tubules; *Utr*, utriculus prostaticus and ejaculatory ducts bound firmly together in envelope.

increase in size, there does not appear any increase in the glandular elements. At eighteen years the organ has increased in size, but the glandular elements are but scantily developed. Between twenty and twenty-five years the prostate is fully developed and becomes an essentially glandular organ." My investigations do not entirely bear out these statements, as observations on fifty prostates between the ages of birth and twenty years seem to indicate a rather gradual increase in the number and size of branches of the tubules up to the period of puberty, at which time there is a tremendous increase in the glandular elements, as is shown in comparing Figs. 1 and 2.

During the second decade there is a very great increase in size. Ten specimens over fifteen years and under twenty years average 3.0 cm. in length, which is more than twice that of the average prostate during the first decade. The average width is 3.8 cm. and the thickness 2.1 cm.

TABLE SHOWING CHANGES IN SIZE OF THE PROSTATE GLAND AT VARIOUS AGES

Age	Number of cases	Length		Width		Height	
		Variation	Average	Variation	Average	Variation	Average
		cm.	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*
First decade... (1–10 years)	38	1.0–1.7	1.2	1.0–2.0	1.5	0.7–1.3	0.9
Second decade.. (10–20 years)	10	2.5–3.5	3.0	.....	3.8	1.8–2.4	2.1
Third decade... (20–30 years)	40	2.8–4.0	3.3	3.6–5.2	4.1	2.0–3.0	2.4
Fourth decade.. (30–40 years)	33	2.4–4.0	3.15	3.0–5.0	4.1	1.6–3.0	2.55
Fifth decade... (40–50 years)	42	3.0–4.6	3.45	3.6–5.0	4.0	2.3–3.8	2.65
Sixth decade... (50–60 years)	29	2.4–4.5	3.65	3.3–5.0	4.37	2.4–3.4	2.75
Old age..... (60 years+)	32	2.6–4.5	3.23	3.0–5.0	4.12	2.0–3.6	2.47

The proper way to consider the size of the prostate seems to be to group the various specimens into decades and the figures obtained have been arranged in a table. Inspection of this table shows that the prostate gland reaches adult size during the third decade. Changes occurring after that period are comparatively slight. The average length is 3.3 cm., width 4.1 cm., and height 2.4 cm.

The figures quoted by all authors seem to vary slightly. Wilson and McGrath consider the average adult prostate to be 3.4 cm. in length, 4.4 cm. in width, and 1.5 cm. in thickness; weight 16 or 17 grammes. Cuthbert Wallace places its dimensions at 3.0 cm. for length,

width 3.6 cm., thickness 1.8 cm.; average weight 20.5 grammes. Sir Henry Thompson states the average measurements in fifty normal adult prostates to be as follows: Length 1.4 inches, width 1.75 inches, thickness 0.7 inch, weight 4 drachms and 38 grains. These figures correspond fairly well with those of Deschamps,[5] Senn,[31] Gross,[12] and Hodgson,[14] but are somewhat smaller than those of Dupuytren.[7]

During the fifth and sixth decades in life there seems to be a slight increase in all of the dimensions of the prostate, but considering all specimens this only amounts to a few millimetres. During the period of old age there is a drop back in size so that these specimens resemble those of the third decade more closely than any of the others. It is noticed in examining the glands of this period that they are either a little smaller in size and atrophied in appearance than those of the preceding period or a little larger and inclined to have the appearance of an hypertrophied condition. The specimens of this period have more abnormalities than those of any of the others; 56.1 per cent. of all specimens observed showing some deviation from the normal. Thirty-three per cent. of the prostates over sixty years of age show more or less a condition of adenomatous hypertrophy.

In cross-sections through its middle portion the prostate gland seems to be made up of concentric layers of tissue. The innermost or central area consists of the horseshoe-shaped urethra with the verumontanum which is made up of the ejaculatory ducts and utricle with their muscular and connective-tissue walls, the terminal ends of the prostatic tubules with their rather thinly disposed circular layers of muscle. The stroma of this layer is not very abundant and is made up of connective tissue for the most part with a moderate amount of smooth muscle-fibres but practically no elastic tissue-fibres. The next layer in the lateral and posterior directions is made up for the most part of stroma with practically no tubular tissue except the ducts proper, which have very few branches. The stroma is largely made up of connective tissue with a generous sprinkling of smooth muscle-cells which are not arranged in definite bundles except around the tubular ducts, where there are two layers, the inner circle which is quite thin and the outer longitudinal which is comparatively thick. There are a moderate number of elastic tissue-fibres here also. In the anterior region there are observed the tubules of the anterior lobe with a very slight amount of muscle around them quite firmly imbedded in the stroma, which consists in the anterior region of the middle concentric layer of a considerable number of smooth muscle-fibres interspersed with the white fibrous tissue bundles with occasional fibres of elastic tissue. Near the upper

border of the layer are seen a few bundles of striated muscle-fibres which in my specimens have not been found to exist among the tubular branches. Wallace, however, reports that he has observed them around some of the peripheral branches of lateral lobe tubules. The outermost of these concentric layers is exceedingly interesting, as it contains practically all of the branches of the posterior and lateral lobe tubules. The middle and anterior lobes are contained for the most part in the middle concentric layer. In the outer layer there is a great preponderance of muscular tissue and mucosa over all other elements of the gland. In the posterior and lateral portions the muscular tissue is practically all smooth and surrounds the tubular elements as has been described. In the anterior portion and extending down the lateral borders almost to the posterior surface are found the striated fibres which make up the so-called muscle of Henle. This muscular tissue is so arranged that near the most anterior portion of the gland it is almost the only tissue present. Looking from this point towards the urethra it is seen to become less and less, gradually shading off and being scattered among the smooth muscle and connective-tissue fibres so that at the edge of the middle concentric layer there are only occasional fibres noted. There is less and less striated muscle down the lateral borders of the gland until it finally disappears altogether.

