VI. POSTERIOR URETHRA

The urethra in woman considered from an embryological point of view develops at the expense of the portion of the urogenital sinus situated above Müller's eminence, and is known by the name of primary urethra.

In the male sex two portions have to be distinguished in the deep or posterior urethra: the first, placed above the verumontanum, is homologous to the female urethra and in a similar way develops at the expense of the portion of the urogenital sinus situated above Müller's eminence, constituting the primary urethra; through it only urine passes. The other portion comprises the inframontanal urethra, the membranous urethra and the urethral bulb. These portions develop at the expense of the urogenital sinus properly-called, or the portion situated below Müller's eminence.

The other portions of the male urethral duct, or penial urethra and glandular urethra, develop at the expense of the folds and of the genital tubule and actually have a rather more genital significance. Though the said portion intervenes in the phenomenon of urination, it is not absolutely necessary for its realization, that is to say: the urethra can be surgically suppressed performing an opening at the perineum, both urination and continency persist in a way that is analogous to what takes place in the female sex. This division in anterior urethra and posterior or deep urethra continues to exist at present in all its value because it corresponds to reality from an embryological as well as from an anatomical, physiological, pathological and surgical point of view. Leaving aside the action of the vesical muscle in the phenomenon of urination and limiting our attention only to the role that the musculature of the deep urethra performs, we have to remark that this portion of the duct is not simply a tube that in a passive way allows the passage of the urine pushed by the contraction of the vesical muscle. This duct opens and closes in an active way: it does not wait for the pressure to dilate it, but opens so as to allow the passage of the urine at the moment of urination and afterwards closes also in an active way, once urination has finished.

Observation shows us daily the existence of both urethras. When an olive tipped bougie is introduced in a normal urethra, it passes freely until reaching the posterior urethra where it is withheld by the contraction of the sphincter; only after a few moments of pressure this muscular resistence gives in, and the prostatic region is reached and hence the vesical

cavity; only a slight resistence is met when passing through the vesico-urethral orifice.

When an instillation is performed in the deep urethra, it remains in it or penetrates into the vesical cavity but does not reflow outside. When the instillation is carried out in the anterior urethra, it reflows to the orifice, and the same happens when lavages of the anterior urethra are performed, the liquid reflows towards the outside. It is well known that when urethrovesical lavages are performed, if it is wanted that the liquid should penetrate into the bladder, it is necessary to exercise a sustained pressure for a certain time and above all to advise the patient to make a slight effort to urinate; in this way the liquid column passes the posterior urethra and penetrates into the vesical cavity.

The true urinary sphincter is placed in the membranous urethra. The action of the sphincteric system of the vesical neck and of the prostatic musculature is secondary. In what refers to the phenomenon of urination, is seems that the action of the smooth vesico-urethral sphincter works as such only when the vesical musculature is at rest. When it contracts, the sphincter of the neck opens synergically in an active manner. The only thing that can voluntarily resist the contraction of the detrusor, is the striated sphincter of the membranous urethra.

In the genital function, the role of the striated sphincter is also ascertained. Thus we see that the liquid secreted by the prostatic gland and the seminal vesiculae turns outside only at the moment of ejaculation when the striated sphincter contracts. Furthermore, the secretion of Cooper's glandulae turns outside during erection because the secretory ducts of the said glandulae empty into the urethral bulb, a region in which there is no striated sphincter. The reflux towards the posterior urethra is prevented by the external sphincter and mainly by Albarran's smooth sphincter, placed near the orifice of the secretory ducts.

It is therefore perfectly logical and in accordance with reality to distinguish two urethras: an anterior urethra and a posterior urethra. According to this division suggested by GUYON, the urethra comprised between the external orifice and the point where the membranous urethra opens into the urethral bulb is to be considered as the anterior urethra, and as posterior or deep the urethra comprised between the urethral bulb or posterior orifice and the vesico-urethral orifice. The posterior urethra opens into the bulb, while the anterior urethra opens into the external orifice. The posterior urethra in reality is a part annexed to the bladder or rather its prolongation, as demonstrated by the disposition of the musculature of the vesico-prostato-urethral compound which forms a morphological unity.

GUYON's observation is exact; according to it, when an individual with a great need to urinate is sounded and the neck is not obstructed, the liquid comes out from the moment in which the probe has penetrated into the prostatic urethra, that is to say: has passed beyond the membranous urethra. When the need to urinate does not exist, it is necessary for the probe to pass the prostatic urethra and the vesical neck. All this demonstrates that the occlusive action of the internal sphincter and of the other sphincterial formations of the vesical neck, is efficacious only when the bladder is at rest. When the vesical muscle contracts, the vesical neck synchronously opens, while the striated sphincter of the membranous urethra acts only as a mechanism for closure.

The role of the anterior urethra in the act of urination though it is not altogether a passive one, is much less important and rather accessory. It is to be remarked that the elasticity of the walls of the penial urethra is a factor that aids the passage of the urinary column; when their elasticity disappears, urination becomes difficult.

A - THE PROSTATIC URETHRA

The urethra crosses the prostatic region penetrating through its base, into the junction of its anterior fourth with its posterior three fourths; it crosses the said region following an almost vertical route describing a slight anterior concave curve and goes out by the vertex of the prostate and continues in the membranous urethra.

The urethral duct does not follow the same direction as the axis of the prostate; both cross each other forming an angle from 15° to 20°. The length of the prostatic urethra is about 3 cm; that of the membranous urethra, 5 cm.

The urethral duct does not follow the same direction as the axis of rarely undergo changes in length. These variations frequently come about in the inframontanal urethra; its lengthening in old age is a sign of prostatic hypertrophy; but it is also observed in inflammatory processes, when the prostate increases in bulk.

In the prostatic urethra we have to consider a notably vertical anterior wall and a posterior wall that starting from the vesico-urethral orifice follows a slightly oblique direction downward and backward; half way through its route, it changes direction and goes downwards and forward describing a slightly anterior concave curve. It derives from this that the posterior wall has a greater length than the anterior one; both walls conjoin in their superior and inferior extremes but are separated in their

middle part, limiting a small ovoid cavity which is the prostatic sinus in which the semen and the prostatic secretion flow during ejaculation. The prostatic sinus is formed at the expense of the posterior wall, for, though the interior wall is also slightly convex, it is never so stressed as to fit in the concavity of the posterior wall.

At the level of the middle part of the posterior wall we come across a prominence with an ovoid appearance; it is the verumontanum or colliculus seminalis.

The structure of the prostatic urethra is not uniform; two distinct portions have to be distinguished in it, each one of which presents a particular constitution suited for the function it has to accomplish; these portions are the supramontanal urethra and the inframontanal urethra.

The supramontanal urethra. It comprises the portion that goes from the superior pole of the verumontanum to the vesico-urethral orifice; in it two elements have to be considered: the urethral mucosa and the musculature.

The mucosa. The epithelium and chorion of the supra- and inframontanal mucosa are analogous. In fact in life the urethral mucosa is uniformally red, due to its great vascular richness. It presents a notable elasticity, due to its richness in elastic fibres owing to which it can be easily dilated. Without any doubt, there is no other mucosa in the organism as rich in elastic fibres. At rest it forms folds that disappear during urination and the passage of instruments, owing to the fact that its chorion, very rich in elastic fibres, distends and retracts most easily. The said fibres are very noticeable in the vesical neck and in the membranous urethra, and less in the inframontanal urethra.

As it is known, in the urethral mucosa there is no submucous tunica of loose tissue which ordinarily accompanies the other mucosae as the vesical one and allows it to slide on the underlying muscular planes; here when the urethral mucosa comes to form folds, the underlying tunicae (vascular and muscular) with which they are closely attached, follow it.

Histologically, in the epithelium three tunicae are to be considered: the superficial tunica formed by a row of cylindrical cells; below, there are various tunicae of polyhedric cells; and the deepest row of cubic cells in contact with the chorion constitutes the basal tunica. In the immediateness of the vesico-urethral orifice, the epithelium increases in height progressively acquiring the character of a vesical epithelium.

The chorion, as we have said, is constituted by connective tissue very rich in elastic fibres, forming longitudinal folds stamped on those of the

mucosa. Dermic papillae are seen with a well manifest sanguineous net, with frequent leukocytal accumulations.

So far the characteristics of the mucosa of both the supra- and infra-montanal portions are identical: the differences arise when the periureteral tissues are examined. On account of the importance that these structures have, it is advisable to detail the different constitution in both ureteral portions.

In the supramontanal urethra two parts are to be distinguished: a higher one that extends from the internal orifice as far as the lower border of the sphincter, constituting the intra-sphincterial portion; and a lower one that extends from the sphincter to the verumontanum, forming the sub-sphincterial portion.

In the higher or intra-sphincterial portion, the periurethral space is limited inside by the chorion of the mucosa and outside by the internal sphincter that separates it from the middle and lateral portions of the cranial gland. In the lower or sub-sphincterial portion, the fibro-elastic periurethral space also exists, limited inside by the mucosa, but outside is lacking of precise limits and continues with the acini of the subsphincterial lobules, except in the points where the vesico-prostato-urethral fibres and the deep loops of the detrusor are interposed. In both portions of the supramontanal urethra, we come across numerous muscular fibres in a longitudinal direction, a continuation of the plexiform tunica and of the external longitudinal tunica of the detrusor, constituting the vesico-cervical muscular system.

In the periurethral fibro-elastic tissue, we find vascular erectile spaces already mentioned by QUENO and HARTMAN (Fig. 112). In this periurethral net the said vascular spaces that represent a rudimentary erectile tissue, develop in a constant manner. These vascular spaces are concentrated in the vicinities of the chorion and appear in the form of fissures strewn with endothelial cells. In its wall is seen at times an arteriole (2) in which, when at rest, blood hardly circulates owing to the existence of a tiny sphincter that prevents the passage of the arterial blood, but at the moment of erection relaxes and allows the influx of blood into the erectile spaces. They are met with in all the perimeter of the duct; their existence is constant in all ages, and are already observed in the full-term fetus, but they present numerous individual variations as regards their development.

These vascular spaces gradually tend to increase in adult age and in senility, and to form at times real vascular cysts that can be the cause of hematuria. At times these hematic cysts can reach a considerable development and determine an obstacle in urination, constituting one of

the anatomo-pathological varieties of the so-called disease of the vesical neck. When a congestion of the pelvic organs happens, the repletion of these vascular spaces increases, making an unimpeded action of the surrounding muscular fibres difficult, namely of the vesico-cervical system which has the function of opening the vesical neck. This would also explain the previous circumstance that the pelvic congestion would result in patients affected by dysuria, especially in case of prostatic hypertrophy.

In the periurethral area, as we have said, we come across a considerable number of smooth muscular fibres in a longitudinal direction, placed around the urethral duct. Examining horizontal cuts that pass through this region, these fibres appear cut transversally. Altough they exist in the whole periurethral space, they are more numerous in the anterior and lateral segments than in the posterior one, and they go on diminishing in number as they gradually come near the veru, owing to the fact that many of them terminate inserting into the fibro-elastic tissue.

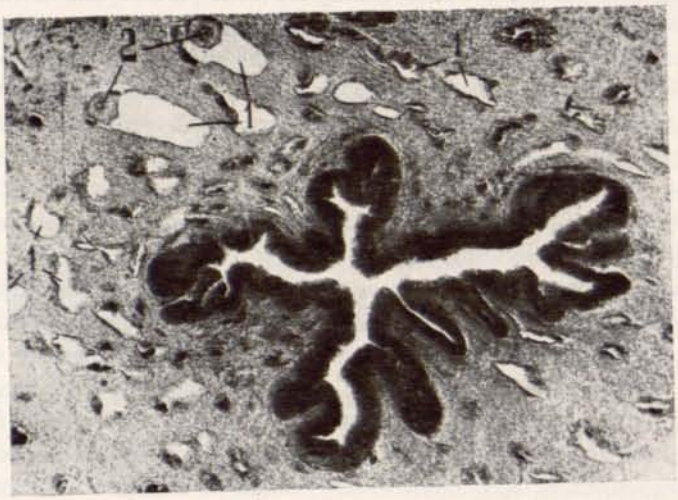

FIG. 112. - 1) Erectile vascular spaces. 2) Arteriole annexed to the erectile vascular space.

We have insisted on these structural details that considered morphologically are of slight importance, because in these formations pathological processes that are really important and of consequence take place. In fact we incidentally declare that in the periurethral space that we have now described, the benign neoformations begin and develop in a constant way when reaching presenility, and constitute the so-called hypertrophy of the prostate, and especially the so-called medial pathological lobule.

Morphologically considered, the supramontanal urethra is exclusively employed for the passage of the urine, and is provided with a smooth sphincteric system that, when at rest, keeps the urethral walls attached. At the moment of urination it opens forming a funnel, the vertex of which corresponds to the verumontanum and the base to the internal orifice. Upon the act of ejaculation, the spasmodic contraction of the internal sphincter prevents the reflux of the semen towards the vesical cavity.

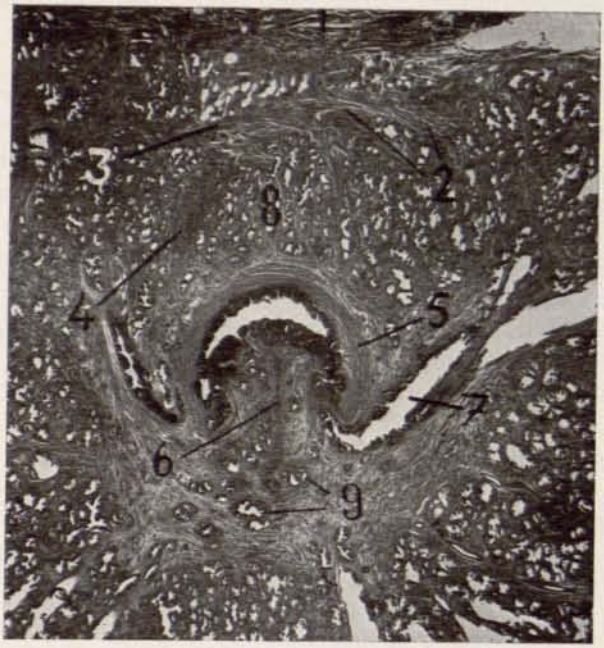

FIG. 113. - Sligthly oblique horizontal cut from above down and from front back, of the prostate of a child. 1) Vesical external sphincter. 2 and 3) Smooth muscular commisure. 4) Anterior prostato-urethral fibres. 5) Inframontanal elastic arcs. 6) Posterior prostato-urethral bundle. 7) Anterior duct of the postero-lateral lobules. 8) Anterior lobule. 9) Secretory ducts of the postero-lateral lobule, cut perpendicularly.

