AN ACCOUNT OF THE ARRANGEMENT
OF THE
MUSCULAR SUBSTANCE
IN THE
URINARY AND CERTAIN OF THE
GENERATIVE ORGANS
OF THE
HUMAN BODY.

BY
GEORGE VINER ELLIS,
PROFESSOR OF ANATOMY IN UNIVERSITY COLLEGE, LONDON.

Received June 18th.—Read June 24th, 1856.

SOME careful dissections of the muscular substance connected with the urinary and generative apparatus of the human body have made known to me many facts with which anatomists seem to be unacquainted; and the desire to add some of these to our common stock of knowledge, so that inaccuracy in our anatomical descriptions may be removed, has influenced me in making the present communication to the Royal Medical and Chirurgical Society. I do not purpose entering on the consideration of the nature of the muscular fibre, and the characters by which this may be

recognised where its existence is doubtful. The microscope will not, therefore, be needful to decide on the correctness of what I advance. With a scalpel and forceps, and a good eye, or, at most, with the aid of a watchmaker's eye-glass of an inch or an inch and a half focus, the following statements may be verified.

Of the Muscular Substance of the Urinary Bladder.

In the bladder there are three more or less perfect strata of involuntary muscular fibres; viz., an external or longitudinal, middle or circular, and internal longitudinal or submucous. These three are united by a mutual interchange of fibres, so that neither can be detached from the rest without cutting through these intercommunicating parts. In each layer, as in all muscular tissue,¹ the fibres are collected into bundles, and from these, offsets pass to adjacent bundles, producing thus a plexiform condition of the muscular web, or a network with meshes of varying size. (Fig. 1 and 2 a.) And as fleshy fasciculi connect the different strata, the fibres on the surface in the external layer become deep in the middle one, and the opposite; a like change in depth is observable between the submucous and the middle fibres. In consequence of this blending of the several layers, contraction of one will call into action the others, and thus the whole fleshy wall will take part in producing diminution of the viscus and expulsion of the urine.

The *outer layer* consists of fibres directed longitudinally from the apex to the base of the viscus, and is best marked below, in front of the neck. Above, the fibres end in tendons which are inserted, for the most part, into the fibrous peritoneal covering of the top of the bladder; but some are prolonged on the urachus, and end as the rest. Below they are differently arranged before and behind; in front some are attached to the back of the pubes by the

¹ The arrangement, structure, ending, &c., of the involuntary muscular fibre are elsewhere described by me.

anterior ligaments of the bladder, whilst others are continued over the sides and upper surface of the prostate as far as its apex, and end by tendon in its sheath; behind, the fibres terminate chiefly by blending with those of the deeper layer and the prostate, though in the female they reach also the fascia investing the lower part of the vagina.

The bundle of fibres connected with the back of the pubes is about half an inch wide, and has been described by other anatomists. Flethy fibres radiate from it; some reaching the prostate and the neck of the bladder, where they cross those of the opposite side, and the remainder diverging to the base of that viscus. From the position of this fasciculus it is most advantageously placed for raising with its fellow the prostate and the neck of the bladder; and its action being, doubtless, to elevate those parts, the term *levator prostatae* might with propriety be applied to it.

The *middle layer* of circular fibres (fig. 1 and 2 *b*) is thickest towards the cervix vesicæ, where it forms the ring called sphincter, and communicates largely with the submucous and external strata. Where the urethra begins it is continuous without any line of demarcation with the fleshy fibres of the prostate (fig. 1 *e*) in the male, and with a corresponding band of circular fibres in the female. The so-called sphincter is only part of the general muscular layer.

The *inner* or *submucous* stratum, alike in both sexes, is much thinner, and does not form so complete a layer as the others. In the lower third or half of the bladder, the fibres are longitudinal in direction, and of tolerably uniform thickness (fig. 1 and 2 *c*); but higher up they are thin, and become oblique and scattered on the mucous membrane. Behind, below the openings of the ureters, this stratum receives an accession of fleshy fibres from the muscular coat of those tubes (fig. 2 *r*). At the neck of the bladder this stratum is continued into the submucous coating around the urethra; and as the fibres pass from one part to another they form the projection called "*uvula vesicæ*." The existence of this layer may be shown by dissecting it

from below upwards, after the manner indicated in fig. 1 and 2; the bladder having been previously hardened in a strong solution of salt, and then distended with cotton wool or tow, introduced through a small opening in the top.

The ending of the ureters may be traced by taking away the two outer vesical strata and part of the prostate, as in fig. 2. These canals pierce the outer and middle strata of the fleshy wall of the bladder, and the fibres of their muscular coat are disposed in both sexes as in fig. 2; viz., the internal, the most numerous, are directed transversely, and unite with the corresponding fibres of the opposite ureter; whilst the remainder join the submucous muscular layer of the bladder, and are directed obliquely downwards over the "triangular space" to the submucous stratum of the urethra.¹

Muscular Substance of the Prostate.