There are islands of lymphoid tissue scattered here and there in the adult prostates. Rarely one finds some of these areas in the prepuberty specimens. They seem to be most frequently met with in specimens older than thirty years. Waldeyer has found similar areas in the prostate of a dog and Weski has studied them in the human and believes them to be normal anatomical structures.

The base of the prostate is intimately attached to the musculature of the bladder.

In regard to the internal sphincter of the human bladder Versari concludes from his investigations: (1) The smooth muscle sphincter of the urinary bladder of man constitutes a structure by itself, which develops independently of the middle layer of the bladder, the circular muscle layer of the urethra and the musculature of the ureters. (2) The sphincter is made up of an urethral and a trigonal portion, and it is the urethral portion only which assumes the form of a ring surrounding the initial part of the urethra. The first groups of the fibres of the sphincter arranged in bundles correspond to the anterior arch of the urethral portion; from there immediately follow those of the urethral portion of the posterior arch, and these last are apparently

those of the trigonal portion. The posterior arch of muscle extends, little by little with new bundles, either upward to occupy part of the trigonal area, or downward along the posterior wall of the urethra, so that it comes to have an extent much greater than the anterior. On the other hand, the older view held by Krause, Hyrtl, Gegenbauer and others is that the sphincter is a continuation downward of the circular musculature of the bladder. The study of sections including the vesical sphincter in this series bears out the conclusions of Versari in regard to its structure.

The capsule of the prostate is composed of a structure which is made up of closely knit connective-tissue fibres and surrounds the entire organ except at the base between the entrance of the ejaculatory ducts into the substance of the prostate and the junction of the bladder wall with the gland. Here the tubules of the middle lobe are almost free and have as a consequence very thick muscular and connective-tissue walls. The large blood-vessels which supply the prostate run in the capsule and intralobular partitions for the most part and are most numerous on the anterior portion of the capsule.

The glandular elements of the prostate are in every instance divided into five portions corresponding to the five original groups of tubular evaginations noted in the embryo. The division between the middle and two lateral lobes becomes less and less noticeable as age advances, but the orifices of the middle lobe tubules are always widely separated from all other tubular orifices and quite closely grouped together. The middle lobe tubules always grow backward posteriorly to the broad ribbon-like sphincter of the vesical orifice and its tubules are never found imbedding themselves in it or extending within the sphincter. This is an important fact to be noted when considering pathological conditions at the vesical orifice.

The lateral lobes during the period of middle age become more and more prominent and cause a bulging of the lateral surfaces to a marked degree, thus making the transverse diameter of the organ proportionately greater than the prepuberty specimens studied. The number of branches of these and tubules of other lobes of the prostate are markedly increased but the number of tubules is certainly not increased and seems rather to be decreased, but this is a variable matter which is undoubtedly determined in the embryo and the exact number is a personal characteristic.

The posterior lobe is fairly well separated from other portions of the gland and is divided off by a rather firm and, in some instances, quite thick connective-tissue partition. It is always present as is the lobe itself and is intimately attached to the ejaculatory ducts which are not imbedded in this partition but seem to be set upon its anterior surface. This is a decidedly important matter to the surgeon in enucleating a prostate either by Squier's suprapubic intra-urethral method, in which the enucleating finger approaches the partition and attached ejaculatory ducts and passes along to the upper

end of the verumontanum, which is usually removed without injuring the ducts and which surely would not be injured if the verumontanum, which is usually torn through with some difficulty, were cut with the scissors; or Young's perineal method, in which the two parallel longitudinal incisions must be extended through the partition, thus preserving the ejaculatory ducts, in order that the enucleating instrument may go into the lateral lobe cavities, because otherwise it will lead into the capsule of the gland and proper enucleation is then an impossibility. The posterior lobe is the part of the gland felt per rectum. Its tubules are in most respects similar to those of the other lobes. In some cases, however, they seem not to be quite so large and in most instances there is evidence that they do not secrete prostatic fluid actively. The branches of these tubules are usually not as numerous as those of the other lobes and have a thinner layer of muscle surrounding them.

The anterior lobe varies greatly in different specimens. At the time of birth it consists of two small unimportant tubules with very few branches. In the postpuberty specimen the anterior lobe is quite prominent and is made up of tubules which branch extensively and are apparently actively secreting prostatic fluid. A number of important changes are noted when the prepuberty prostates are compared with the gland in adult life. The mucosa of the terminal branches of prostatic tubules in prepuberty specimens is made up of cuboidal-shaped cells with nuclei which are quite large and situated in the centre of the cells. They are usually two layers thick and occasionally three. Scattered here and there are occasional cylindrical-shaped cells with the nuclei elongated and in the centre of the cell. The lumina are very small and apparently devoid of secretion. The mucous cells are placed upon a felt-like base made up of minute connective-tissue fibres, as described by Walker. The smooth muscle layer surrounding the terminal branches are very interesting as brought out by Van Giesen's differential stain. Each branch is surrounded by a definite layer of smooth muscle circularly arranged. The branches occur in groups of 5 to 10 and the entire tubule is surrounded by a much heavier envelope of smooth muscle also circularly arranged. Outside of this envelope there are several small bundles of longitudinal fibres which occur at intervals around the tubule but not as a definite intact sheet. The branches of tubules all extend backward towards the base of the prostate with the exception of a few of the most anterior tubules of the lateral and posterior lobes. The collecting ducts are situated at the most anterior portion of a given group of branches and pass directly towards the verumontanum so that almost the entire duct, with the exception of a very small portion which turns forward, may be seen in one cross-section. The ducts are lined by mucous membrane which resembles that already described in practically every detail. There is, however, a great difference noted in the arrangement of the musculature. A thick layer of smooth muscle surrounds the ducts but it is arranged almost entirely in a longitudinal direction, very little circular muscle being noted. There are practically no branches from this part of the tubule, most of them occurring in the peripheral third of the gland. In the verumontanum the tubule turns and runs forward for a slight distance again and about nine-tenths of them open on the lateral walls of the verumontanum in such a manner that there is a little leaflet of tissue covering the orifice which is an exceedingly