The inframontanal urethra. If we observe a horizontal cut that involves the inframontanal urethra (Fig. 113) we distinguish in the centre the urethral duct in the shape of a horseshoe, due to the prominence that in the posterior wall the so-called urethral ridge forms. This prominence is due to the existence of a powerful myoelastic column in a longitudinal direction, which appears cut transversally and occupies the centre of the urethral ridge, constituting the posterior prostato-urethral bundle. The mucosa of this region, as we have said, does not differ from the one that lines the supramontanal urethra; what varies is the disposition of the

periurethral tissues. In fact around the myoelastic bundle which occupies the space comprised between it and the urethral mucosa, some erectile vascular spaces are seen; and there circulate the terminal portions of the great collecting ducts of the postero-lateral lobules of the caudal prostate. These ducts open into the bottom of the canals situated on each side of the urethral ridge, or else at the sides of the most prominent point of the ridge. This ridge constitutes the limit that separates the two halves of the caudal prostate.

In the antero-lateral border of the urethral duct that ends by representing three fourths of it, the periurethral fibro-elastic tissues condense, forming together a robust arc (5), which is set in the shape of a posterior concave crescent, the extremities of which end at each side of the urethral ridge (Fig. 113); thus the border of the urethra is provided with a robust arc which, to be able to form a complete circle is only lacking of a posterior wall that corresponds to the urethral ridge. This arc is constituted by a compound of fibro-elastic laminae juxtaposed one on the other, which carry out an important role in the mechanics of urination and ejaculation. When at rest, the elasticity of this arc keeps the anterior wall of the urethra attached to its posterior wall. At the moment of urination when the urinary column passes, it easily extends on account of its elastic nature, at the same time in which the prominence, that the urethral ridge forms, sinks; with this circumstance the lumen of the duct acquires a cylindroid shape. Once the passage of the urine has finished, the elastic arc then automatically applies to the urethral ridge, and this ridge becomes again a prominence in the urethral lumen, as can be seen in the diagram of figure 114. In the act of ejaculation these formations act in an analogous way.

However, for a perfect realization of the phenomena that we have described, a necessary condition for the delicate periurethral elastic tissues is to be in a perfectly normal state, because if this is altered in consequence of inflammatory or sclerotic processes, they lose their normal softness and elasticity, causing urination to become difficult. These tissues are likely to undergo alterations on account of inflammatory processes that are frequently seated in this region, especially in chronic posterior urethrites.

Other times the lesions affect also the surrounding glandular ring, contributing to make the normal functioning of these functional mechanisms difficult. An example of this is given in the chronic sclerotic prostatites that alter the glandular parenchyma which surrounds the urethra, transforming it into an inextensible or very slightly extensible fibrous sheath, making it more or less difficult to open the urethral duct.

In front of the elastic arc we come across the glandular acini of the anterior lobule of the caudal prostate (8), which occupy the middle line establishing a contact, when they reach a certain bulk, with the corresponding portion of the lateral prostato lobules of the caudal prostate (Fig. 113). In a foremost plane, we find a series of muscular bundles in a longitudinal direction, that appear cut transversally; in front, a plane is seen of smooth muscular fibres in a transversal direction; and in front of them a plane of striated fibres. This compound of muscular formations constitutes the anterior muscular commisure.

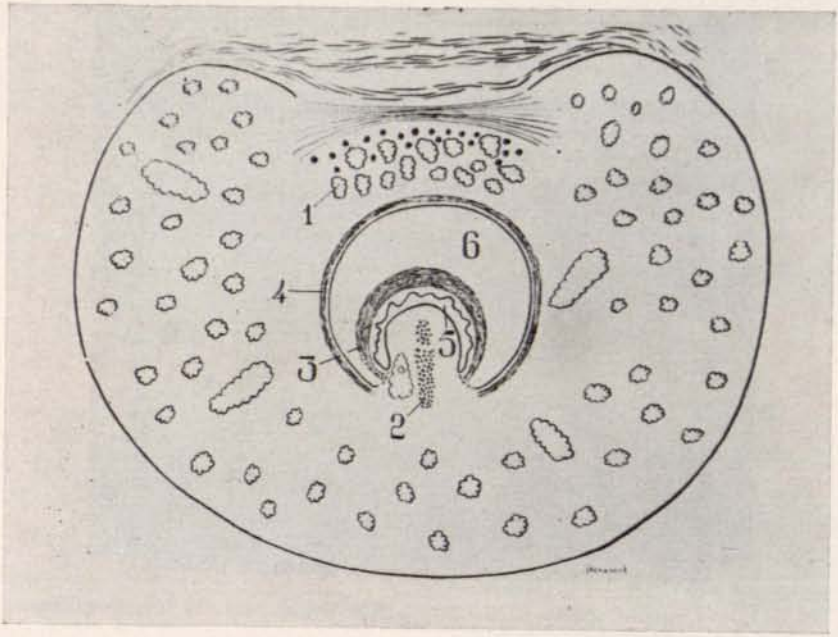

FIG. 114. - 1) Anterior lobule of the caudal prostate. 2) Posterior prostato-urethral myoelastic column. 3) Inframontanal elastic arc at rest. 4) Inframontanal elastic arc relaxed. 5) Inframontanal urethra at rest. 6) Inframontanal urethra during urination.

What is the functional meaning of the architecture of the supra- and inframontanal portions of the urethra? There is a fundamental difference between the two portions: in the supramontanal urethra, the opening of it at the moment of urination or the closing of it and the coaptation of its walls during the intervals, is realized in an active way through the specific action of particular muscular bundles. In the inframontanal urethra instead, the changes that the lumen undergoes at the moment of urination and when it is at rest, are mainly due to the action of the inframontanal elastic arc that surrounds almost the whole perimeter of the duct; it lets

itself be passively distended by the urinary column during urination, and then reacts by itself automatically and fastens to the urethral ridge also in a passive way.

The membranous urethra. In the membranous urethra we have to consider the urethral mucosa with its annexed glands, together with the periurethral elastic tissues. Around these structures there is a compound of smooth and of striated muscular formations that will be described further on.

The urethral mucosa. When a transversal cut which involves the membranous urethra, is examined with a magnifying glass (Fig. 115), in

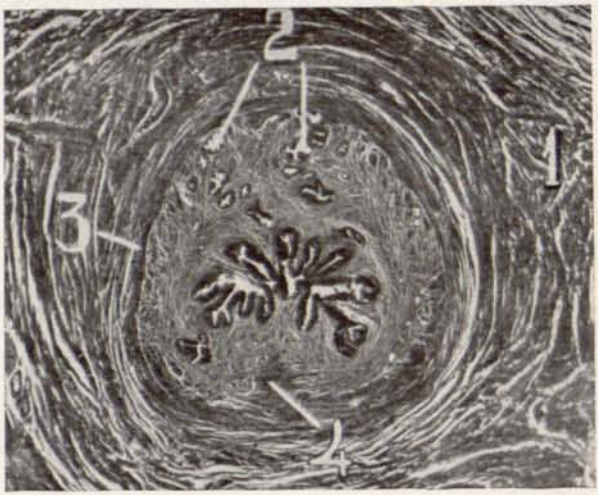

FIG. 115. - 1) Striated sphincter. 2) Intrasphincterial glandulae. 3) Smooth sphincter. 4) Posterior prostato-urethral bundle.

the centre the urethral lumen is seen in a stellated shape owing to the existence of numerous mucous folds that disappear at the moment of urination. One of these folds, the bulkiest, is situated in the posterior wall (4); very noticeable in the higher part contiguous to the apex of the prostate, it goes on diminishing in the prostatic urethra as it gradually nears the lower extreme. It is produced by the same myoelastic column that establishes the formation of the urethral ridge; it is the posterior prostato-urethral bundle. Immediately outside of the mucous folds formed by the epithelium and the chorion, a tunica of elastic tissue is met with that surrounds the urethral duct like a circle (Fig. 116). However it must be remarked that this circle (2) is not complete; in its higher part

it is interrupted by the mentioned myoelastic column. This circle is very visible in its higher part where it continues in the inframontanal elastic arc; lower down, it goes on tapering until it disappears in the urethral bulb. Between the chorion of the mucosa and the elastic circle, erectile vascular spaces are met with.

Immediately outside of the elastic connective ring, some glandulae are met with in the form of small culs-de-sac very noticeable in the higher third contiguous to the apex of the prostate; they go on diminishing as they come near the lower extreme and finish by disappearing.

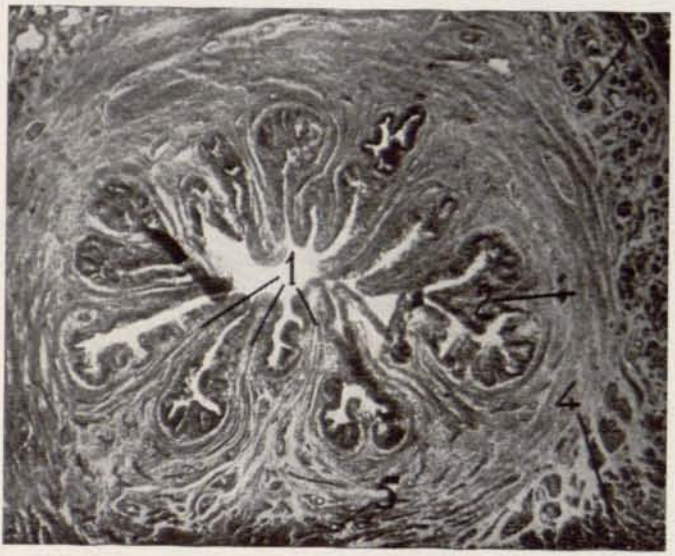

FIG. 116. - 1) Folds of the mucosa. 2) Periurethral elastic circle. 3 and 4) Longitudinal smooth fibres. 5) Erectile vascular spaces.

A demonstration of the important role performed by the elastic tissue arranged like a plastic sphincter around the inframontanal urethra is given in Figure 117 concerning a tabetic patient. In this figure we can see, at the bottom of the funnel, widely opened and at the same time sloping, formed by the vesical neck, the inframontanal arc closed like a sphincter around the lower portion of the veru.

The description and demonstration that we have now given of the elastic tissue around the inframontanal and membranous urethra, are taken literally from the ones we published in 1952. Of no influence on the exactness of our descriptions is the fact that PENNINGTON and LUND (1940) discovered in 1940 or rather eight years later, the same anatomical disposition.

What is original in the mentioned paper is that the postoperative incontinency consequential of endoscopic resections of the prostate, are due to lesions of the elastic elements of the inframontanal urethra and of the membranous urethra. If the mentioned authors, after reporting

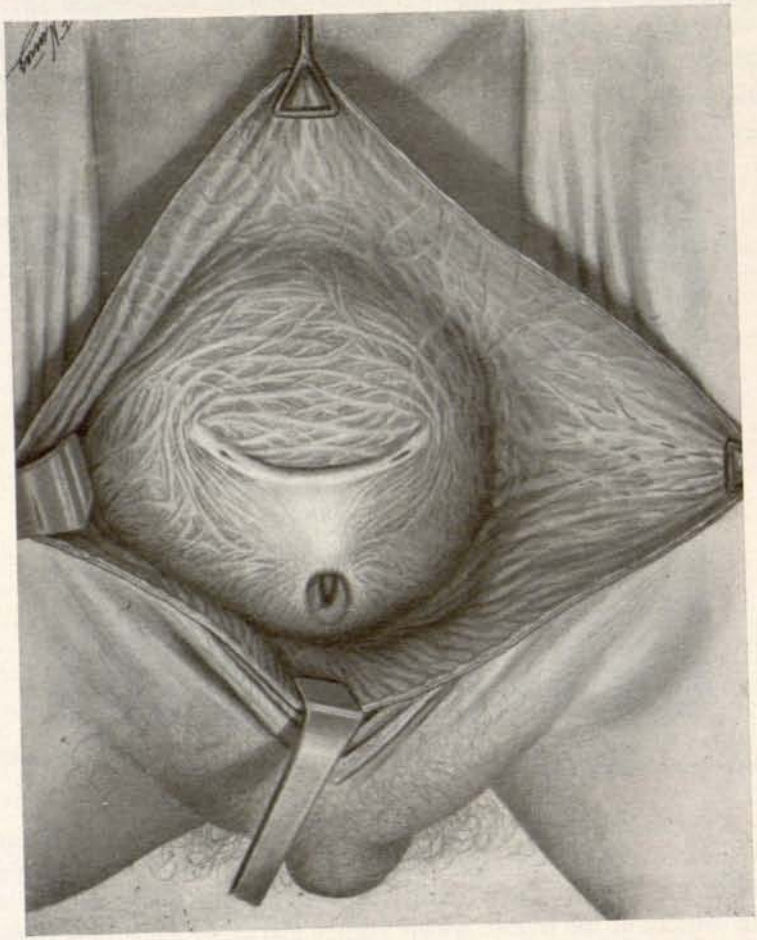

FIG. 117. - Enormously extended bladder of a tabetic, which reached the navel. In it can be observed the vesical neck widely open allowing to see the verumontanum. Paralysis of the detrusor (Schramm's sign n/n).

their interesting clinical observations, had added that they were in agreement with our anatomical studies, we would have no reason to object or to complain. To each one his due. As we do not perform the endoscopical resection of the prostate, it had not occurred to us to think of the possibility of lesioning the elastic arc that is placed like a plastic

sphincter around the urethra. But we can perfectly understand that its lesions can be the cause of postoperative incontinency.

The verumontanum. The verumontanum or colliculus seminalis is an ovoid prominence that stands out in the posterior wall of the prostatic urethra. The higher pole of this ovoid is very bulky and from it issue the frenula of the veru, that are some delicate folds that go up to the posterior border of the vesical neck, and are produced by underlying muscular fibres.

Above the higher pole of the veru at times there is a depression that is known by the name of supramontanal fossula in which at times small orifices are seen that correspond to Albarran's submucous glandulae, which are not constant.

The lower extremity of the veru is very delicate, and is prolonged as far as the membranous urethra, forming the so-called urethral ridge. This ridge, very prominent in its point of origin, goes on diminishing gradually in bulk and finishes by disappearing in the urethral bulb. The urethral ridge, as we have said, is a prominence originated by the presence of the posterior prostato-urethral bundle, that from the verumontanum and the caudal prostate, extends along the membranous urethra establishing a connexion with its sphincterial system.

On each side of the veru there are two small canals, the canals of the veru, which continue with other analogous ones placed at the sides of the urethral ridge; along these canals the great collecting ducts of the caudal prostate open.

In the most prominent portion of the veru the prostatic utricle opens in the form of a fissure, and on each side of it, the orifices of the ejaculatory ducts. In the higher pole of the veru the secretory ducts of the middle portion of the cranial prostate open. In the lateral walls of the higher half of the veru the secretory ducts of the lateral portions of the cranial gland or subsphincterial lobules open, which we call like this because they open below the internal sphincter.

The anatomical constitution of the veru. The urethral mucosa covers the surface of the veru in a uniform manner; in normal conditions there are no folds that, as some authors describe, disappear at the moment of erection on account of the congestion of the underlying erectile tissue. Actually no folds or erectile tissue exist; this is the only portion of the mucosa of the posterior urethra that has no vascular spaces.