The prostate is essentially a muscular body, consisting of circular or orbicular involuntary fibres, with one large central hole for the passage of the urethra; and another smaller, oblique opening, directed upwards below the former, for the transmission of the common ejaculatory seminal ducts to the central urinary canal. The few longitudinal fibres on the upper surface of the prostate, which are derived from the external layer of the bladder, can scarcely be said to form part of that body.

Its circular fibres² are directly continuous behind, without any separation, with the circular fibres of the bladder; and in front a thin stratum, about one thirtieth of an inch

¹ The ending of the ureters has been differently described by the late Sir Charles Bell, in vol. iii of the Transactions of this Society. A fleshy bundle, which he called muscle of the ureter, is described as descending from the uretral opening towards the neck of the bladder, where it joins the like part of the other side; and the two conjoined are said to be inserted by a tendon into the middle lobe of the prostate.

² The thickness, dimensions, and topographical relations of the prostate will be found described in the common text-books.

thick, is prolonged forwards from it around the membranous part of the urethra¹ (fig. 1 *e*), so as to separate this tube from the surrounding voluntary constrictor muscle. These facts seem to show the inappropriateness of the older view respecting the distinctness and glandular nature of the prostate, and indicate its being a portion of a muscular layer, which surrounds the intra-pelvic part of the urethra, and is continuous without interruption with the circular fibres of the bladder. Within, and quite distinct from the circular fibres, lies the tube of the urethra, incased by its submucous layer of longitudinal fibres (fig. 1 *d*). Towards the lower and outer aspects, the fibres are less firmly applied together, especially where the vessels enter; and they appear to be superadded to those which join the coat of the bladder.

As only so small a portion of the prostate is glandular, the propriety of calling that body a gland is rendered doubtful; for the small secreting glands contained in it are but appendages of the mucous membrane, which project amongst the muscular fibres in the same way as the other glands of the urethra extend into the surrounding submucous tissues. The glands are situate towards the base of the prostate, and more are below than above the urethral tube, especially in the part called middle lobe; their largest ducts enter the urethra opposite the opening in the circular fibres for the common ejaculatory seminal ducts.

In the female the urethra corresponds with the intra-pelvic part (prostatic and membranous) of that of the male, and is surrounded in all its length by circular involuntary muscular fibres, which are external to the submucous, and are continued, as in the male, into the middle stratum of the bladder. Thus, the posterior third of the urethra of the

¹ Professor Müller has described a layer of voluntary circular fibres around the membranous part of the urethra; but he considers it to form part of the constrictor urethræ muscle outside, and he does not show its connection with the prostate and bladder. See the treatise of J. Müller, 'Ueber die Organischen Nerven der erectilen Männlichen Geschlechts Organe des Menschen,' &c., Berlin, 1836.

male differs chiefly from the tube of the female in having the surrounding involuntary circular muscular fibre extremely developed at one spot in connection with special functions, and in being provided at the same spot with large secreting glands, for the purpose of increasing the quantity of the seminal fluid.

From the above-given anatomical facts, we may conclude that the prostate is less of a glandular than a muscular body, and is only a largely developed portion of the circular muscular layer that invests all the urethra behind the bulb or the spongy portion. The existence, too, in the female of a thin muscular stratum in the corresponding position gives support to the view of its muscular office. As the prostatic enlargement includes only part of the muscular stratum on the urethra, I would propose the name *orbicularis vel sphincter urethræ*¹ for both the prostate and the prolongation around the membranous portion of the urethra; whilst I would confine the old term prostate (without the word gland) to the thickened and more powerful part near the neck of the bladder. This orbicularis may be considered as only an advanced portion of the circular layer of the bladder, though it must have the power of acting independently of the vesical fibres, as, for instance, in the propulsion of the seminal fluid. Its chief office will probably be, to hurry on the semen, and deliver this into the grasp of the voluntary muscular fibres of the constrictor urethræ, which are external to it along the membranous part of the urethral tube.

Submucous Fibres of the Urethra.