important factor in protecting the tubules of the gland from an inpouring of urine and other foreign matter when the posterior urethra is put under pressure. The direction of the openings of the tubules of the prostate and ejaculatory ducts is an important consideration also because instrumentation will frequently cause an infection by forcing foreign substances into them. In the adult prostate there is noted a great change in the mucosa. I have found in my specimens that the tubules and their branches are lined by a single layer of high cylindrical cells with the nuclei at their bases. Occasionally there is inserted between the bases of adjoining cells a round or conical cell, as Krause pointed out. In some cases there is a piling up of the cylindrical cells, but I have not found that there is a double layer of cylindrical cells in all of the terminal branches as Langerhans states. Near the orifices of the ducts the epithelium is transitional in type, being similar to that of the urethra itself. The muscle bundles surrounding the tubular branches are very thick in the peripheral portions of the gland and particularly in the case of middle lobe tubules near its base. These muscular bundles are much more pronounced comparatively speaking in the case of the younger specimens than in the older and this is probably due largely to the fact that the entire gland becomes more compactly arranged after puberty.

Some of the older writers gave very interesting reports upon the minute anatomy of the prostate. Dr. Hansfield Jones[18] in 1847 affirmed that pale or unstriped muscle entered largely into the composition of the gland. Kölliker[21] in 1848 declared that the larger part of the organ was constituted of pale muscular tissue and that the smaller portion only consisted of glandular tissue. Professor Ellis[8] of University College in 1856 declared the prostate to be essentially a muscular body: "as only so small a portion of the prostate is glandular, the propriety of calling that body a gland is rendered doubtful, for the small secreting glands contained in it are but appendages of the mucous membrane which project amongst the muscular fibres in the same way as the other glands of the urethra extend into the surrounding submucous tissues." Jarjavay partly confirmed the above view also.

Sir Henry Thompson wrote as follows in 1873: "The glands themselves are somewhat peculiar and characteristic of the prostate. They are classified as multilobular or compound racemose. The walls of the vesicles and crypts are covered with an extremely regular epithelium, the cells of which show a disposition to be ovoid but apparently become polygonal under the influence of lateral pressure. The ducts are lined with prismatic cells."

Rüdinger states that no other viscus encloses within itself so great a number of muscular fibres in such a limited area as the prostate, especially where the glandular substance is subordinate to the muscular layers.

A specimen obtained from a man seventy-six years old (Fig. 3) who died of cerebral lues bears out in a general way the findings observed in the younger specimens described. There is, however, a difference noted which is interesting. The tubules are for the most part collapsed and show definite signs of atrophy. Here and there are seen corpora amylacea of various sizes.

The Middle Lobe.—Ten moderately large, numerously branching tubules form the middle lobe which is in this instance usual in size. The course of the tubules is similar to that of like structures already mentioned and the ducts open on the summit of the verumontanum and its lateral surfaces above the point where the ejaculatory ducts empty into the urethra. There are a number of corpora amylacea present and only a few of the tubules are distended, most of them showing signs of atrophy. They extend behind the vesical sphincter to a level with its upper border. In most places it is easy to distinguish the point of separation between the middle and lateral lobes, although there is not a well-defined wall of tissue separating them at all points.

Lateral Lobes.—The largest portion of the gland is occupied by twenty-four tubules which are contained within the two lateral lobes. Corpora amylacea are present and a few of the lumina are distended, but for the most part are collapsed and show definite signs of atrophy. The lumina are almost entirely obliterated in some instances, being occupied by a shrunken and distorted mucosa, while the muscle-bundles are not nearly so thick and distinct as those observed in younger specimens. The course of the tubules follows very closely those previously described. They open a little below the mouths of the ejaculatory ducts in the prostatic furrows or on the lower lateral surfaces of the verumontanum. A few of them open into the prostatic furrows above and below this point and a few open upon the lateral walls of the urethra itself.

The Posterior Lobe.—This is definitely separated from all other portions of the gland by a thick, well-defined layer of muscle and connective tissue. The separation is more complete in this instance than it is in any other gland studied. The tubules, eleven in number, have grown back to a point behind the ejaculatory ducts and reach the same level as do those of the lateral and middle lobes. The branches are numerous but not large and invariably show a distinct atrophy. There are a few corpora amylacea in these tubules and where they occur the lumina are entirely occupied by the laminated bodies, the walls of the tubules being contracted upon them and much constricted before and behind. The ducts of the posterior lobe tubules proceed behind the ejaculatory ducts and empty into the urethra upon its floor outerward from the verumontanum as far as the apex of the gland. The outermost tubules have branches which extend forward.

The anterior lobe is comparatively large in this specimen. It is made up of five tubules which are quite as large as those of the other lobes. These tubules have many branches, some of which are distended but most of which show signs of atrophy as do those of the other lobes. The ducts of this lobe empty into the urethra upon its ventral and lateral walls. They are not grouped near the mouths of the ejaculatory ducts as are those of the middle and lateral lobes but enter indiscriminately. Histologically these tubules present an appearance similar to that of the tubules of other lobes.