In 1952 we carried out a detailed study of the verumontanum, of the utricle and of the ejaculatory ducts, that on account of its length we cannot relate here. We will limit ourselves to say that the three ducts

together with the fibro-muscular sheath that wraps them, derive from the genital cord of the embryo. The fibro-muscular sheath isolates these ducts from the prostatic lobules with which it has no connexion, neither vascular nor nervous. The vessels and nerves purposed for the ejaculatory ducts, the utricule and the verumontanum are altogether independent of the ones of the prostatic gland; they are in connexion with the vessels and nerves of the seminal vesiculae, of which they are a continuation.

The fibro-muscular sheath, when it reaches the base of the prostate, continues in the walls of the seminal cell; which means that both formations amply communicate. Hence when a cystic dilatation of the utricle is produced, it emerges from the prostate and invades the seminal cell from where it easily develops.

B - THE ANATOMICAL AND FUNCTIONAL SOLIDARITY BETWEEN THE INFRAMONTANAL PROSTATIC URETHRA AND THE MEMBRANOUS URETHRA

The study that we have now carried out on the constitution of the posterior urethra leads us to the conclusion that the anatomical and functional features of the prostatic inframontanal urethra are in unison with those of the membranous urethra. This is mainly due to the fact that their elastic and muscular tissues have a close connexion that establishes a real organic interpenetration between both urethral portions.

The inframontanal urethra surrounded by the caudal prostate, continues in the membranous urethra with which it is closely connected, without it being possible to establish a precise limit between the two.

On the basis of its embryonary development, anatomical constitution, physiology and pathology, we can establish a very marked division of the posterior urethra into two portions: a higher or supramontanal one, that corresponds to the vesical neck, developed at the expense of the primary urethra, and surrounded by the cranial prostate. It has exclusively a urinary significance except for the action of the internal sphincter that obstructs the neck at the moment of ejaculation. All the other muscular elements are exclusively a dependence of the vesical musculature mainly forming the vesico-cervical system purposed to open the neck, in opposition to the internal sphincter, the trigonal loop and the loops of the detrusor, that keep it shut in the intervals between urinations. It has a

pathology of its own, characterized by urinary difficulties that are in a certain way summarized in the so-called disease of the vesical neck.

The lower portion extends from the verumontanum to the urethral bulb, comprising at the same time the inframontanal urethra surrounded by the caudal prostate and the membranous urethra surrounded by the external sphincter. Both form a morphological unity: its embryology shows that the inframontanal urethra, the caudal prostate and the membranous urethra are formed at the expense of the urogenital sinus. Its physiology demonstrates that it has a twofold functional character, both urinary and genital; but with a predominance of the latter as evidenced by clinic observations and its pathology. The pathological processes that have seat in this region and are principally characterized by genital disorders; and incontinency greatly prevails in what refers to the urinary function, in contrast with the pathology of the vesical neck in which obstruction has a predominance.

The muscular connections between the two great segments of the posterior urethra, are less noticeable than those that exist between the inframontanal urethra and the membranous urethra. It cannot be said that a total separation exists between both supra- and inframontanal segments; but the connections are weak, reduced to some minute muscular fascicles pertaining to the posterior vesico-cervical group, that incorporate in the powerful posterior prostato-urethral bundle. In the anterior wall, another muscular connection exists between both great segments, very noticeable in the newborn and in the child and less in adults, owing to the predominance of the prostatic gland that disgregates and at times overcomes these weak muscular formations.

Though acknowledging these connections between the two great segments of the posterior urethra, they cannot be compared with the powerful prostato-urethral bundles which establish a direct and close junction between the inframontanal urethra and the membranous urethra.

The sphincterial system of this zone in much more powerful than that of the vesical neck, and constitutes a true sphincter of the bladder, as it is the only one that functions after the total removal of the prostate. This sphincterial system is directly connected with the vesical musculature mainly by vesical-urethral fibres, that from the transverse precervical arc go to the external sphincter of the membranous urethra; these connections however are not as powerful as those that the detrusor presents in the sphincterial elements of the vesical neck through the vesico-cervical system and the powerful posterior small longitudinal fascia.

In what refers to the genital function, we must point out the behaviour of the musculature of the great lower segment of the posterior

urethra. In the ejaculation, the evacuation of the semen towards the outside is under the exclusive dependence of the smooth and striated musculatures that surround the urethral duct, in the segment that goes from the verumontanum to the urethral bulb. In that moment the powerful myoelastic column acts; this column forms the posterior prostato-urethral bundle and the anterior prostato-urethral bundles, all of them of genital significance. In a first phase, the filling of the prostatic sinus is performed by the semen that flows through the ejaculatory ducts and by the prostatic secretion that empties through the great collecting ducts of the prostate. The dilatation of this portion of the posterior urethra is made possible by the energetic action of the powerful prostato-urethral bundles, that upon contracting cause the shortening and dilatation of the prostatic urethra and of the membranous urethra. In a second phase, when the dilatation reaches a sufficient degree, the brusque and violent contraction of the striated sphincter takes place in a reflex manner, provoking the expulsion of the semen outside in the form of rhythmical jerks. After the first contraction of the external sphincter, the filling of the urethral duct again takes place and consecutively another contraction of the external sphincter. At the same time the spasmodic contraction of the internal sphincter comes about, preventing the reflux of the semen towards the vesical cavity.

The lesions of these muscular formations that frequently accompany old prostatites and later urethrites explain the perturbances of the genital functions. Many times the treatment of these lesions leads to curing them.

Besides the muscular element there is, however, another important factor represented by the elastic tissue, which is also found all along the inframontanal urethra and the membranous urethra acting as a plastic sphincter.

C - SECONDARY FACTORS THAT INTERVENE IN CLOSING THE VESICAL NECK

An important role in the closing of the vesical neck during the intervals between urinations has been attributed by some authors to two factors that would act in a passive way. The factors are: the veins of the vesico-urethral orifice and the exuberance of elastic connective tissue in the sphincteric system.

Veins of the vesical neck. The author who has given the most importance to the veins in the act of closing was HEISS, though previously other authors had upheld the same point of view. HEISS compares the action of these veins to that of the hemorrhoidal plexuses in the anal duct: they would work like a sort of soft cushion that would contribute to close the vesical neck. According to the said author, an emptying of these veins would take place at the moment of urination and would contribute to give passage to the urine through the vesical neck.

We have the impression that HEISS and the authors who have his same opinion, have mistaken the erectile vascular spaces that are met with all along the posterior urethra and especially along the supramontanal urethra, with the submucous veins that undoubtedly exist there as in the urinary bladder. Though admitting the existence, at the level of the trigone and of the neck, of an arterial and venous net more noticeable than in the rest of the bladder, this does not mean to say that even these veins exercise an important action in closing the vesical neck at least in normal conditions. This task in all events could be attributed to the erectile vascular spaces that we have described around the posterior urethra, especially in the vesical neck (Fig. 112). Probably together with the contraction of the internal sphincter they help to close the vesical neck in the moment of ejaculation; this is the only action that these vascular formations have in normal conditions. According to our point of view they are alien to the urinary act. It is only when these vascular spaces dilate forming true haematic cysts, that they perturb the functioning of the musculature of the vesical neck making urination difficult.

The role of the elastic tissue of the vesical neck. The importance of the elastic elements has been put in evidence by CAVAZZANA and other authors. Though since long its action as a coadjutant element in closing the vesical neck was surmised, we must point out that KOHLRAUSCH, when describing the internal sphincter muscle, considered it to be formed by elastic fibres; an error that naturally was cleared later by HENLE and other anatomists. This confusion is not to be reproached, for at times it is difficult to distinguish in certain bundles whether they belong to a muscular tissue or to an elastic tissue, and other times the fusion of these elements takes place and constitutes myo-elastic bundles.

No doubt there is a richness in elastic fibres in the dense intrafascicular net that forms the stroma of the internal sphincter muscle, the same as in all the elements that constitute the vesical trigone. The massive consistency of the latter is due to the dense elastic connective net that forms the skeleton, the stroma of the trigone. The action of this elastic

tissue would be a kind of plastic tone that would add to the muscular tone of the internal sphincter, of the trigonal loop and of the loops of the detrusor, contributing to keep the closed condition. At the same time it would by its elasticity facilitate the distension of the sphincteric system at the moment of urination. The plastic tone that this elastic net of the trigone and of the vesical neck performs, is analogous to what we have ascribed to the fibro-elastic inframontanal arc and to the circle that surrounds the membranous urethra, that we described when we dealt with the constitution of this urethral segment.

The functional importance of these fibro-elastic formations are evidently placed in a pathological condition when by a process of sclerosis the fibro-elastic fibres disappear and consequently the vesical neck loses its normal softness and elasticity. This alone is sufficient to cause the disectasia of the vesical neck. In past years several authors have dealt with the role that the elastic fibres perform in closing the vesical neck and the inframontanal and membranous urethra. In particular we must point out the interesting works by WOODBURNE who calls attention to the great quantity of elastic fibres in the submucosa and among the muscular bundles particularly in the longitudinal fibres of the urethra. Both tissues are intermingled in such a way that they are worthy of the name of myo-elastic tissue. We have been able to verify this disposition in the powerful posterior prostato-urethral bundle which is formed by a mixture of elastic and smooth muscular fibres. WOODBURNE is of the opinion that the closing in the intervals of urination is due to the elastic tissue that has a circular orientation especially prominent in the neck and posterior urethra.

The importance of the elastic element in the constitution of the urethral wall is known ab antiquo. The rest of the urethral mucosa is formed by connective tissue to which is added a great number of elastic fibres that according to ROBIN and CADIAT amounts to 80%. It is well known that of all the mucosae of the organism, the urethral is the richest in elastic elements; this is in agreement with the function that it performs, having to adapt itself to the brusque changes that it undergoes during urination. When at rest the walls of the urethral duct coaptate; the urethral cavity becomes real when the urinary column passes and disappears at once when urination ceases.

It is necessary to remark the concentration of elastic elements in the inframontanal and membranous urethra, that we described in detail in the previous chapter. This great richness in elasticity, together with the existence of smooth muscular fibres placed circularly, and the rings that the striated sphincter of the membranous urethra forms, are the realiza-

tion of the prevailing functional role of this small zone in order to achieve the urinary contention. The urinary contention depends on the anatomical integrity of these delicate factors performing the closure.

The post-operative incontinency that consecutively arises after operations in this region, almost always obeys lesions of these structures during the performance of the operation. One must insist on this fundamental idea and not let oneself be led astray by attributing to nervous factors to be the usual and common cause of the post-operative incontinencies. It is obvious that the possibility of the nervous factor cannot be excluded in an absolute manner; that is to say: the section of nerves appointed to this small zone can be the cause of incontinency. But its occurrence will be an exceptional fact; at the utmost the elongation of these nerves can take place or the section of some of them, which will be the cause of post-operative paresis, from which the patient does not take long to recuperate.

To account for what we have said, it is sufficient to examine preparations in which the membranous urethra appears wrapped by the external sphincter. The latter appears surrounded in its periphery by a great number of nerves; it is very difficult to section all these nerves during the operation.

The post-operative incontinency is produced mainly when the operation is performed through the perineal route or through the endourethral route. It is evident that when the endoscopic resection of the prostate is performed, it is very difficult, not to say impossible, to lesion the nerves. In these cases the incontinency is produced by the lesion of the three sphincters that surround the membranous urethra that from inside to outside, are: the elastic sphincter or inframontanal arc, the smooth muscular sphincter and the striated muscular sphincter. The lesion of these three elements or of anyone of them, is the cause of the incontinency when the operation is performed by the endourethral route, for the simple reason that they are the most exposed to be lesioned, especially the elastic sphincter.

When the operation is carried out by the perineal route, the incontinency is produced by the lesion of the external striated sphincter that surrounds the membranous urethra, at the moment of performing perineotomy and also during the proceedings for the removal of the adenoma.

When the operation is performed by the transvesical route or by retropubical route, it is rare for post-operative incontinencies to arise. The exceptional cases that have occurred are almost always due to the fact that in performing the removal of the adenoma, gashes have been

made in the mucosa of the inframontanal urethra that have lesioned the elastic and smooth sphincters of this region.

Summarizing and concluding we especially call attention to the importance of this small region, restricted to the membranous urethra and to the inframontanal urethra, where the clue lies concerning the closing, and the maintaining of the contention in the intervals between urinations. And don't forget that its constituent elements are very fine and very delicate, and therefore are to be handled with much care in order to avoid post-operative incontinencies and genital disorders.

D - THE SMOOTH MUSCULATURE OF THE POSTERIOR URETHRA

The existence of a muscular tunica in the posterior urethra placed in two planes, a longitudinal external one and the other, internal or circular, is a known fact since very long ago. There was the belief that both tunicae extended all along the urethra in a uniform manner with likeness to what happens in the small intestine, where the circular and longitudinal tunicae extend in all the length of the said duct without any differentiation.

It is over a century since KOHLRAUSCH demonstrated that the longitudinal fibres of the urethra continue in the plexiform fibres of the bladder. At the end of the past century VERSARI demonstrated the connexion of the external longitudinal fibres of the detrusor with the smooth internal sphincter and demonstrated the functional synergy between both antagonistic formations, that is to say, when the detrusor contracts, the sphincterial ring actively opens.

Apart from these contributions little more was known about the disposition of the smooth musculature of the urethral duct. Even KALISCHER in his precious book declares, when he describes the longitudinal fibres of the urethra, that the said fibres have their insertion of origin in the erectile tissue of the urethral bulb, presenting their maximum thickness in the membranous urethra and going on diminishing as they near the vesico-urethral orifice. Notwithstanding the respect that is due to the splendid work of the mentioned author, we cannot accept his opinion on this actual point. We say in advance that it is a basic error to consider the compound of longitudinal muscular fibres of the urethra as a continuous and uniform tunica that without solution continues to extend from one extreme to the other of the posterior urethra. In reality this muscular compound is constituted by different segments, one of which

performs a peculiar role, although all mutually aid the same purpose: to open and close the posterior urethra.

Speaking of the smooth musculature of the urethra, we refer to the posterior urethra that is comprised from the internal orifice to the point where the membranous urethra opens into the urethral bulb; and more precisely as far as Albarran's sphincter. Here finishes the smooth urethral musculature, forming systemized groups which we have dealt with. Further on from this sphincter the circular and the longitudinal fibres disappear.

This having been explained, when we speak of smooth musculature of the urethra we refer to the posterior urethra inasmuch as the only portions of the urethra provided with smooth muscular fibres forming well differentiated layers, are the prostatic and the membranous urethra.

a) THE LONGITUDINAL FIBRES OF THE POSTERIOR URETHRA

In the study of the longitudinal fibres of the posterior urethra various groups have to be considered. The first group comprises the fibres that are a continuation of the plexiform tunica and of the antero-lateral external longitudinal tunica of the detrusor; as they all terminate inserting into the fibro-elastic tissue of the wall of the vesical neck, the compound of these fibres constitutes the vesico-cervical system. As an annex of this group we include those fibres that originate in the derma of the mucosa of the internal orifice and contiguous portion of the said orifice; these fibres join with those that form the superficial trigonal muscle, constituting all conjoined, what we consider as muscularis mucosae. We also include in this group the cervico-prostatic fibres that originate in the thickness of the sphincterial system of the neck, and terminate in the stroma of the cranial prostate.