A submucous stratum of longitudinal muscular fibres surrounds the urethra throughout its whole length, and is continued behind into the submucous layer of the bladder. It is strongest around the first third of the urethra (that

¹ Professor Kölliker applies the term *sphincter prostate* to some of the more internal circular fibres. He says the other fibres radiate from the centre to the circumference. ('Mikroskopische Anatomie.')

next the bladder), especially so in the prostate (fig. 1 and 2), and becomes gradually thinner as it proceeds towards the end of the penis; much fibrous is intermingled with the muscular tissue. At the fore part of the urethra its fibres end in tendons in the usual way, many of these blending with the submucous fibrous tissue. At the hinder third, that part embraced by the circular fibres of the orbicularis urethræ, many longitudinal fibres become oblique in direction, and are applied to those of the orbicularis. And at the neck of the bladder, other fibres join the circular stratum of that viscus, as is represented in fig. 1 and 2. In the prostatic part of the urethra, the central median crest or ridge (*crista seu veru montanum*) is formed by a bundle of this layer, whose longitudinal fibres separate to enclose the opening of the vesicula prostatica (*sinus pocularis*); and in the same spot the submucous stratum is joined by muscular fibres that accompany the ejaculatory ducts. No circular fibres have been recognised by me in the submucous layer of the urethra; where such external fibres appear after the removal of the longitudinal, they belong to other structures, viz., to the orbicularis muscle in the posterior third, and to the septum corporis spongiosi (to be afterwards referred to) in the anterior two thirds of the urethra.¹

In the urethra of the female, the submucous fibres are like those in the male, and have a similar position and arrangement, blending behind with the circular fibres of the urethra and bladder; but as there are not any seminal ducts in this sex, the accessory bundle in the male is wanting. About a quarter of an inch from the anterior opening of the tube, the longitudinal fibres are collected into bundles, between which are openings of the submucous glands arranged in lines.

¹ I have not met with the circular fibres in this layer, which Professor Kölliker describes (*Mikroskopische Anatomie*). Still less could I verify the statements of Mr. Hancock respecting it. (*Lettsomian Lectures*, 'Lancet,' 1852.) Those who are acquainted with the descriptions of the writers referred to, will perceive that I have not borrowed my account from them.

Muscular Covering of the Vesiculæ and Vasa Deferentia.

A muscular layer covers and partly surrounds the vesiculæ seminales and the ending of the vasa deferentia. It will be brought into view, when the bladder is placed upside down, by removing carefully from the seminal vesicles their sheath of the recto-vesical fascia. It consists of one layer of longitudinal and another of transverse fibres; and the whole might be named, from its office, *compressor vesiculæ et ductûs seminis*.

The transverse fibres are the more superficial in the inverted position of the part; some stretch over the vesiculæ, and are inserted at each side into the investing fascia; but others, and these are the most numerous, reach only as far as the outer border of the vasa deferentia: by this arrangement both the parts of the seminal apparatus may be compressed. This stratum is thickest near the prostate, and joins in front the circular fibres of that body.

The longitudinal fibres are beneath the others, and form a less extensive plane. For the distance of half an inch behind the prostate, they give rise to a continuous fleshy layer over the seminal apparatus; and from this, fibres are continued forwards and backwards. The anterior offset surrounds the common ejaculatory ducts, and joins the submucous layer of the urethra in the prostate; and the posterior is continued along the vasa deferentia for a short distance, as well as along each vesicula, where it is strongest at the outer and inner margins.¹

This muscular layer will compress and shorten the vesiculæ seminales, and the lower dilated ends of the vasa

¹ Professor Kölliker gives the following description of this structure: "Externally the vesiculæ are surrounded in part only by a membranous, and, in part, by an evidently muscular sheath, as at the hinder surface. This enters between the different windings of the canal uniting them together, and at the lower end passes as a broad muscular band from the one vesicula to the other." *Mikroskopische Anatomie: zweiter band*, p. 405.

deferentia. If the bladder is distended during the contraction, giving, in this condition, support to the seminal organs, the muscle will be enabled to act much more efficiently in the expulsion of the semen.

Sheaths around the Spongy Structure of the Penis.

The sheath investing the spongy material of the corpora cavernosa is commonly described as being composed of fibrous tissues, like those in tendons, without any special arrangement, except that they are said to be mostly longitudinal. My dissections demonstrate two layers of fibres in it, with a constant arrangement, one being superficial and having longitudinal fibres, the other deep, with transverse fibres, as in the wall of the alimentary tube. Moreover, the fibres have the same arrangement as in involuntary muscle, that is to say, they have a net-like disposition with small meshes.

In the outer stratum, where the fibres are directed longitudinally in bundles $\frac{1}{30}$ th to $\frac{1}{20}$ th of an inch wide, meshes about $\frac{1}{4}$ th of an inch in length are left between the offsets that pass from bundle to bundle. (See fig. 3.) Towards the front of the penis the bundles and the meshes are smaller; and in the crus the bundles are whiter, apparently from a greater mixture of fibrous tissue.

In the inner stratum, which is rather thinner than the other, the fibres are disposed circularly or transversely, though with the plexiform arrangement before described; and they will be best seen by opening the sheath and removing the spongy substance, as in fig. 4. Passing circularly around the cavity, the fibres blend in the middle line with those of the opposite corpus cavernosum, and construct in this way the imperfect septum (sept. pectiniforme) along the centre of the penis. (fig. 4 m.)