The mucous membrane of the tubules of this specimen is quite interesting. In the prepuberty specimens it is composed of epithelial cells piled two or three

deep, with nuclei which are elongated and almost fill the cell. The lumina of the tubules of that period are very small and show no evidence of containing secretion. In early adult life and middle age the mucosa in most cases is composed of a single layer of high columnar epithelium with a granular protoplasm and a fairly small round nucleus situated near the base. There are occasional conical cells placed here and there between the bases of the others and the entire epithelium placed upon a felt work of fibrils of connective tissue. The lumina are large and filled with secretion. Rarely there is seen a corpus amylacea. There are folds in the epithelial lining of normal middle-age specimens but very few finger-like projections or bridging of epithelium, such as is noted in adenomatous hypertrophy. In this specimen the mucosa is composed of columnar epithelium cells of the usual type but the individual cells are not so clear cut. Their nuclei are somewhat smaller and stain more deeply. Very few of the lumina are distended. Most of them are collapsed and show little or no evidence of secretion. The mucous layer is in many instances shrunken and distorted. Corpora amylacea are fairly numerous. They usually occupy the entire lumen of the tubule, the walls being contracted tightly down upon them. The smooth muscular envelopes retain their characteristic arrangement but are atrophied in appearance. There is a moderate amount of lymphoid tissue here and there throughout the stroma. By utilizing Van Giesen's differential stain it has been determined that in the middle lobe 25 per cent. of the stroma is composed of smooth muscle. In the lateral lobes 25 per cent. is smooth muscle and 10 per cent. striated muscle. The posterior lobe, like the middle lobe, contains no striated muscle and the stroma contains about 25 per cent. smooth muscle. The anterior lobe stroma is made up of 30 per cent. striated muscle, 25 per cent. smooth muscle and the remainder connective and elastic tissue fibres.

In youth before puberty the comparison between glandular tissue and stroma is about one to five. After puberty in the adult it is one to three, and in normal old age one to four.

The subtrigonal glands are present but are small in size. They are similar in type to those already described as regards their histology and location. In this specimen twenty-one of them are found between the middle of the trigonum vesicæ and the vesical orifice. In no instance do any of them have branches and they do not extend through the submucosa.

The tubules of Albarran, thirty-three in number, are found in their usual location. They seem rather more extensive in this specimen. The uppermost branches have grown to a point on a level with the upper margin of the vesical sphincter. They are contained within the sphincter and for the most part are embedded in the submucosa, although a few branches have extended for a short distance into the muscularis. Most of these structures empty into the urethra near the upper end of the verumontanum but there are a few that have their openings between this point and the vesical orifice on the floor of the urethra. The tubules have quite a number of branches and their histological characteristics are similar to those already described in other specimens. An interesting feature of this particular group is that quite a number of the tubules are distended, in some cases reaching five or six times the usual size.

The verumontanum is usual in shape and its length is 1.85 cm., being 0.5 cm. high and 0.43 cm. broad at its base. About 15 per cent. of the stroma of

the verumontanum is smooth muscle, the remainder being entirely composed of connective tissue, as there is no elastic tissue present in this structure.

The utriculus prostaticus is present and fairly large in size. It is found only in the verumontanum and ends in a bicornuate manner. It opens in the midline on the crest of the verumontanum below the mouths of the ejaculatory ducts and is surrounded by a number of large tubules, some of which empty into the utricle and a few of which empty into the urethra itself. The muscular walls surrounding the utricle are quite thick and prominent. The ejaculatory ducts accompany the utricle and the three structures are firmly held together by a thick muscular envelope which also surrounds the tubules mentioned above. The mucosa of the utricle is thrown into numerous folds and the lumen of the structure is almost filled with them.

The vasa deferentia are thick walled and retain their customary shape and appearance. Occasional simple tubular glands without branches are seen in their walls and communicate with the lumina. The ampullæ of the vasa deferentia are large in size and have a folded mucous membrane which almost occludes the lumina.

The seminal vesicles are collapsed and the mucosa folded. They are made up of a main chamber on each side with five small branches which are much folded and contained within a fibrous sheath. Their walls are thick and compact. They are surrounded by a rather rich blood supply which traverses the fibrous tissue between the convolutions of the various portions of this structure.

The ejaculatory ducts formed by the junction of the mouth of the seminal vesicle on each side and the vasa deferentia begin well within the substance of the prostate and proceed in an oblique direction until they reach the level of the upper end of the verumontanum, at which point they turn abruptly and pass almost perpendicularly up into the verumontanum, where they become separated by the utriculus prostaticus which is contained in the same thick sheath with them. They run parallel with the axis of the urethra for a considerable distance and then each one turns sharply laterally and empties into the urethra on the sides of the verumontanum in such a manner that a thin area of tissue extends over the mouths of the ducts.

The Apex Group.—There are twelve small tubules with a few minute branches which make up the apex group of glands. These are delicate in their outlines, small in size and do not have thick muscular walls. They are found for a short distance in the membranous urethra as well as surrounding the urethra at the apex of the prostate. They do not extend deeply into the peri-urethral tissues. They are similar in type to those observed in other specimens.

The number of prostatic tubules is a subject that has been much discussed and concerning which there is a great deal of divergence of opinion. Svetlin by counting the excretory ducts has determined the number to vary between fifteen and thirty-two. I am convinced that in health most of the prostatic duct orifices are invisible to the eye or the cysto-urethroscope of Buerger or McCarthy. I have used the latter instrument repeatedly on a large number of cases and rarely have

been able to count more than fifteen duct orifices and these have usually been in pathological conditions in which they were held open due to induration of the tissues composing them. As has already been explained earlier in this paper, the prostatic tubules open into the urethra at an angle and in such a manner that the orifices are protected by a thin valve-like lappet of tissue which usually drops down over the orifices and closes them quite effectively, particularly upon distention of the posterior urethra. Kölliker has estimated the tubules to be thirty to fifty in number; Hessling fifteen to thirty. From the investigations made here it seems to be a much more accurate method to study the entire prostate gland, and in following the various tubules from section to section the exact number of tubular ducts opening into the urethra can be determined for each lobe of the prostate. By pursuing this method in twelve cases, varying in age from two and one-half months intra-uterine to seventy-six years of age, it has been found that the number of tubules of the prostate varies from forty-one to seventy-four, the average for all specimens observed being fifty-eight.