The second group is formed by fibres that originate in the walls proper of the sphincterial system of the vesical neck in its anterior part, and terminate in the walls of the membranous urethra, constituting the cervico-urethral group.

The third group is integrated by the prostato-urethral fibres that originate in the stroma of the caudal prostate and terminate connecting with the smooth and striated sphincters of the membranous urethra.

The fourth group is constituted by fibres that are the continuation of the bundles of the detrusor muscle; they go across the region of the neck and end in the membranous urethra, constituting the group of transit fibres.

A good description of these different muscular groups requires an accurate study of their origin, their route and ending. This is the best way to understand their functional significance.

Vesico-cervical fibres. These fibres have been repeatedly mentioned but have only been described in a fragmentary way. A general survey permits to distinguish three different portions: anterior vesico-cervical fibres, lateral vesico-cervical fibres, and posterior vesico-cervical fibres.

The anterior vesico-cervical fibres. The most important source of these fibres is rooted in the bundles of the plexiform tunica situated in the anterior border of the vesical neck that at this level continues in very fine and tenuous fibres. To this main group others are added that come from the anterior longitudinal fascia.

To understand the origin, route and ending of these fibres it is advisable to examine sagittal cuts that pass through the middle line. In them can be seen how the plexiform fibres continue and transform into vesico-cervical fibres, and also how the anterior longitudinal fibres when reaching the transverse precervical arc divide: some go downward and forward following a descending route and cross the anterior wall of the neck and of the prostate as far as reaching the external sphincter of the membranous urethra, forming the group of vesico-urethral precervical fibres; while others run downward and backward continuing in very delicate fibrils and in greater part cross the interstice that exists between the loop of the detrusor and the internal sphincter; others cross the same loop of the detrusor, and others the interstice limited by this loop and the lowest bundles of the circular tunica of the detrusor. But almost never are fibres seen crossing the compact mass of the internal sphincter. (See diagram Fig. 77).

Lateral vesico-cervical fibres. These fibres come into sight outside the middle line, in the lateral parts of the vesico-urethral orifice; the greater part of them is the continuation of the bundles of the plexiform tunica and in a lesser proportion of the external longitudinal bundles of the detrusor.

In figure 81 the lateral plexiform bundles are clearly seen when they penetrate into the lateral parts of the neck (4) changing into lateral vesico-cervical fibres. In figure 83 these fibres (1), being very hypertrophied on account of an enormous inveterate fibroma, can be seen still better.

Besides the ones indicated, there are other fibres that issue from the lateral longitudinal fibres of the detrusor. These fibres, when reaching the lateral part of the loop of the detrusor, transform into tenuous

small tendons that cross the fascicles of the said loop reaching the parts of the periurethral space. In the diagram of figure 89 they are signed with number 6.

Posterior vesico-cervical fibres. The origins of these fibres are much more complex and not yet completely made clear. The posterior vesico-cervical group should be revised and studied again. The description of it that we gave in 1952 must be completed and partly modified. The constitution of this group, i.e. the compound of fibres situated in the posterior wall of the neck between the mucosa and the sphincterial system of the neck, comprises several categories of elements that have in common their topographical situation in the posterior wall, but differ in what pertains to their functional and morphological significance. We must distinguish the submucous group, the properly called vesico-cervical group and the cervico-prostatic group.

a) *The submucous group.*

We described it when we studied the sagittal series (figure 34 - 42) defining the origin of the bundles that form the superficial trigonal muscle, i.e. the longitudinal muscles that occupy the superficial part of the trigone and lie underneath the mucosa from which they are inseparable. We come to the conclusion that these very fine fibrils which form the superficial trigonal muscle do not intervene in the formation of the important group of the properly called posterior vesico-cervical fibres.

To the fibres of the superficial trigonal muscle are to be added other fibres of an analogous significance, that originate in the derma of the mucosa of the internal orifice and contiguous portion of the said orifice. Altogether they form what we consider as a muscularis mucosae. We have the impression that this rudimentary muscular compound originates and terminates in the derma of the mucosa of the trigone, of the internal orifice and of the posterior wall of the neck; it has the task of keeping the mucosa of the region firm, avoiding the formation of folds that could be an obstacle to urination.

To corroborate this statement we present the microphotograph of figure 118, that is a frontal cut which involves the posterior wall of the neck precisely in the exact point where the very fine muscular fibres underlying the mucosa, circulate. Notice some very fine fibres in a perfectly vertical direction, that above terminate in the same mucosa from which they are inseparable.

In the parasagittal cuts, as in the case of figures 128 and 129, the existence is frequently observed of some fibres of the lateral vesico-cervical

group (1), a continuation of the plexiform tunica. But together with these fibres, others are seen that do not have any connexion with the plexiform fibres and give the impression of inserting into the derma of the mucosa placed in the lateral part of the internal orifice. Investigating into the subject, we could state that some fibres of this group seem to originate in the derma of the vesical mucosa, in the portion contiguous to the internal orifice. In many preparations we can verify that some insert into the derma of the mucosa, without being able to clearly see them continue in the plexiform fibres.

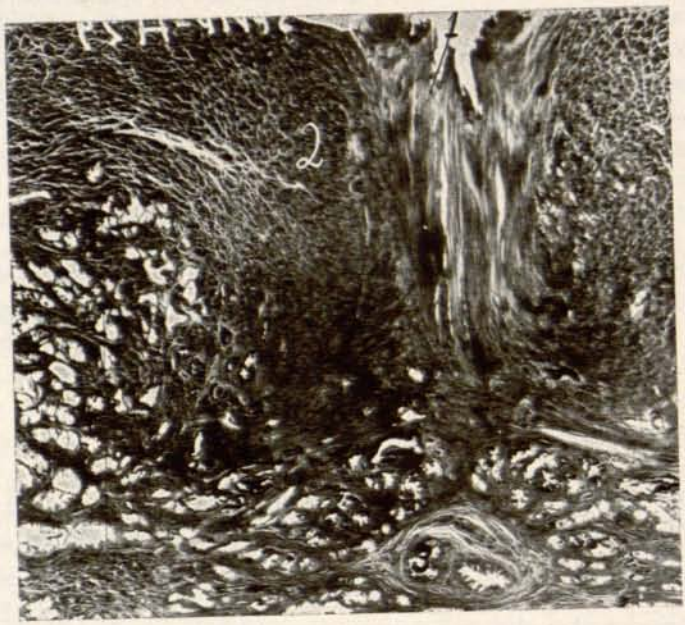

FIG. 118. - Frontal cut that passes through the posterior wall of the vesical neck. 1) Longitudinal fibres attached to the mucosa. 2) Sphincterial system of the neck. 3) Ejaculatory ducts.

b) *The posterior vesico-cervical group proper.*

The true origins of the properly called posterior vesico-cervical group correspond to the plexiform tunica and to the trigonal loop. To understand this it is sufficient to examine the microphotograph of figure 119 that is a cut that passes at the anterior half of the trigone. Attached to the mucosa some weak longitudinal fascicles can be observed, that represent the superficial trigonal muscle (1). Immediately below, the bundles of the trigonal loop (2) are seen, that incorporate in the previous ones. Figure 120 corresponds to the same series but involves the posterior wall of the

neck a little below the internal orifice. Notice that the group of longitudinal fibres underlying the mucosa (1) has increased considerably if compared with figure 119. The increase is due to the input of new fascicles coming from the trigonal loop that go and form the posterior vesicocervical group (2).

In 1952 dealing with this problem, upon the occasion of describing and interpreting the preparation of figure 124, we said: « It can be ascertained that the muscular bundles of both sides converge (3) towards the

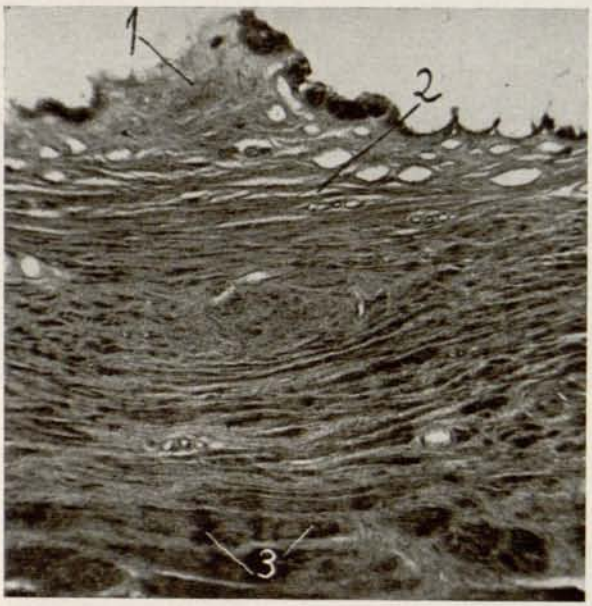

FIG. 119. - Frontal cut that passes through the anterior part of the trigone. 1) Longitudinal fibres of the muscularis mucouse. 2) Post-trigonal loops.

posterior border of the supramontanal urethra, coming to form together a kind of V open downward and forward that enfolds the lateral and posterior walls of the urethra; these bundles cross perpendicularly the internal wall of the internal sphincter muscle. The action of these fibres when contracting is to push outwards the lateral parts of the sphincter, opening the lateral walls of the neck and at the same time provoking the rising of the verumontanum ». This is what we thought then, but now after reading important papers based on radiological studies and having studied these structures again, we are inclined to believe that in the act of urination instead of the verumontanum rising, what happens is the lowering of the internal orifice and of the contiguous portion of the base

of the bladder, with the consequent shortening of the vesical neck. The verumontanum is a fixed structure.

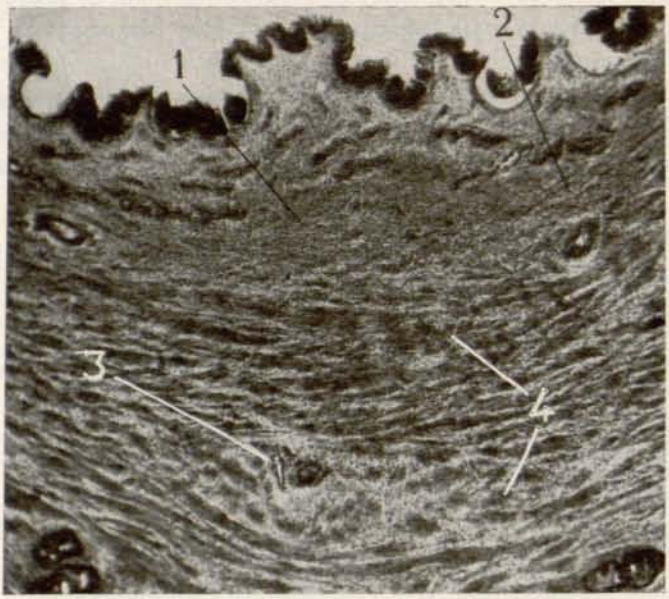

FIG. 120. - Frontal cut that involves the posterior wall of the neck in its higher part. 1) Longitudinal fibres of the posterior wall of the neck. 2 and 3) Fibres of the trigonal loops incorporating in the group of posterior vesico-cervical fibres. 4) Fibres of the trigonal loop.

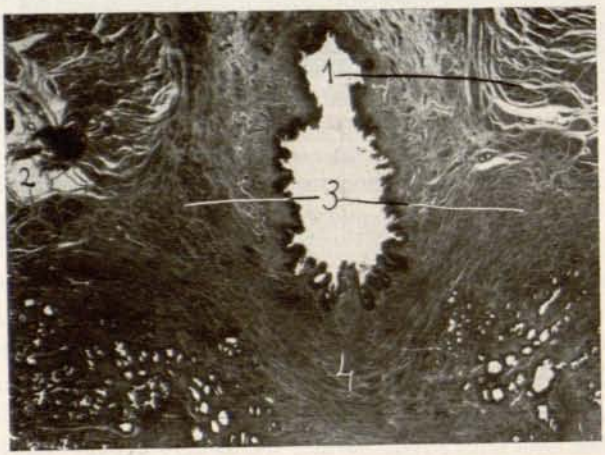

FIG. 121. - 1) Bundles of the circular tunica of the detrusor. 2) Loop of the detrusor (superficial portion). 3) Sphincterial system of the neck. 4) Posterior wall of the vesical neck.

Keeping now within the merely morphological aspect, we must remark that some of the plexiform fibres and of the trigonal loop terminate as vesico-cervical fibres in the posterior wall of the neck, as we have described. But after returning to study the problem, we believe that another important factor intervenes in the constitution of the group of longitudinal fibres placed in the posterior wall of the neck, constituting the cervico-prostatic group.

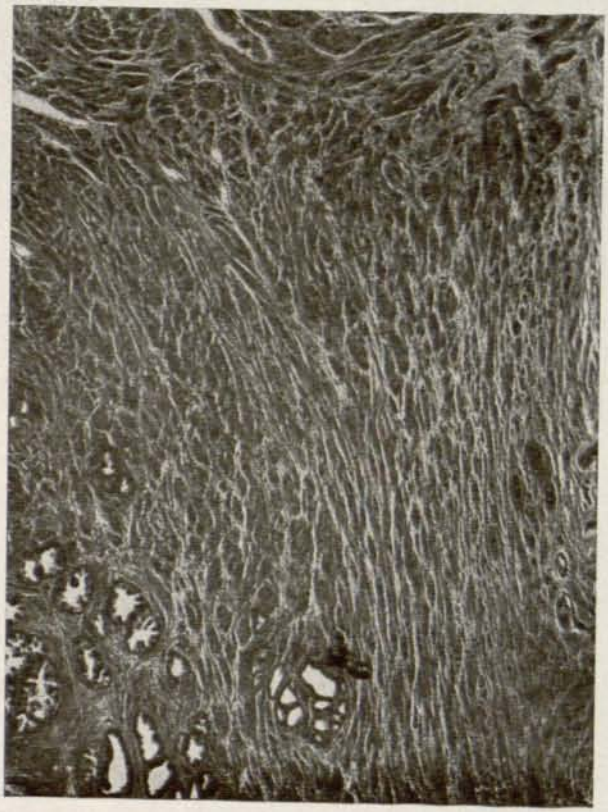

FIG. 122.

c) *The cervico-prostatic group.*

Figure 121 is a cut that involves the posterior border of the neck, a little below the internal orifice. In this panoramic view on both sides the lowermost circular fibres of the bladder can be seen (1); below, the superficial portion of the loop of the detrusor (2) is seen. Notice on each side of the neck a dense muscular mass (3) in which fibres cut across

faintly appear, and others that appear cut longitudinally owing to the fact that they have an oblique direction downwards back and inwards, i.e. they have the same direction as the cuts. These fibres go and end with those of the opposite side in the posterior border of the neck (6).