Only circular fibres enter into the composition of the septum between the cavernous bodies, as before described; and the fissures in it, corresponding with meshes in the other

parts, are here greatly enlarged to permit the free communication of the vascular or erectile tissue at opposite sides.

Where the cavernous bodies terminate in points anteriorly, small bands are continued into the glans penis.

The sheath of the corpus spongiosum urethræ resembles that of the cavernous bodies in incasing the vascular substance, and in possessing like them a central partition; but it has only one layer of fibres. It is formed of thin circular or transverse fibres, as is the deeper layer of the corpora cavernosa, but near the bulb some of them are oblique. Towards the front of the penis the place of longitudinal fibres is supplied by the "fascia penis."

The septum is connected with the surrounding sheath, and reaches vertically, as in the cavernous bodies, from the upper to the under aspect of the corpus spongiosum. As it crosses the included space it incases the urethral tube with the submucous layer, a piece being continued on each side. Its length below the tube of the urethra, and the way in which it surrounds this canal, are seen in fig. 1 *f, g*. This partition exists throughout the whole extent of the corpus spongiosum, though towards the front it is very imperfect, resembling in this respect the representative part in the corpora cavernosa. In a favorable body, I have traced it from the bulb to the glans, but its connection with the outer sheath is very slight in front; commonly it will not be traceable as a distinct partition much more than two inches from the bulb. It is composed of vertical fibres with minute clefts, as is the septum of the corpora cavernosa. All that part of the glans penis which is reflected back on the cavernous bodies above the tube of the urethra, wants the median partition.¹

The sheaths surrounding the vascular or erectile structures of the penis are, therefore, alike in their texture; but one is composed of two strata with fibres taking different directions,

¹ Mr. H. Thompson, in a 'Treatise on Stricture of the Urethra,' calls in question the fact of the septal process being continuous with the sheath; but I think he will allow the existence of this junction if he seeks it in the way represented in the drawing.

whilst the other has only a circular layer. Across the space included by the sheath in both the cavernous and spongy bodies is placed an imperfect partition, which is formed of circular fibres.

EXPLANATION OF THE FIGURES.

All the figures have been taken by the skilful hand of Mr. Ford from my own dissections.

FIG. 1.—For this figure the outer and middle strata of the muscular coat of the bladder, and the muscular layer around the prostatic and membranous parts of the urethra, were cut through in the preparation, so as to show the submucous stratum of the bladder and urethra. The corpus spongiosum was cut into, and the contained spongy material removed for a short distance to lay bare the septum. The same letters are used to indicate like parts in fig. 1 and 2.

a. External or longitudinal muscular layer of the bladder.

b. Middle or circular.

c. Internal or submucous. Many of its fibres are shown entering the circular fibres of the middle stratum.

d. Longitudinal submucous fibres of the urethra as they pass through the prostatic and membranous parts of that tube, internal to and separate from the circular layer *e*. At the neck of the bladder some are represented cut, as in the dissection, and others blend with the circular fibres.

e points to the circular fibres around the hinder third of the urethra, which I have named orbicularis urethræ: their continuity, behind, with the circular fibres of the bladder appears in the drawing.

f. The septum of the corpus spongiosum: the way in which this encloses, and shuts out the urethra with its longitudinal submucous layer from the spongy tissue, is referred to by *f*. Some apertures have been made in the septum to show the space on the other side: the piece of whalebone, introduced into the left half of the corpus spongiosum, appears through the apertures.

h. Corpus spongiosum urethræ.

k. Corpus cavernosum penis.

l. Ureter of the right side.

FIG. 2.—In the dissection here represented, after the separation of the vesiculæ seminales and vasa deferentia, which have been drawn forwards, the two outer strata of the muscular coat were taken away over the triangular space at the base of the bladder, in order that the expansion derived from the ends of the ureters might be seen joining the submucous layer. The lower half of the prostate was cut away in greater part, and the submucous layer of the urethra laid bare.

a, b, c. The different muscular strata of the bladder as in fig. 1.

d. The layer around the urethra in the prostate: the central ridge corresponds with the prominence in the floor of the urethra. Some of the fibres join the circular of the bladder, while others enter the deepest or the submucous layer of that viscus.

n. Vesicula seminalis and the vas deferens joining to form the common ejaculatory duct.

p. Membranous part of the urethra.

l. End of the ureter: some fibres from it, *r*, are seen joining those around the urethra, while others enter the submucous muscular layer of the bladder.

FIG. 3.—The longitudinal fibres and the meshes of the outer stratum of the corpus cavernosum are here indicated. The part selected for the drawing was not far from the crus penis.

FIG. 4.—The piece for the drawing fig. 3 was cut open, and the spongy tissue removed to make the preparation for fig. 4. It illustrates the circular arrangement of the inner layer of fibres of the corpus cavernosum; *m* points to the formation of the septum pectiniforme by those fibres.

Fig 3.

Fig 4.