TABLE SHOWING NUMBER OF PROSTATIC AND OTHER TUBULES WHICH ENTER THE URETHRA

No.	Age of specimen	Middle lobe	Lateral lobes		Posterior lobe	Anterior lobe	Total prostatic tubules	Subcervical glands Albarran	Subtrigonal glands	Apex group
			Right	Left						
1	2½ months; intra-uterine.....	0	0	0	0	0	0	0	0	0
2	3¼ months; intra-uterine.....	12	20	19	11	12	74	0	0	0
3	.....	7	13	14	6	13	53	0	0	0
4	4 months; intra-uterine.....	10	23	23	4	14	74	8	0	0
5	4½ months; intra-uterine.....	0	21	21	10	7	59	11	5	0
6	7½ months; intra-uterine.....	11	18	18	9	8	64	9	4	12
7	At birth.....	9	17	17	11	2	56	19	9	19
8	4 years.....	12	10	14	11	5	52	33	23	26
9	4 years; Dr. Vance's specimen..	7	11	12	8	4	42	39	?	?
10	17 years.....	12	11	11	12	5	41	43	32	16
11	35 years.....	7	15	11	11	4	48	31	38	9
12	76 years.....	10	12	12	11	5	50	33	21	12
	Average.....	10	16	16	9	7	58	25	19	15

The five original independent lobes of the prostate have been distinguishable in every specimen observed in this research. The middle lobe has been definitely absent in one intra-uterine specimen, in five cases there has been some doubt about its presence and in 447 cases it has been definitely present, as shown in the accompanying table. Thus it is seen that this investigation bears out the statements of Griffith who

declared that (1) the middle lobe may be either present or absent at the time of puberty and in adult life before enlargement takes place; (2) that this lobe is independent, having glands of its own which open upon parts of the posterior wall of the prostatic urethra. Tandler and Zuckerkandl [32] agree with this opinion and base their theory of prostatic hypertrophy largely upon this anatomical fact. Pallin,[26] Evatt,[9] Jores,[19] and others consider the middle lobe to be a glandular outgrowth from each lateral lobe.

TABLE SHOWING THE FREQUENCY OF THE OCCURRENCE OF MIDDLE LOBES

Specimens	Number of definite middle lobes	Questionable middle lobes	Middle lobes definitely absent
Twenty cadavers in Dr. Mall's laboratory	20	0	0
Ten fœtuses	9	0	1
Thirty-three enlarged prostates in museum of Brady Institute of Urology	31	2	0
Forty autopsy specimens of enlarged prostates in Guy's Hospital, London	37	3	0
Three hundred fifty post-mortem specimens, Bellevue and Post-Graduate Hospitals, New York	350	0	0
Total	447	5	1

The number of tubules composing the middle lobe varies from 0 to 12, the average being 10. The average number of tubules in each lateral lobe is 16, as few as 10 being found and as many as 21 in one case. The posterior lobe tubules vary from 4 to 12, the average being 9. The anterior lobe was found to be least conspicuous in the prostate of a new-born child which was exhaustively studied and remodelled in wax. Another specimen showed as many as 14. After birth this particular group of prostatic tubules never numbered more than 5, although in a specimen observed just after puberty its tubules seem to be as actively functionating as any other portion of the structure. The average number for all specimens is seven.

The structures, which have been termed in this investigation "accessory organs," are interesting, and a discussion of histological characteristics seems proper.

The trigonum vesicæ was shown by Lieutaud to be superimposed upon the vesical floor, its constituent fibres coming from each ureteral wall. J. Griffiths [11] believed it to be composed only of the innermost bands of muscular bundles of the bladder wall. W. Waldeyer [37] believes that there is a separate development of its musculature which is continuous with that of the ureters and the prostatic urethra. There

is an absence of submucosa over the trigone. It has firm, smooth, thick-layered muscular membrane. Versari [35] concludes from his studies that normally the musculature of the trigonum vesicæ is made up of (*a*) the trigonal portion of the internal sphincter, (*b*) part of the muscular layers of the ureters, and (*c*) the muscle-bundles of their sheaths. In adults there are present in the trigonal region bundles which come from the muscular layer of the bladder. Walker [36] agrees with the above in part. He observes that from the ureter on each side a thick band of muscle passes down towards the urethra. These bands converge and unite so that this longitudinal muscle flows over the margin of the urethral opening in a continuous sheet. In the centre of the triangle formed by these bands of muscle the fibres appear to interlace indiscriminately. Delbet [4] declares the trigonum vesicæ to be an appendage of the ureteral walls. Congenital lack of an ureter shows the trigonum to be lacking on that side. Passavant has described a case in which the trigone was entirely separate from the bladder wall.

The mucosa of the trigonum is quite thick, being composed of many layers of transitional epithelial cells. This portion of the bladder mucosa is always smooth and free from folds, regardless of how trabeculated the remainder of the organ may be. The submucosa is not extensive. The group of mucous glands which I have called the subtrigonal group and which has been fully described is found extending from about the middle to the apex of the structure. There is a surprising increase in the number of tubules composing this group after birth. In an adult specimen as many as thirty-eight are observed, while before birth five is the greatest number. The average for all specimens is nineteen.