If we examine the dense muscular mass signed with number 3 more magnified, we can verify that there is a considerable number of fibres

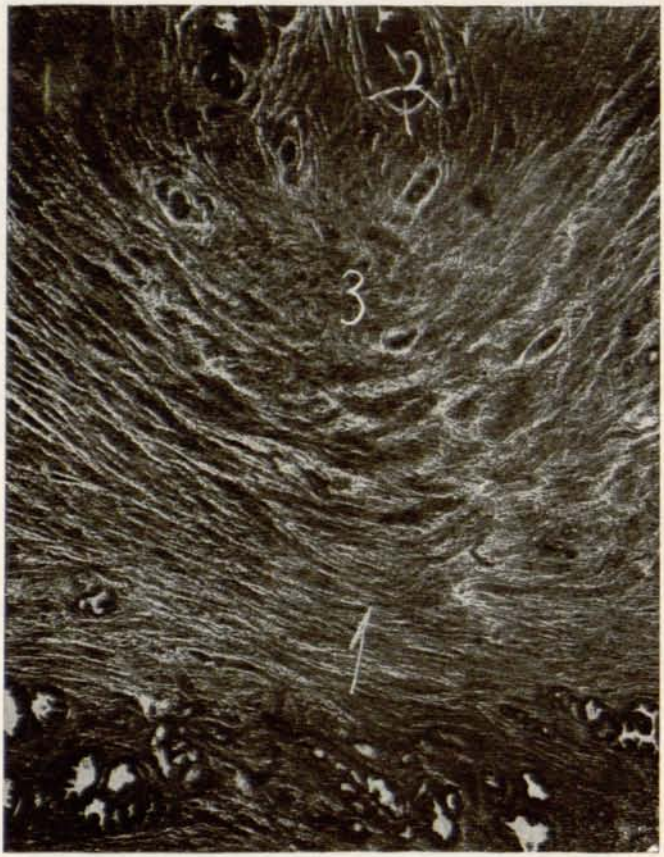

FIG. 123. - 1) Vesico-prostatic fibres. 2) Fibres pertaining to the muscularis mucosae. 3) Posterior vesico-cervical fibres.

cut transversally that correspond to the sphincterial system of the neck (Fig. 122) and among these bundles others appear cut in a longitudinal direction and issue from the thickness of the sphincter and run towards the posterior border of the neck. If now we examine this zone more magnified as it appears in figure 123, we are shown how these fibres end:

we observe that the greater part ends in the stroma of the cranial gland (1), and some very few others, that here are not seen, insert into the fibromuscular case or sheath that surrounds the utricle and ejaculators, as can be ascertained examining figure 134.

Figure 124 shows the loop of the detrusor (1 and 1') placed below the circular fibres of the bladder which appear schredded. In 2 are seen the anterior vesico-cervical fibres, a continuation of the plexiform tunica. Notice in each side of the neck the dense muscular mass that we have seen in figure 121. This compact mass also comprises fibres cut across that pertain to the sphincterial system, and fibres cut longitudinally that cross the interstices of the sphincterial fibres and go downwards inside and backwards, converging in the posterior border of the vesical neck and forming with those of the opened side an upward and forward V (3).

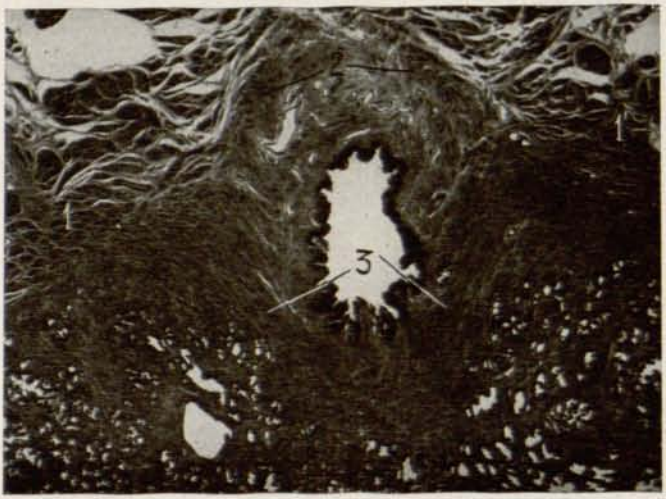

FIG. 124. - 1 and 1') Loop of the detrusor. 2) Vesico-cervical fibres, continuation of the plexiform tunica. 3) Vesico-prostatic fibres.

If we examine this dense muscular mass more magnified, we can verify that the fibres cut longitudinally issue from the thickness of the sphincterial system but we have not the possibility of ascertaining their continuation with the external fibres of the detrusor and with the plexiform fibres. All these fibres terminate inserting into the stroma of the prostatic gland (1). Notice that these bundles are independent of the tiny thin bundles attached to the mucosa (Fig. 125).

Figure 126 of the same series passes a little below the previous one, involving the part immediate to the higher pole of the verumontanum.

In it the same panoramic disposition can be seen: at each side of the neck is seen the dense muscular mass (5) formed by fibres of the sphincterial system, from which some longitudinal fibres issue, that run backwards, downwards and inwards, terminating on each side in the postero-lateral part of the neck in the immediate region of the higher pole of the veru (7). If we examine the zone signed with number 7 more magnified, we will realize how these fibres terminate in the stroma of the prostatic gland; but furthermore we will verify that they have nothing to do with the

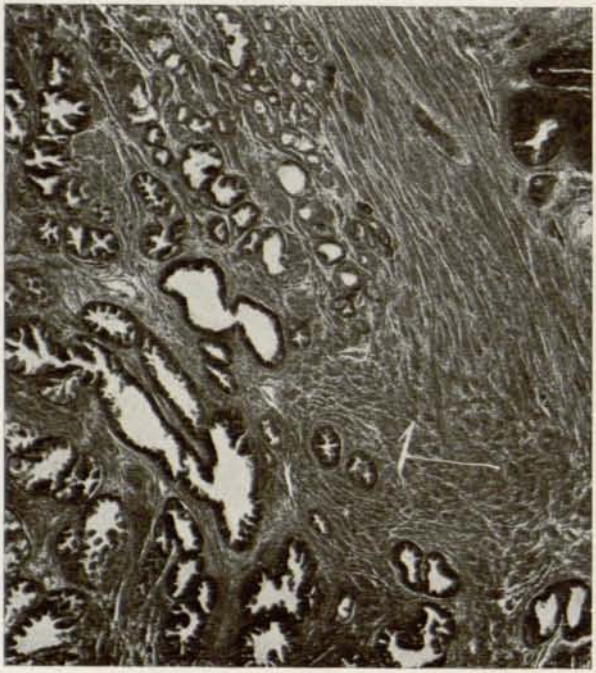

FIG. 125. - 1) Termination of the vesico-prostatic fibres.

tenuous fascicles attached to the urethral mucosa from which they cannot be separated. The latter represent the ending of the muscularis mucosae and of the superficial trigonal muscle, that here appears as insignificant bundles at the side of the important group formed by the cervico-prostatic fibres that we are describing.

From the description, verified also in other series, that we have now given of the compound of longitudinal fibres placed in the posterior wall, important facts are deduced that it is advisable to point out. In the first place it is evident that the group of the properly called vesico-cervical

fibres intervenes in considerable degree in the constitution of the group situated in the posterior wall of the neck; but together with them, others must be added which differ both in origin and termination. In fact, these fibres originate in the thickness of the same sphincterial system and terminate inserting into the prostatic parenchyma. The compound of fibres that originate in the thickness of the sphincterial system of the neck and terminate in the parenchyma of the prostate, we believe have the same morphological and functional significance as the group of cervico-urethral fibres, with the only difference that the terminal insertion of the latter takes place in the walls of the membranous urethra, while those that we are describing, terminate in the stroma of the cranial prostate, and for this reason, we believe, should be called cervico-prostatic fibres.

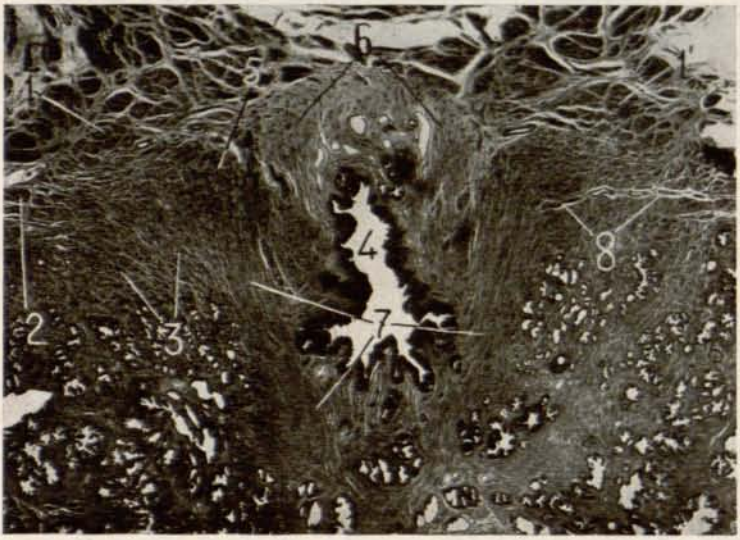

FIG. 126. - 1 and 1') Loop of the detrusor (superficial portion). 2) Mixed bundle of the external vesical sphincter. 3 and 5) Sphincterial system of the neck. 4) Supramontanal urethra. 6) Anterior vesico-cervical fibres. 7) Cervico-prostatic fibres. 8) Vessels destinated to the vesical neck.

What we have now stated concerning the significance of the cervico-prostatic fibres is in agreement with what at present is thought of the mechanism of urination on the basis of X-ray observations. They have demonstrated that when urination begins, the internal orifice moves downwards and backwards at the same time that the neck opens, forming the preurinary funnel. We believe that this double displacement is due to the combined action of the small posterior longitudinal fascia and of the

cervico-prostatic fibres. The fascia pushes the neck backwards and the fibres make the vesico-cervical orifice descend, shortening it in a synergic action with the cervico-urethral fibres that are functionally homologous.

Upon contracting, the posterior longitudinal fascia makes the vesico-urethral angle, which corresponds precisely to the posterior border of the neck, disappear at least in part. The neck, as we have said, goes from the higher pole of the veru to the anterior half of the trigone. It is precisely this portion of the trigone that is displaced during urination, while the interureteric ridge, the ureteral orifices and the posterior half of the trigone remain still. This explains why we consider the anterior half of the trigone as annexed to the vesical neck.

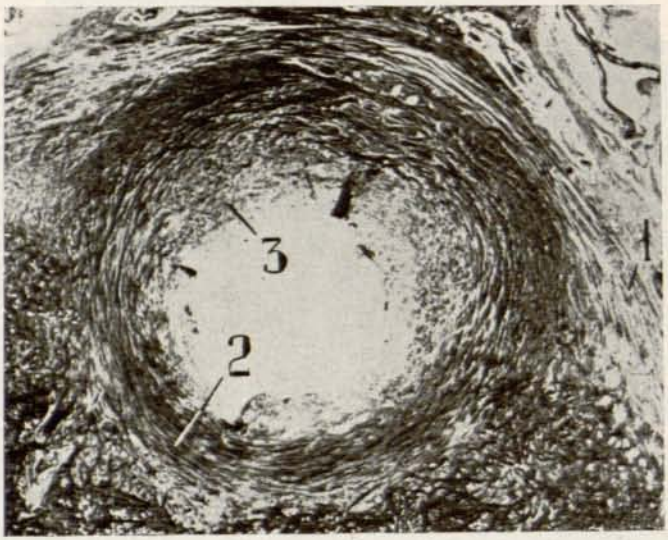

FIG. 127. - Horizontal cut of the neck in the tabetic. 1) Striated fibres of the external vesical sphincter. 2) Internal sphincter of the vesical neck. 3) Antero-lateral vesico-cervical fibres.

The termination of all these fibres which constitute the vesico-cervical system is in common: they all end in the vesical neck occupying around it the space limited inside by the mucosa and outside by the sphincterial system. The periurethral space in which these fibres circulate and terminate, is constituted by a tissue of elastic nature closely adherent to the derma, as can be seen in the microphotograph shown.

When the vesico-cervical fibres contract, the internal orifice and the supramontanal urethra open, transforming the neck into a funnel, the vertex of which corresponds to the verumontanum. This is precisely what

is seen in figure 117 that shows the bladder of a tabetic, constituting Schrann's sign. Notice the aspect of the orifice widely open, in a way that allows to see the verumontanum; and above all, notice how the latter appears circumscribed in its lower part by an arc in the shape of a posterior-concave horse-shoe, that closes the urethra in the exact point where the vesical neck terminates and the inframontanal urethra begins. Without any doubt this arc corresponds to what we have described with the name of inframontanal elastic arc that acts as a plastic sphincter in the interval between urinations.

Figure 127 is a horizontal cut of the vesical neck of the tabetic shown in figure 117. See how the folds have disappeared, which when at rest form the urethral mucosa. To come across a neck as open as this in a piece by necropsy is exceptional, as almost always it appears more or less occluded by the folds of the mucosa. The internal sphincter (2) here appears forming complete rings. Upon the evidence of this preparation the existence of this muscle cannot be denied. The vesico-cervical fibres (3) give the impression of stretching the mucosa making the folds of the vesical neck disappear.

The cervico-urethral fibres. This group is represented by a compound of extremely fine fibres that have their origin in the thickness of the muscular mass formed by the internal sphincter, the deep loops of the detrusor and the external vesical sphincter, and are placed in the anterior wall of the neck. These fibres terminate in the membranous urethra and connect with the smooth and striated sphincters that surround it; this is the reason why we call them cervico-urethral fibres because they originate in the region of the neck and terminate in the membranous urethra.

To have an idea of the origin, route and termination of the cervico--urethral fibres, it is advisable to examine them first in a sagittal cut like the one in figure 128 that passes a little outside of the middle line. In it we can verify that from the anterior wall of the neck in the zone that corresponds to the deep loops of the detrusor, to the internal sphincter and to the external vesical sphincter, very fine fibrils come outwards which are the origin of the external cervico-urethral fibres (2'), and inwards other analogous fibrils which originate the internal cervico-urethral fibres (9 and 9'). In the mentioned figure, signed with number 4, are seen the lateral vesico-cervical fibres that above continue with the plexiform fibres and below are lost in the region of the veru. Marked with number 2, the transverse precervical arc appears, into which the anterior longitudinal fibres of the bladder (1) terminate, and from which descending fibres (2) issue, that terminate in the membranous urethra. Together with these

fibres the precervical vasculo-nervous bundle is seen, that we have described in papers on the innervation of these structures. In 2 is indicated the emerging of the external cervico-urethral fibres that together with those that proceed from the transverse precervical arc, terminate in the external sphincter of the membranous urethra. With number 9 is indicated the emerging of the internal cervico-urethral fibres; and in 9' together with

FIG. 128. - 1) Anterior longitudinal fibres of the detrusor terminating in the transverse precervical arc. 2, 2' and 2'') External cervico-urethral fibres. 9 and 9') Internal cervico-urethral fibres.

other muscular elements they form some longitudinal bundles situated immediately in front of the anterior lobule of the caudal gland and follow a descending route as far as reaching the membranous urethra.

In the microphotograph of figure 129 corresponding to the same preparation but more magnified, the origin of the internal and external cervico-urethral fibres can be seen better. In it can be clearly seen the origin of the external cervico-urethral fibres, signed with number 2, which follow a descending route and are attached to the precervical vasculo-

rvous bundle. The internal cervico-urethral fibres appear, signed with number 3, originating in the mass of the deep loops of the detrusor, and following a descending path they reach the membranous urethra.

Figure 130 corresponds to the lower part of figure 128 but seen more magnified. The external cervico-urethral fibres are signed with number 2; some of them issue from the thickness of the loop of the external vesical sphincter and from there follow a descending route until reaching

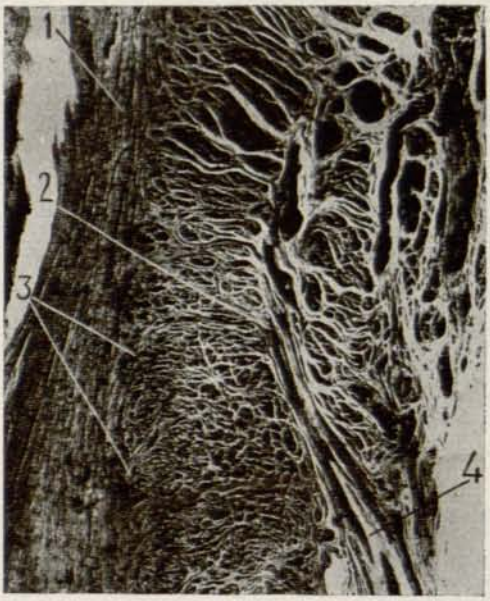

FIG. 129 - Partial view of the previous figure showing the origin of the cervico-urethral fibres. 1) Vesico-cervical fibres. 2) External cervico-urethral fibres together with precervical vasculo-nervous bundle. 3) Internal cervico-urethral fibres. 4) Precervical vasculo-nervous bundle.

the external sphincter of the membranous urethra. It is worth mentioning that the external cervico-urethral fibres, signed with number 4, are constituted by smooth and striated fibres, a circumstance that never occurs with the internal cervico-urethral fibres; this would come to demonstrate that these fibres are in part a dependence of the loops of the external vesical sphincter. The internal cervico-urethral fibres (6) contribute in forming the longitudinal muscular bundles that continue as far as the membranous urethra.

To complete the study of the cervico-urethral fibres it is necessary to examine them in horizontal cuts carried out in the zone where they originate. For this purpose, it is necessary to examine the cuts that pass

above the verumontanum, as shown in figure 131. This figure comprises the anterior wall of the urethral duct that at this level is almost exclusively formed by muscular elements constituting the so-called anterior muscular commissure. In the frontmost part of it, signed with the numbers 1 and 1', striated fibres are seen in a transversal direction; some of these fibres

FIG. 130. - Partial view of fig. 128, showing the origin, route and termination of the cervico-urethral fibres. 1) Vesico- cervical fibres. 2 and 2') Internal and external cervico-urethral fibres. 3) Striated fibres of the anterior wall of the prostate. 4) External cervico-urethral fibres, in part smooth and in part striated terminating in the external sphincter of the membranous urethra. 5) Anterior lobule of the caudal gland. 6) Pre-urethral muscular columns.

insert into the glandular stroma of the prostate, but the greater part corresponds to the lower bundles of the loop of the external vesical sphincter. In back, smooth muscular bundles in a transversal direction are seen, arranged in an irregular way; some of these smooth bundles seem

to be the termination of the vesico-prostato-urethral fibres and of the subsphincterial arc (2 and 3). In the form of tenuous fascicles arranged in a postero-anterior direction, the origin is seen of the external cervico-urethral fibres (4) that tend to emerge towards the external surface, originating the external cervico-urethral fibres, while others tend to emerge towards the periurethral space, forming internal cervico-urethral fibres.

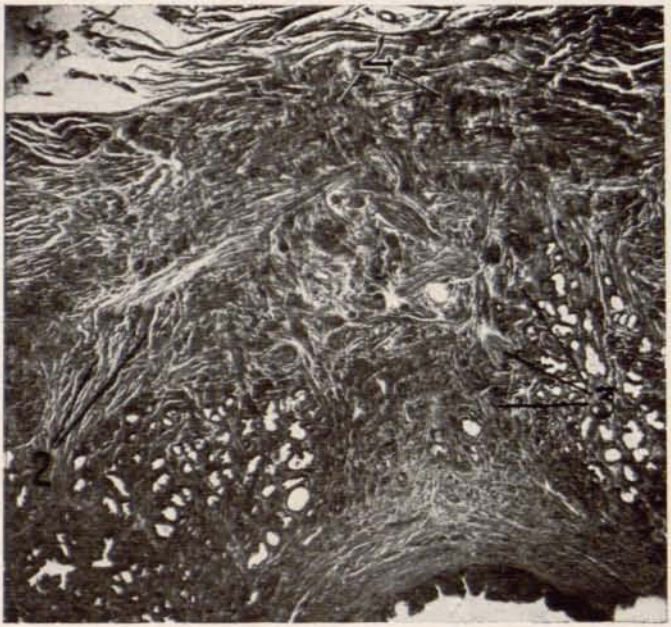

FIG. 131. - Horizontal cut of the anterior wall of the prostatic urethra showing the origin of the cervico-urethral fibres. 1 and 1') Striated bundles of the external sphincter of the bladder. 2 and 3) Terminal portions of the deep loops of the detrusor, of the subsphincterial arc and of the vesico-prostato-urethral fibres. 4) Tenuous fascicles that represent the origin of the cervico-urethral fibres.

The disposition that we have now related, we see repeated in the contiguous cuts situated above and below what we have just described, so that we could state that these fibres come into sight at the level of the internal spincter, and continue originating in lower planes until reaching the higher limit of the anterior lobule of the caudal prostate that coincides with the lower limit of the neck.

Figure 131 corresponds to the point where the two great segments of the posterior urethra coincide: the supramontanal urethra or neck on one side and the inframontanal or membranous urethra on the other; which, as we know, constitute an anatomical and functional unity. It is

at this level that the bundles of the external vesical striated sphincter terminate, and is also the point where the elements pertaining to the deep loops of the detrusor, to the subsphincterial arc and to the vesico-prostato-urethral fibres, coincide. They give the impression that a part of these fibres terminate in the glandular stroma, while others join with those of the opposite side forming bundles in a transversal direction, and others continue in the form of longitudinal columns as far as the membranous urethra. These fibres are seen very clearly in the full-term fetus and in the child, as can be ascertained in fig. 109, marked number 6. But when they are examined in later-on periods and in adults, these fibres appear dislocated and disgregated by the glandular acini.

If now we examine the diagram in figure 77, we shall see that the cervico-urethral fibres form together inferior concave arcs (7 and 7'), which in a certain way correspond to others arranged in the opposite direction, and formed by the deep loops of the detrusor and by the external vesical sphincter. The extremities of the loops, that the cervico-urethral fibres form, terminate: the external ones (7') in the mass of the striated sphincter of the membranous urethra; the internal ones (2') in its smooth sphincter. Owing to this and taking into account their origin and ending, we call them cervico-urethral fibres.

To understand the action of these fibres, one must start from the principle that the deep loops of the detrusor and of the external vesical sphincter have an oblique direction from above down and from back forward. One understands from this, that when the said loops contract, they must operate pushing upward the descending fibres that issue from them, that is to say the cervico-urethral fibres which in their turn are connected with the musculature of the membranous urethra. This interpretation however sets a problem that at first sight seems insoluble, as it apparently presents an incongruity. In fact, if the contraction of the fibres that surround the vesical neck, that is to say, if simply their tonicity in the intervals between urinations keeps the vesical neck closed, it seems logical that upon contracting at the moment of urination, they should automatically determine even a very intense closing of the vesical neck. It would be so, if at the same time the powerful and numerous antagonistic elements, which we have described during this study, did not come into action and at the moment of urination actively dilate all the muscular elements that act in a sphincterial sense. Starting from this principle, the interpretation that we have given does not seem unlikely.

Another consequence that ensues from what we have said, is that the external vesical striated sphincter and the striated loops situated in the anterior wall of the prostate, would come to realize an action antagonistic

to the one exercised by the striated sphincter of the membranous urethra. This does not actually constitute an insurmountable obstacle, as an analogous thing happens with less complicated muscles. A very clear example of this is given by the elevator muscle of the anus, that by means of an important part of its fibres acts as a true and powerful sphincter of the ano-rectal region, and by means of some other of its innermost fibres

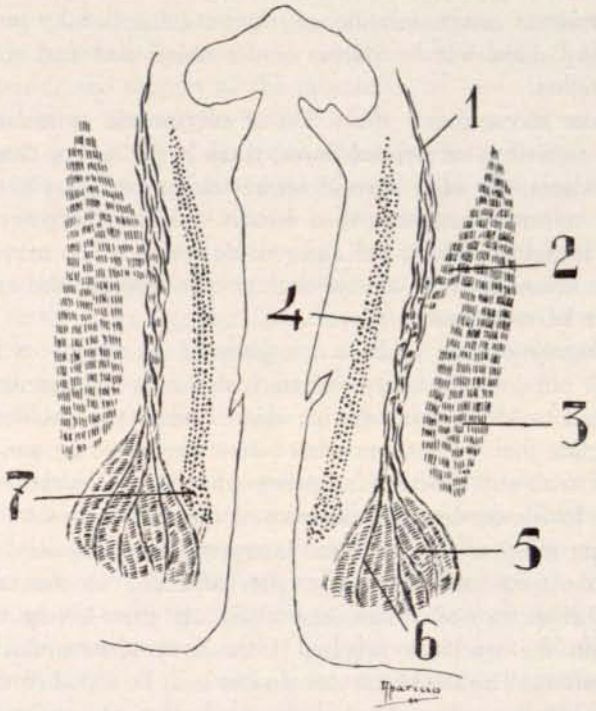

FIG. 132. - Schematic disposition of the smooth and striated musculature of the rectum and of the anus. 1) Smooth longitudinal fibres of the rectum. 2) Striated fibres of the elevator muscle of the anus incorporating in the longitudinal fibres of the rectum. 3) Portion of the elevator muscle of the anus acting as a sphincter. 4) Circular smooth fibres of the rectum. 5) Striated fibres of the external sphincter of the anus. 6) Small tendons, continuation of the mixed smooth and striated bundle, penetrating into the mass of the external sphincter.

together with the smooth longitudinal fibres of the rectum, determines the opening of the external sphincter of the anus (Fig. 132). Thus the same muscle that in the intervals between defecations keeps the anal orifice closed with a part of its fibres, is the one that through other of its fibres acts in the act of defecation opening the said orifice. The fact is that there, as in all the muscular groups of the organism, a functional

antagonism always exists. The existence of flexor muscles cannot be conceived of, without there being extensor muscles at the same time, nor could it be even understood that there are natural apertures and organic ducts that presuppose only muscular systems for closing. In all of them, besides muscles that close, there are muscles that open. But it becomes here very difficult to understand and even more to demonstrate this fact, that in general is so clear, on account of its great complexity and the intimate compenetration of elements functionally antagonistic, that is to say, dilators and occlusors of the vesical neck and of the membranous urethra.

In order to coordinate the action of antagonistic muscular elements of smooth as well as of striated fibres, there is the law of cross-innervation. It declares: the same nervous centres either medullary or ganglionic when they transmit incitations to a certain muscular group, at the same time send stimuli to inhibit the antagonistic system. The nervous action excites the musculature of closure and in turn inhibits the antagonistic musculature of aperture.

The description that we have now given of the cervico-urethral fibres and of their physiological interpretation, is the exact reproduction of what we published in 1952. After having again studied this problem, we are able to declare that we confirm what refers merely to the morphological aspect, and with still greater fundament, what we had occasion to ascertain in the female urethra, the existence of the cervico-urethral fibres.

In what refers to the functional interpretation of the cervico-urethral fibres we must confess our doubts, after reflecting on the task of the mentioned fibres in both sexes, and above all after having taken into consideration the teachings acquired from X-ray observation and from experimentation. The reason for our doubts is to be found in the circumstance that before we thought that the fixed point of insertion of these fibres was in the vesical neck, and now we believe that these fibres upon contracting take as point of fixed insertion the walls of the membranous urethra. When these fibres contract they would bring downward their mobile point of insertion, namely the vesical neck, and at the same time would produce the result of making the base of the bladder descend, which is the phenomenon that takes place when urination begins, as shown in HUCHT's diagram.

On conjectural grounds however, we would think that what we consider as points of fixed insertion and of mobile insertion, in reality would both be movable. The result would then be that these fibres, when contracting, would provoke the nearing of both and consecutively the shortening of the anterior wall of the vesical neck and of the membranous ure-

thra. At the same time, the synchronous contraction of the cervico-prostatic fibres provokes the shortening of the posterior wall of the vesical neck.

Years ago this problem was set for the first time when BOEMINGHAUS demonstrated that during urination a descent of the vesico-urethral orifice takes place. It was thought that all the prostate descended, but soon it was seen that this was physically impossible. But now, considering the cervico-prostatic group, it is possible that upon contracting synergically they automatically cause the descent of the base of the bladder without causing the descent of the prostate.

Summarizing: the cervico-urethral fibres jointly acting with the cervico-prostatic ones, shorten the membranous urethra and the vesical neck causing the descent of the base of the bladder. The widening of the neck and of the internal orifice is carried out by the vesico-cervical fibres and the small posterior longitudinal fascia. The active opening of the membranous urethra and of the sphincterial system that surrounds it, is realized by the vesico-urethral precervical fibres; the contraction of these fibres has the task of bringing outwards the anterior wall of the membranous urethra that is precisely where these fibres end.

A valuable supplement in order to reach a knowledge of the disposition and interpretation of these structures, is to verify the variations that they undergo in certain pathological conditions. We will see this demonstrated in an evident way in the microphotographs of figures 82 and 83 that show sagittal cuts of a prostate in a patient, affected by an inveterate prostatic hypertrophy, in which an enormous hypertrophy is seen of the vesico-urethral (6) and vesico-cervical (1) fibres, in their struggle to open respectively the membranous urethra and the vesical neck. Notice in figure 82 the termination of the vesico-urethral fibres (6) inserting into the centre of the anterior wall of the membranous urethra, where the external sphincter forms a complete ring. Upon contracting, the said fibres that here appear extremely hypertrophied, bring the sphincter forward and outward.

To fully understand the way in which the shortening and widening of the membranous urethra takes place during urination and ejaculation, it is necessary to know the disposition of the prostato-urethral fibres of which we give a description.

Once again we have to insist that to understand the function of the vesico-prostato-urethral compound, it is not sufficient to know the disposition of some elements no matter how exact their description is; the knowledge is necessary of all and of each one of their constituent elements as well as of the structural and dynamic pattern of the organic compound.

As one of the practical consequences of this study we will point out that the compound of muscular formations that establish the connexion between the detrusor and the membranous urethra are by force lesioned when, following the retropubical route, a transversal incision is carried out in the anterior wall of the prostate in order to reach the adenoma. This comes to refute the statement of those who believe that this route more than any other spares the muscular structures, vessels and nerves of this delicate region. The lesions of these muscular structures surely bring about the vesical after-effects that frequently ensue after the adenectomia by transversal or perineal route. In our opinion they are due to lesions of the muscular systems that establish the connexion between the detrusor and the musculature of the membranous urethra that by force are sectioned when the incision is performed in the anterior wall of the prostate. Therefore it is advisable to make use of the medial longitudinal incision as, by means of it, it can be avoided to considerably lesion the said structures.