The muscle and connective-tissue bundles of the trigone are derived from the walls of the ureters and extend from the apex to the upper end of the verumontanum. The tissue composing the trigonum is very compactly arranged and this structure is very richly supplied with blood-vessels. The number of small vessels is so great that the trigonum has a dark-reddish appearance when seen post mortem or with the cystoscope.

The fibres from its apex connect with the upper end of the verumontanum and are seen to be arranged in a varying number of folds, usually two or three. This structure is normally an equilateral triangle, although the base or distance between the ureteral orifices is often a little less than the distance between ureter and the vesical orifice. In the first decade the average trigonum measures 1.2 cm. This increases in the second decade to 1.6 cm. During the third period it reaches

adult size, 2.2 cm., and remains practically the same throughout adult life.

The superposition of the trigonum upon the bladder wall, as described by Lieutaud, can be demonstrated by Mall's method, in which the structure is dissected entirely free from the vesical wall.

Asymmetry of the trigone occurs with considerable frequency. In my series it occurs most frequently in the fourth decade. Fifty-nine of the entire number of specimens, or 26.3 per cent., show a considerable difference in the distance of the two ureters from the vesical orifice. This variation may be as much as 1.2 cm. and in this day of instrumental investigation of the bladder and ureters this is an important consideration. In adults the ureters may be as near to the vesical orifice as 1.5 cm. or as far from it as 5.0 cm. Eight and one-half per cent. of my specimens have a trigonum vesicæ more than 1.0 cm. larger than normal, while 2.7 per cent. are unusually small without other signs of abnormality. Seventeen specimens, or 7.6 per cent., show an hypertrophy of the trigonum vesicæ which stands out markedly superimposed upon the bladder. It is in every such case somewhat contracted with a deep bas-fond behind its base. This condition rarely, if ever, occurs before the fortieth year.

Abnormalities in the structure of the trigonum vesicæ are very frequently met with. The existence of an hypertrophy of the group of fibres extending from one ureter to the other is so common an occurrence that a so-called interureteric bar is taken for granted in adults. I have come across a number of specimens in which there is apparently no tissue extending from one ureter to the other, but there is a distinct bundle extending from each ureter to the vesical orifice. Frequently bundles of fibres extend toward the middle line and then curve rather sharply toward the apex, forming a wide V-shaped structure. Several of the specimens show the remarkable condition of a bar extending from one ureter just to the midline where it stops off short, and extending from the other ureter to the orifice of the bladder there is a well-marked bundle of fibres.

The structure of the internal sphincter has already been discussed. The tubules which occur within the sphincter chiefly on the floor of the vesical orifice are of great interest. They were described in detail by Albarran [1] and enlargements of this group attracted the attention of authors as early as 1700. Sir Everard Home in 1802 described pathological hypertrophies of this group as the "third lobe," and such conditions even to-day are mistaken by some writers for middle lobe enlargements. As a matter of fact, true enlargements of the middle

lobe are extremely rare, while hypertrophy of Albarran's group occurs to a greater or less extent in 25 per cent. of the cases over thirty years of age, as shown by the examination of 350 postmortem specimens and about 500 cases observed by means of the cystoscope.

These tubules make their appearance at about the fourth month of intra-uterine life. They are not very numerous up to the time of birth, as there are never more than eleven. After birth they increase greatly, so that in one specimen there are as many as forty-three. The average number for all specimens is twenty-five. Structurally they differ from prostatic tubules in a number of important details. There is not a differentiated layer of muscular and connective-tissue fibres around them, although in disease the fibrous tissue develops an encircling sheath in many instances. The mucosa is composed of two or three layers of low columnar or cuboidal epithelial cells, chiefly the latter placed upon a felt-like basement membrane. The lumina are small and usually circular or oval in shape and rarely have an irregular outline with finger-like projections, as do the prostatic tubules. These tubules in an adult resemble the tubules of an embryonic prostate gland to a considerable degree.

According to McMurrich [24] the seminal vesicles begin to develop at about the third intra-uterine month. The embryonic specimens observed bear out this statement. Gustaf Pallin [26] has described very accurately the development of the seminal vesicles. They grow backward and laterally, consisting of a main part which is convoluted and from which rather numerous short convoluted branches grow out. The seminal vesicles and lower ends of the vasa deferentia are bound together by a structure composed of anterior, middle, and posterior lamella. This fascia is of interest because it tends to prevent the dissemination of carcinoma of the seminal vesicles to contiguous structures, it causes a true middle lobe hypertrophy of the prostate to project into the bladder, and it supports the base of that viscus. The seminal vesicles attain adult size during the third decade, and normally do not enlarge after that period. Histologically the seminal vesicles show a thickened wall in later years of life composed of some muscular but mainly connective-tissue fibres. These are very compactly arranged. Their lumina are quite irregularly convoluted and lined with simple non-ciliated columnar epithelium containing yellow pigment. Enlargement of these structures occurs in 32.4 per cent. of all cases over twenty years of age. The greatest period of affection is during the third decade, at which time 42.5 per cent. are abnormal. The right seminal vesicle is enlarged three times as frequently as the left in this series,

there being thirty-seven cases of the former and ten of the latter, and ten in which both sides are symmetrically enlarged. There are five cases of atrophy of both structures.

The vasa deferentia are comparatively larger in embryonic life than in specimens after birth. They widen out into the ampullæ in the region of the seminal vesicles and at that point there are observed a number of definite evaginations from the lumina into the solid walls which are lined with mucous membrane similar to that of the vasa deferentia themselves. These evaginations are only found after the period of adolescence. The mucosa of the vasa deferentia is made up in part of simple ciliated columnar epithelium and in part of stratified ciliated columnar cells with two rows of nuclei. The cilia are frequently absent. In the ampulla of the vas the epithelium is for the most part simple columnar in type and the cells often contain granules of yellow pigment.