The prostato-urethral fibres. As prostato-urethral fibres we mean those that have their insertion, fixed or of origin, in the stroma of the caudal prostate, and their terminal, or movable, insertion in the membranous urethra; for this reason we call them prostato-urethral fibres. To understand the disposition of these fibres as well as of the rest of the smooth and striated musculatures of the prostate, the division of the prostate into two segments must be kept in mind: cranial prostate and caudal prostate. To facilitate the knowledge of these fibres, we will describe two groups: posterior fibres and anterior fibres.

The posterior prostato-urethral fibres. They constitute the most important group. Their origin is in the lower part of the veru from where the fibres follow a perfectly vertical descending route. They are situated exactly in the middle line and cross the inframontanal region of the prostate and then the posterior wall of the membranous urethra until they reach the urethral bulb in its lower extreme. Considering the origin and termination of this muscular formation, we call it column or posterior prostato-urethral bundle.

In figure 133 this muscular formation appears in all its extension, letting us see in this preparation that this robust bundle partly muscular and partly elastic, originates below the ejaculatory ducts (1), in the lower pole of the verumontanum. At first it is very delicate but goes on increasing in size as it descends, owing to the input of new fibres issuing from the stroma of the caudal prostate. All these elements give origin to a

nyoelastic column that has expression in the lumen in the prominence known by the name of urethral ridge. This column occupies exactly the middle line and represents the dividing line between both halves of the caudal prostate; on each side, arranged in a linear way, appear some series

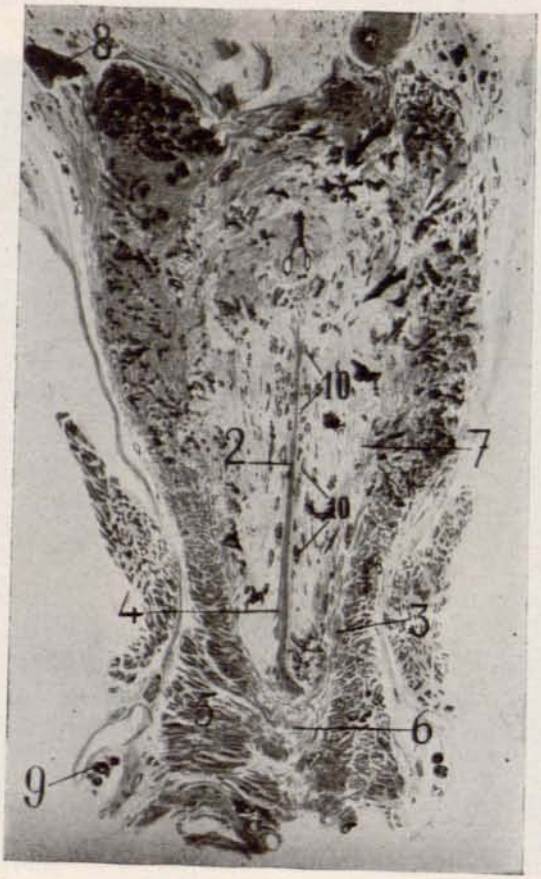

FIG. 133. - 1) Ejaculatory ducts. 2) Posterior prostato-urethral bundle. 3) Smooth sphincter of the membranous urethra. 4) Terminal portion of the posterior prostato-urethral bundle. 5) Striated sphincter of the membranous urethra.

of secretory ducts that pertain to the postero-lateral lobules of the caudal prostate. The origin of the posterior postero-urethral column results from the confluence of numerous fibres of different origin. In fact, examining figure 134 we can verify that from the fibromuscular sheath that wraps the utricle and the ejaculators, some tenuous fibrils issue that at the level of the lower pole of the verumontanum (5) incorporate in the posterior prostato-urethral column (5).

The microphotograph of figure 135 obtained from the same preparation as the one of figure 133, shows the origin and the higher segment of the posterior prostato-urethral bundle, and on each side of it are seen the collector ducts of the postero-lateral lobules of the caudal prostate (3 and 3').

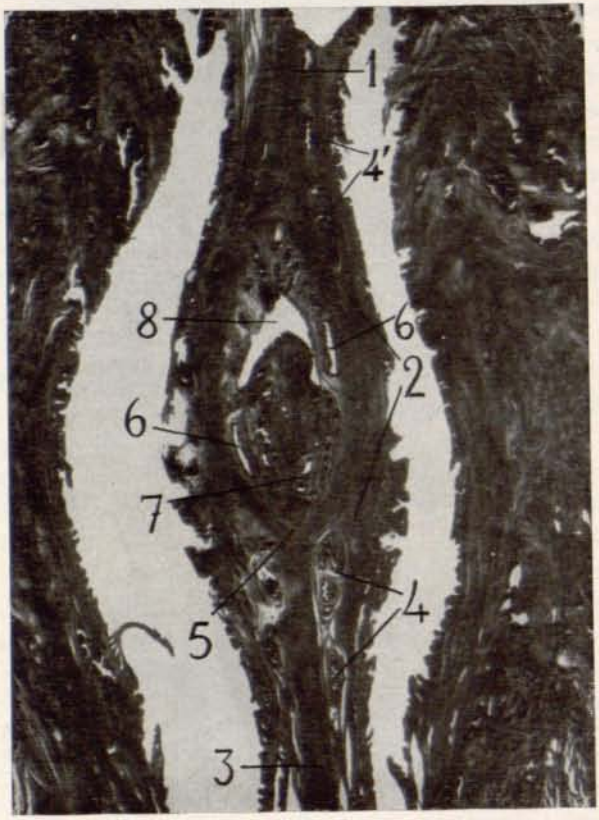

FIG. 134. - 1) Vesico-prostatic fibres. 2) Fusion of these fibres with the fibro-muscular cover of the genital ducts. 3) Posterior prostato-urethral bundle. 4) Secretory ducts of the postero-lateral lobules of the caudal prostate. 4') Secretory ducts of the medial portion of the caudal gland. 5) Point of origin of the posterior prostato-urethral bundle. 6) Ejaculatory ducts. 7) Glandulae annexed from the utricle. 8) Utricle.

Figure 136 refers to the same preparation as figure 133 and shows the termination of the posterior prostato-urethral column and its connexions with the sphincteric musculature of the membranous urethra. In fact, we can verify how the muscular fibres of the said column (4) connect with the striated bundles of the external sphincter (2).

When we examine preparations of a series cut horizontally (Fig. 137), we can verify that the posterior prostato-urethral bundle that at the beginning forms a marked prominence (the urethral ridge), reaching the membranous urethra goes on flattening little by little, extending in surface, occupying the posterior border of the urethral duct; it is lost in part

FIG. 135. - 1 and 2) Prostato-urethral bundle. 3 and 3') Collecting ducts of the postero-lateral lobules of the caudal prostate.

in the periurethral connective elastic stroma and in part establishes anastomosis with the smooth and striated fibres that surround the membranous urethra. The result of this is that when the posterior prostato--urethral bundle contracts, it diminishes the length of the prostatic inframontanal and membranous urethra provoking its widening and completing the analogous action of the cervico-urethral fibres.

Antero-lateral prostato-urethral fibres. These fibres originate in the stroma of the antero-lateral parts of the caudal prostate and from there,

bordering the lateral parts of the urethral duct, reach the anterior part of it in the point situated at the level of a horizontal plane that passes through the centre of the verumontanum and the superior extreme of the anterior lobule of the caudal prostate. This plane signs well enough the dividing line between the supramontanal and inframontanal urethra.

FIG. 136. - Termination of the posterior prostato-urethral bundle (4) connecting with the sphincters (1, 2, 3, and 5) of the membranous urethra.

In the first part of their route, as seen in figure 138, these muscular fibres follow a horizontal direction forming together a muscular plane (2). When these fibres reach the anterior wall of the urethra, some anastomose in the middle line with those of the opposite side, forming posterior concave arcs (4'); but other fibres arriving there change direction and become vertical, contributing to enlarge the longitudinal muscular bundles, signed number 3, that together with others reach the membranous urethra. These longitudinal fascicles appear indicated with number 6 in figure 109 and correspond to a newborn; their considerable bulk is to be remarked. In the adult they appear very much diminished.

In the diagram of figure 139 is shown the constitution of these preurethral longitudinal muscular bundles, to the formation of which contribute the vesico-prostato-urethral fibres (3), the fibres issuing from the subsphincterial arc (5) and the fibres proceeding from the caudal prostate (9). From their point of origin these muscular bundles follow a vertical descending route along the membranous urethra as far as reaching the urethral bulb.

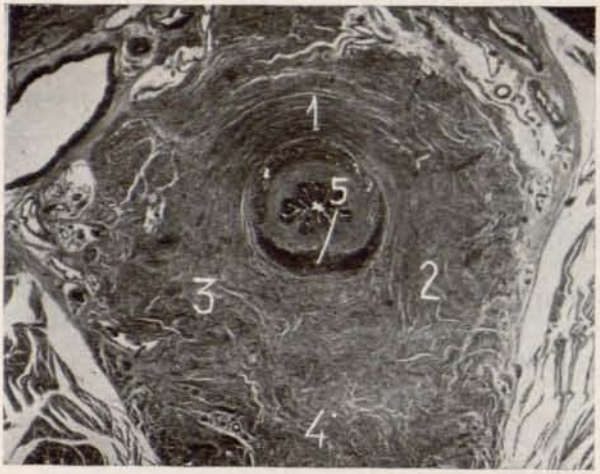

FIG. 137. - Horizontal cut of the membranous urethra in its lower third. 1, 2 and 3) External sphincter of the membranous urethra. 4) Nucleus of the perine. 5) Posterior prostato-urethral muscular column.

FIG. 138. - 1) Ejaculatory ducts. 2) Antero-lateral prostato-urethral fibres.

At the level of the membranous urethra, these longitudinal muscular bundles occupy the anterior border of the urethra and are separated from the external sphincter by a tunica of smooth circular fibres pertaining to the smooth sphincter. During their descending path in the membranous urethra, the muscular columns go on diminishing in bulk owing to the fact that successively fibres depart that are lost in the periurethral connective elastic net. The action of these fibres when they contract, provokes the shortening and dilatation of the membranous urethra during urination as well as during ejaculation; they are antagonistic fibres of the smooth and striated sphincters.

FIG. 139. - Horizontal cut that passes at the apex of the prostate, showing the disposition of the lower portion of the striated fibres of the prostate. 1 and 1') Anterior branch of the superficial portion of the striated musculature of the prostate. 2 and 2) Deep or annular portion of this musculature. 3) Posterior prostato-urethral bundle. 4) Anterior prostato-urethral bundles. 5) Smooth fibres forming posterior-concave arcs.

From all that has been described can be traced the mistake of many authors who take for the origin of the longitudinal fibres of the posterior urethra what in reality is their termination. In fact, the longitudinal fibres do not originate in the urethral bulb, nor in the contiguous portion of the membranous urethra, but on the contrary it is there that they terminate.

Transit fibres. In this group we comprise a compound of fibres that proceeding from the detrusor muscle crosses the supramontanal urethra and continues in the lower segments without stopping. For this we call them transit fibres. The origin, route and termination of these fibres

is not known; they form two groups: one situated in the posterior wall of the urethra and the other in the anterior wall.

The posterior group. - These fibres are the continuation of the cervico-prostatic fibres that are part of the posterior vesico-cervical group. Some of the cervico-prostatic fibres follow a descending route until reaching the fibro-muscular sheath that surrounds the utricle and the ejaculators where in part they terminate, while other fibres when reaching the lower pole of the veru, join with others that originate in the parenchyma of the caudal prostate contributing in a minimum proportion to form the powerful posterior prostato-urethral bundle. Before, we thought that these fibres when contracting provoked the rising of the verumontanum. Now after studying the problem again we have to state that the functional role of these fibres is of no interest in line with the fact that frequently they are missing and other times are so weak that their action is insignificant. It is a fixed structure and it is not likely that it can realize movements of ascent and descent. The action of these fibres that we have described with the name of cervico-prostatic is to shorten the vesical neck, making the trigone and the internal orifice descend.

The anterior group. - The constitution of this group is much more complex. It is sufficient to recall that to it pertain the vesico-prostato-urethral fibres, the subsphincterial arc, the deep loops of the detrusor and the cervico-urethral fibres. All these elements have been described in detail.

E - SMOOTH CIRCULAR FIBRES OF THE POSTERIOR URETHRA

If we examine a sagittal cut that passes through the middle line (Fig. 78) of a block that comprises bladder, prostate, membranous urethra and urethral bulb, we notice that the urethral duct describes an anterior concave curve. We note that the urethral duct appears divided into two great segments: an anterior one and a posterior one. If we carefully examine both segments we shall see that they greatly differ, above all in what refers to the disposition of the smooth and striated musculatures.

In the posterior segment, the prostate occupies a considerable space giving the impression that in developing it has pushed upward and downward the contiguous muscular structures as if they were two completely independent segments. The higher or supraprostatic part corresponds to

the vesical neck, and the lower or infraprostatic part corresponds to the membranous urethra. This double displacement of the muscular elements explains the different orientation that they present in both segments: in the neck, the internal sphincter and the loops of the detrusor have an oblique direction from above down and from back forward; and in the membranous urethra, the smooth and striated rings situated in the proximal extreme, have an oblique direction from above down and from front back. The greater the size of the prostate, the greater will be the separation of the supra- and infraprostatic muscular elements, and the more accentuated the oblique direction of the rings. This is another factor to be taken into account in order to explain the difficulties in urination that arise in old-age as a consequence of the hypertrophy of the prostate. What we have stated appears quite evident in the parasagittal cut of figure 145.

If now we examine the anterior wall and compare it with the posterior one, we are struck by its great muscular richness represented by an enormous quantity of smooth and striated muscular loops cut across, which extend uninterruptedly from the loop of the detrusor to the lower extreme of the membranous urethra. Between this circular tunica and the urethral mucosa, appears cut lengthwise a mass of smooth longitudinal fibres that extend from the internal orifice to the urethral bulb.

A comprehensive study of the circular elements disposed in the form of a loop or ring in all the length of the inferior urethra, is necessary though it will lead, as can be imagined, to repeat notions already mentioned.

Smooth circular fibres of the supramontanal urethra. - The detailed study that we have made of the loops of the detrusor, of the internal sphincter, of the trigonal loop and of the subsphincterial arc will facilitate their understanding.

From the analytical study reported in the preceding pages we know that of all the elements that appear cut across, only the bundles of the internal sphincter form complete rings; they represent a minimum proportion. They are indicated with number 7 in figure 78. Above the sphincter the corresponding bundles of the loop of the detrusor are seen (3 and 4). In front, signed with number 2, are seen the bundles of the transverse precervical arc. Below, appear the bundles pertaining to the deep loops of the detrusor (3'); it is possible that some of these bundles correspond to the post-trigonal muscular bundles indicated with number 1 in figure 49, which would give for result the formation of complete rings. But we have the impression that they would be very few because the

deep loops of the detrusor are formed in great part by elements that issue from the posterior longitudinal tunica of the detrusor. In front of the internal sphincter and of the deep loops of the detrusor appear the striated bundles pertaining to the external vesical sphincter; they are signed with number 8.

We shall now analyse the muscular elements situated in the posterior wall of the supramontanal urethra. In this wall the rings of the internal sphincter are indicated with number 7'; notice that they are situated in a plane that is not more elevated than those that occupy the anterior segment. We must not be surprised by this because the sphincterial bundles

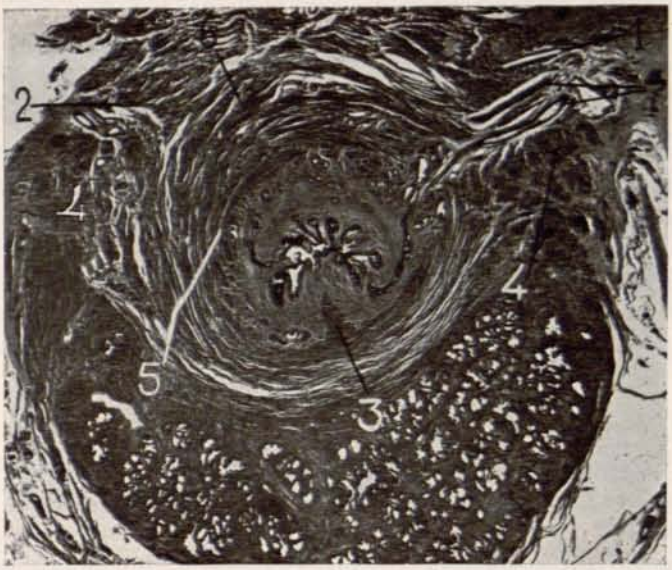

FIG. 140. - Cut of the same series as in the preceding figure, showing the disposition of the striated fibres of the lower portion of the prostate. 1 and 2) Anterior branches of the superficial portion of the striated musculature of the prostate. 3) Posterior prostato-urethral bundle. 4 and 4') Posterior branches. 5) Smooth sphincter. 6) Circular portion of the striated musculature. 7) Artery and nerve penetrating into the interstice that separates both the anterior and posterior branches of the anterior portion of the striated musculature of the prostate.

are disposed following an oblique direction from above down and from back front. Below the internal sphincter some very fine bundles are seen that correspond to the subsphincterial arc, and lower down together with the glandular acini are placed the fibro-elastic fascicles corresponding to the supramontanal arc.

Above the internal sphincter are seen bundles cut across; they are bundles that pertain to the trigonal loop and occupy the anterior part

of the trigone. In back of the internal sphincter, indicated with number 12, the deep loops of the detrusor appear. Below these loops, some very fine and compact muscular bundles attached to the medial lobule of the cranial gland are almost always seen; we believe that they pertain to the intrinsic fibres of the prostatic gland. When they arrive at the lateral parts of the prostate they are lost in the glandular stroma. Our impression is that these bundles serve to squeeze the glandular parenchyma during ejaculation.

Smooth circular fibres of the inframontanal urethra. - These fibres originate in the limit that separates the cranial from the caudal prostate,

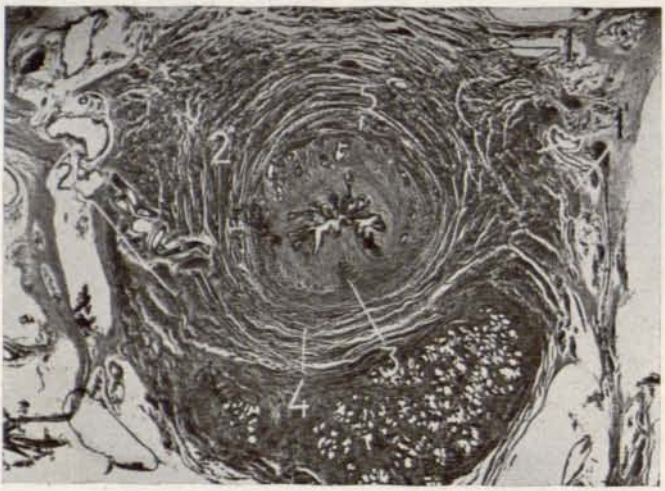

FIG. 141. - Cut, from the same series of the two preceding figure, in the portion contiguous to the membranous urethra. 1) Anterior branch of the superficial portion of the striated musculature. 1') Posterior branch of the same portion. 2) Last fibres of the posterior branch. 2') Striated circular fibres forming a complete ring. 3) Posterior prostato-urethral fibres. 4) Posterio portion of the circular ring of the striated sphincter. 5) Smooth sphincter of the membranous urethra.

that is to say the limit between the vesical neck and the inframontanal urethra. These fibres originate on each side in the stroma of the postero-lateral lobules of the caudal gland (Fig. 138) and from there go forward and inward anastomosing with those of the opposite side (4') forming posterior concave arcs. Slightly lower down, in the point where the prostatic urethra continues in the membranous urethra, these fibres that so far formed posterior-concave crescents, we see that gradually they go on bordering the lateral and posterior parts of the urethra, following an oblique direction from above down and from front

back until they form complete rings around the initial portion of the membranous urethra, in an analogous way to what the striated fibres do (Fig. 139, 140 and 141). In figure 139, indicated with number 5, smooth muscular fibres appear forming inferior-concave arcs. In figure 140 these arcs go on increasing in extension (5), occupying approximately three fourths of the urethral duct. In figure 141, which passes at the higher extreme of the membranous urethra, the smooth muscular fibres (5) form a complete ring around the urethral duct.

It must be pointed out that the smooth circular fibres of this region appear precociously in the embryo; this is in agreement with the embryological studies by VERSARI who called attention to these bundles which appear well developed at the fourth month, while the bundles of the internal sphincter are seen only in an initial stage, especially those set in the posterior border.

Smooth circular fibres of the membranous urethra. - These fibres form complete rings situated between the internal plane of longitudinal smooth fibres and the external plane of striated fibres of the external sphincter. The circular fibres of the membranous urethra are very evident in their higher and medial third and tend to diminish in the lower third. Nevertheless they persist in the bulbar urethra where they form the Albarran's sphincter.

Albarran's sphincter. - The only information that we have about this small muscular formation is what PAUL DELBET mentions: « Les fibres circulaires après s'être prolongées dans une étendue de 2 à 4 millimètres entre la couche spongio-vasculaire et le corps spongieux et avoir formé là une sorte de petit sphincter antérieur (ALBARRAN, 1925) finissent par être dissociées peu à peu par les vaisseaux et cessent d'exister en tant que couche spéciale ».

We think it is advisable to give a description of the smooth and striated musculatures of the bulbar urethra, which is surrounded by two sphincters: a smooth one, Albarran's sphincter, and the other, a striated one represented by the circular fibres of the bulbo-cavernous muscle.

Histotopography of the bulbo-urethral region. - To comprehend this important and interesting region that has as centre the bulbar urethra, we present a frontal cut of the said region, shown in figure 142. This general view shows us the roots of the cavernous bodies surrounded by ischio-cavernous muscles (1). In the centre of the preparation the spongeous body (2) is seen; in its thickness the bulbar urethra (4) and the secretory ducts of Cooper's glandulae (3) circulate. The bulbo-

cavernous muscle (5) with a part of its fibres disposed circularly wraps the spongeous body and the bulbar urethra, while its tendinous fibres go and terminate above it; the result of this is the formation of a striated sphincter disposed around the urethra and the spongeous body. The urethra, as can be seen, is surrounded by a smooth sphincter (4) that isolates it from the erectile tissue of the spongeous body.

FIG. 142. - 1) Ischio-cavernous muscle. 2) Spongeous body. 3) Secretory duct of the bulbo-urethral glandulae. 4) Bulbar urethra. 5) Bulbo-cavernous muscle.

Figure 143 is an enlargement of the previous one, in the point corresponding to the bulbar urethra. Here the urethral lumen (1) is seen with the folds that are formed by the mucosa and the derma; around it the elastic tissue is seen where there are some erectile vascular spaces (2). The smooth sphincter mentioned by ALBARRAN, appears here in an evident way, forming a complete circle around the urethra (3); below and outside of the sphincter the secretory ducts of the bulbo-urethral glands appear (4). Inside of the sphincter some smooth muscular fibres are seen cut across (5), that represent the termination of the smooth longitudinal tunica of the posterior urethra.

Examining the seriated cuts of the region, we verify that, a few microphotographs after the cut of figure 143, the smooth sphincter suddenly ceases; at the same time the longitudinal fibres terminate. This happens in a few microphotographs in back of the point where the secretory ducts of

Cooper's glandulae open out. It means that this sphincter is situated immediately in front of the point where the ducts open out. Their physiological task is to avoid during erection the reflux of the secretion of the said glandulae towards the membranous urethra, which in consequence causes it to turn outside after lubrificating the penial urethra. This small sphincter represents in a certain way the door-keeper of the posterior urethra; a few millimeters further back, this guardian appears reinforced by smooth circular fibres of the membranous urethra, and further back by the external striated sphincter.

FIG. 143. - 1) Bulbar urethra. 2) Erectile spaces. 3) Albarran's sphincter. 4) Secretory ducts of the bulbo-urethral glandulae.

The significance of the striated sphincter, which forms the bulbo--cavernous muscle around the bulbar urethra, is twofold: it principally serves to expel the semen during ejaculation, acting synergically with the external sphincter muscle of the membranous urethra, and also serves for the contention of the urine especially when urination is voluntarily interrupted, acting synergically with the striated sphincter of the urethra. It is to be remarked that both muscles contract in unison, together with the other perineal muscles: the external sphincter of the anus, the ischio-cavernous muscle and the elevator muscle of the anus without any of them intervening at all in the functions of urination and ejaculation.

From what we have said we deduce that in man three sphincterial

systems exist along the posterior urethra: the sphincterial system of the vesical neck, the sphincterial system of the inframontanal and membranous urethra, and the sphincterial system of the bulbar urethra.

In woman there are only two sphincterial systems: the one of the vesical neck and the one of the urethra properly-called; both are very weak, less powerful than the sphincters in man. This anatomical disposition together with others explains why in man incontinency is much less frequent (except that caused by surgical acts); at the same time it explains why the difficulties in urination are frequent owing to the accumulation of factors that in one way or the other intervene in closing the posterior urethra. This is in contrast with what happens in the female sex in which incontinencies are frequent and obstructions rare.

In a paper published in 1944 concerning muscles and aponeurosis of the perine (GIL VERNET, 1944), describing the bulbo-cavernous muscle we wrote: « The fibres of the bulbo-cavernous muscle after tracing internal-concave curves that enfold the lateral parts of the bulb terminate in the albuginea of the spongeous body of the urethra insinuating between this and the cavernous bodies that terminate in the dense cellular tissue that conjoins these formations. In the treatises on Anatomy is described a delicate fascicle, flattened, that surrounds obliquely the cavernous body and terminates in the middle line fusioning with the homologue of the opposite side, constituting a strip that compresses the deep dorsal vein of the member during erection. This formation is indicated with the name of Houston's muscle attributing to it an important role in the mechanism of erection, as by compressing the deep dorsal vein of the member, it makes the return circulation difficult ».

We have not seen Houston's muscle as it is described. Not even KALISCHER was able to verify it; and in general anatomists agree in considering this muscle as very inconstant. Instead of the muscular strap we have sometimes seen minute muscular fascicles that after surrounding the lateral walls of the cavernous bodies terminate in their albuginea or rather in the lateral part of the deep portion of the suspensory ligament of the member as can be seen in figure 144. But we have not been able to verify the continuity of the muscular fibres above the dorsal vasculonervous bundle of the member. On the other hand, the same authors that describe it as a normal disposition admit that many times it is missing. One cannot understand how a muscular formation that performs an important function, is frequently missing. It isn't in this rudimentary muscular formation that the explanation of the mechanism of erection is to be looked for, but in the constant structural disposition of the wall of the deep dorsal vein of the member. The considerable thickness of the

musculature of the said vein is to be remarked: at first we thought it to be an anomaly; later we ascertained that it is a normal, constant fact intimately related to the function of erection.

In figure 144 A can be seen slightly magnified the deep dorsal vein (10) with very enlarged walls that cause a prominence in the vascular lumen.

FIG. 144 A. - 1 and 1') Cavernous bodies. 2 and 2') Albuginea of the cavernous bodies. 3) Fusion of both cavernous bodies. 4) Urethra. 5) Spongeous body of the urethra. 6) Albuginea of the spongeous body. 7) Bulbo-cavernous muscle. 9) Bundles of the ischio-cavernous muscle inserting into the suspensory ligament of the penis. 10) Deep dorsal vein of the member.

Seen more magnified as it apears in figure 144 B, this vein presents some muscular swellings formed by longitudinal fibres developed in the intima and upon contracting obstruct the lumen of the vessel preventing the return circulation. It represents a real mechanism that regulates the circulation of the organ in a reflex way according to the functional necessities.

This is the true mechanism of erection, to which are to be added the tiny sphincters of the arterioles of the erectile tissue, closed when at rest and open during erection allowing the afflux of blood in the cavernous bodies. Naturally to these fundamental vascular factors are added secundary, accessory factors as it happens in all the functions of the organism. Therefore the role of the fascia penis has to be taken into account: an inextensible membrane that would act compressing the veins

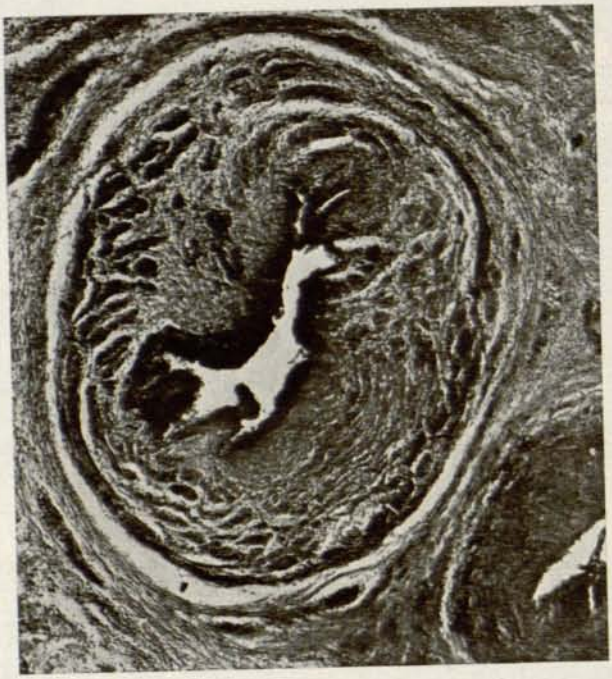

FIG. 144 B.

of the member during erection; and it is also possible that at times aberrant bundles of the bulbo and ischio-cavernous muscles act in the sense that is attributed to the mentioned Houston's muscle.