The course of the ejaculatory ducts has already been described. They are lined as a rule by a single layer of columnar cells, although the mucosa is often folded and the cells are frequently arranged in two or three layers. Their walls are composed of smooth muscle and connective tissue circularly arranged, as Porosz described, but the walls become exceedingly frail in the region of the verumontanum so that any sphincteric action must be very slight. The main barrier against ascending infection seems to be the thin lappet of mucosa which is left above each orifice of the ducts as they enter the urethra obliquely on the lateral walls of the verumontanum. When these valve-like orifices become diseased, as in chronic posterior urethritis, they become indurated and are often held open, thus greatly increasing the danger of ascending infection and resulting epididymitis.

The utriculus prostaticus in old-age specimens is longer than in those of preceding periods, its average length being 0.89 cm. In later embryonic specimens as well as in the adult there are two types found. The most common is that which is contained within the tip or upper end of the verumontanum. The other extends to the base of the prostate. In this series there is one embryonic specimen which has a very small atrophied tube extending between the vasa deferentia and connecting with a thick-walled utricle which is found at the base of the prostate. This vestigial organ is absent in one case, the region usually occupied by it being filled by two tubules with many branches which enter the urethra separately. Its orifice is unprotected and, occurring as it does on the summit of the verumontanum in the midline and with its many tubules and branches contained within its wall, seems

to offer a splendid site for a stubborn infection, a fact which is borne out by clinical experience. We have in no instance found an ejaculatory duct opening into the utricle and Dr. George S. Huntington [16] asserts that he has never found the condition existing in the lower animals. Its mucosa is composed of stratified transitional epithelium and is usually much folded. The glands contained within its walls which are composed of compactly arranged smooth muscle and connective-tissue fibres are also lined with stratified epithelium.

The verumontanum is composed of tissue derived from the ejaculatory ducts and utricle which in their development push the floor of the urethra up into a mound. The length of that portion of the urethra between the vesical orifice and the upper end of the verumontanum increases quite markedly in the old-age period. During the second decade this distance measures 1.2 cm. It remains practically the same during the third and fourth decades, in the fifth decade it increases to 1.55 cm. Between fifty and sixty years of age this portion of the urethra increases to 1.75 cm. and in the old-age period measures 1.85 cm. Histologically the verumontanum is very interesting, as most of the structures entering the prostatic portion of the urethra pass through its substance, including a large majority of the prostatic ducts. By the use of Van Giesen's stain it is noted that the main portion of the stroma is made up of connective-tissue fibres, although there is some smooth muscle besides that which surrounds the ducts of prostatic tubules, the ejaculatory ducts and utriculus prostaticus.

The upper end of the verumontanum is usually quite high and arises abruptly from the floor of the urethra, while the lower end tapers down and some tissue spreads out in one or two bands on each side while fibres become lost in the tissues of the urethral wall. In one interesting case [28] these laterally disposed bands became hypertrophied and completely blocked the urethra except at one small area forming a diaphragm-like obstruction.

A group of tubules occurs in the wall of the urethra in the region of the apex of the prostate which has been termed the apex group. They are found in every specimen older than seven and one-half months intra-uterine. The largest number, twenty-six, is noted in a specimen aged four years. In older specimens they are not so numerous. The average is fifteen for all specimens studied.

Histologically they consist of small tubules, sometimes simple, but in most of the older specimens they have two or three branches. They are very delicate in architecture, not being surrounded by a definite muscle or connective-tissue envelope. They extend for some distance into

the walls of the urethra. Their lumina are small but fairly regular in outline. The mucosa is not folded. It is composed of one layer of small columnar epithelial cells. They are most numerous at the apex of the prostate and just below that point, but disappear from the urethral mucosa lower down in the membranous urethra.

Nerves.—The prostate is richly supplied with nerves and contains ganglian nodes, ganglion cells, and numerous end organs. They are derived from the inferior hypogastric plexus of the sympathetic system. A delicate plexus of nerve-fibres communicates between the seminal vesicles and prostate. Fibres from the anterior roots of the third and fourth sacral nerves are present. It is a well-known fact clinically that pathological conditions of the prostate are accompanied by very severe disturbances of various sorts. The most common of these are the referred pains which may occur in the small of the back, in or about the rectum, or down the legs. Timofeew in his very complete study has described a complicated system of nerve-fibres and endings which assists greatly in understanding this feature of the anatomy of the prostate. Von Planer described numerous nerve-endings situated in the superficial layer of the mucous membrane of the prostatic urethra. Timofeew describes a wide-meshed plexus of medullated fibres within the deeper layers of the capsule. Fine non-medullated fibrillæ pass through the prostate from the plexus and, branching freely, end between the epithelial cells. Other branches form tuft-like end bodies and still others encapsulated end organs. Some of these resemble Pacinian corpuscles with two fibres each, one of which is thick and enters as a naked axis cylinder and ends in the opposite pole as a pointed or knoblike structure; the other is thin, loses its medullary sheath, forms a finely divided fibrillary web and surrounds the axis cylinder of the first fibre as a loose tunic, but does not come in contact with it. He describes another nerve-ending as a single fibre more or less branching in all stages of transition from the simplest cylindrical form up to multiple branching forms besides the usual Pacinian corpuscles. Besides the sensory fibres he mentions the existence of many others which are apparently secretory, as they resemble similar fibres in other glandular structures. Timofeew describes both motor and sensory end structures on the fibres of Henle's muscle (striated). They are at first medullated and terminate as non-medullated fibres. The nerves of the smooth muscle-fibres are non-medullated. They form between the muscular layer thick plexuses of varicose fibrillæ which send out numerous branches.

The arteries of the prostate are derived from the internal pudic,

middle hemorrhoidal and chiefly from the inferior vesical. Branches of these vessels coursing in the capsule divide and enter the gland in the interlobular septa and dividing further send capillaries to nourish the individual branches.

The veins collect the blood from the capillaries just described and pass out to the lateral and anterior portions of the prostatic capsule, where they become quite large as a rule and intercommunicate very freely, forming the plexus of Santorini which receives the dorsal veins of the penis and is often the seat of phleboliths. This plexus also communicates with veins from the bladder, seminal vesicles, and rectum and is continued as the prostatovesical plexus to the internal iliac veins. There are exceedingly few veins found in the capsule of the posterior surface of the prostate, some of the veins collecting blood from the para-urethral region communicate with the vessels of the trigonum vesicæ.

The lymphatics begin as a network around the acini of the gland. They pass outerward and form a second plexus beneath the capsule. Here collecting tubules arise, several of which pass from the posterior part of the gland. One trunk passes to the external iliac gland, one to the internal iliac gland, and several end in the lateral sacral glands and glands of the sacral promontory. An anterior trunk is joined by lymphatics from the membranous and prostatic urethra and passes to a gland on the internal pudic artery.

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LITERATURE

[1] Albarran: Maladies de la prostate, p. 526, 1902.
[2] Ciechanowski, S.: Anatomical Researches on the So-called Prostatic Hypertrophy, p. 73, 1903.
[3] Cruveilhier, J.: Anat. Path. du. Corps Humain, livr. 17, p. 3.
[4] Delbet: Traité d'Anatomie Humaine, vol. 5, p. 110.
[5] Deschamps: Traité Historique et Dogmatique de l'Opération de la Taille, Paris, 1796, vol. i, pp. 39–40.
[6] Desnonvillers: Propositions et Observations d'anatomie, de Physiol. et de Path., Thèse de Paris, 1857.
[7] Dupuytren: Mémoire sur l'Opération de la Pierre, Paris, 1836, p. 21.
[8] Ellis: Trans. Med. Chir. Soc., vol. 39, pp. 330–331.
[9] Evatt: Jour. of Anat. and Physiology, vol. 43, p. 314, 1908.
[10] v. Frisch: Die Krankheiten der Prostata, 1910.

[11] Griffiths, J.: Jour. of Anat. and Physiol., vol. 23, p. 374, 1889; Jour. of Anat. and Physiol., vol. 23, p. 535, 1891.
[12] Gross: Diseases of the Bladder, etc., Philadelphia, 1855, 2nd ed., p. 69.
[13] Guyon: Über die pathologische Anatomie und Physiologie der retentio urinæ. Zentralblatt für die Krankheiten der Harn und sexual organe, 1890, S. 7.
[14] Hodgson: The Prostate Gland and Its Enlargement in Old Age, London, 1856, p. 4.
[15] Everard Home: Philosophical Transactions, 1806, paper 8.
[16] Huntington: Personal communication.
[17] Hunter, John: A Treatise on Venereal Diseases, London, 1788, p. 170.
[18] Jones, Dr. Hansfield: Medical Gazette, London, August, 1847.
[19] Jores: Virchow's Archiv für pathologische Anatomie, Bd. 135, 1894, p. 224.
[20] Keibel-Mall: Human Embryology, Philadelphia, vol. 1, 1910, pp. 180–200.
[21] Kölliker: Zeitschrift für Wissenschaft, Leipsic, 1848.
[22] Kuss: Anatomie normale de la Prostate. Trav. de Chir. (voies urinaires).
[23] Lowsley: The Development of the Human Prostate Gland. Amer. Jour. of Anat., vol. 13, No. 3, July, 1912. The Human Prostate Gland at Birth. Jour. of Amer. Med. Assoc., January 11, 1913, vol. 60, pp. 110–114. Congenital Malformation of the Posterior Urethra. ANNALS OF SURGERY, December, 1914. The Gross Anatomy of the Prostate Gland. Surgery, Gynæcology and Obstetrics, February, 1915, pp. 183–192.
[24] McMurrich: The Development of the Human Body, Philadelphia, 1902.
[25] Morgagni, G. B.: De Sedibus et Causis Morborum per Anatomem indagatis, Venis, 1761, Letter 41, Article 18.
[26] Pallin, Gustaf: Archiv für Anat. und Physiol., 1901.
[27] Porosz: Daten zur Anatomie der Prostate. Archiv f. Anat. u. Physiol. Anat., Leipzig, 1913, suppl., 172.
[28] Porier and Charpy: Anatomie Humaine.
[29] Richardson: Development and Anatomy of Prostate Gland, 1904.
[30] Dorn-Santorini, Jno.: Observations anatomical, Venice, 1724, Chap. 10.
[31] Senn: Traité d'Anatomie chirurgicale, Paris, 1838, vol. 2, p. 329. Par J. F. Malgaigne.
[32] Tandler and Zuckerkandl: Folio Urologica Internationales-Archiv. für die Krankheiten der Harnorgane, March, 1911.
[33] Thompson, Sir Henry: Diseases of the Prostate, 1873.
[34] Timofeew: Über die Nervenendigungen in den Mänlichen Geschlechtsorganen von Saugetieren und Menschen, 160 Seiten, 5 Tabeln, Kasan, 189.
[35] Versari: Ric d. Roma, vol. 13, 1907.
[36] Walker: Jour. of Anat. and Physiol., vol. 40, p. 190, 1906.
[37] Waldeyer, W.: Das Trigonum vesicæ. Sitzungsberichte der akadamie Wissenschaften in Berlin, 1897, p. 732.
[38] Wilson and McGrath: Surgical Pathology of the Prostate. Surg., Gyn. and Obst., December, 1911, p. 647.