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## THE SURGICAL DISEASES OF THE GENITO-URINARY ORGANS

### PART I

#### DISEASES OF THE URINARY ORGANS, INCLUDING GONORRHEA

#### CHAPTER I

##### ANATOMY AND PHYSIOLOGY OF THE URETHRA—CURVE OF URETHRAL INSTRUMENTS—URETHRAL AND SEX- UAL HYGIENE

##### ANATOMY OF THE URETHRA

THE urethra is always a closed canal throughout its whole course, except when distended by some foreign substance. Commencing at the neck of the bladder, it tunnels the upper part of the prostate, perforates the triangular ligament, and terminates at the end of the penis. Its outer opening is known as the *meatus*, or the *meatus urinarius*. The urethra is divided naturally into two parts, the *anterior* and the *posterior urethra*, by the triangular ligament, the anterior urethra lying external to the anterior layer of that structure, and the posterior urethra being the continuation of the canal backward into the bladder. The anterior or spongy portion of the urethra is again subdivided into four parts, the navicular (or the fossa navicularis, Fig. 1), penile (Fig. 2), scrotal, and bulbo-perineal (or simply the bulb) (Guyon<sup>1</sup>). The posterior urethra is subdivided into the membranous and the prostatic portions. It is much more accurate to speak of a lesion, such as a foreign body or a stricture, as being at the peno-scrotal angle or in the bulb, than to say it lies at a depth of 4 or 6 inches, for not only does the length of the urethra vary according as the penis is erect or flaccid and in disease (hypertrophy of the prostate), but the urethral *length*, the urinary distance,<sup>2</sup> varies widely in different healthy individuals.

<sup>1</sup> Leçons cliniques, 1896, ii, 295.

<sup>2</sup> Keyes, Am. J. of Med. Sci., 1898, cxvi, 125.



The mucous membrane of the urethra consists of a layer of epithelium, of which the superficial cells are squamous in the navicular and prostatic regions and columnar elsewhere, on a connective-

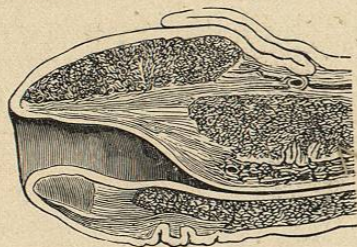


FIG. 1.—CRUVEILHIER.  
Vertical section through glans and fossa navicularis.

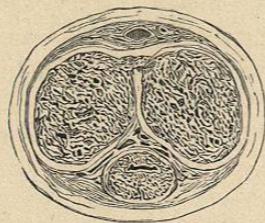


FIG. 2.—CRUVEILHIER.  
Transverse section of penis.

tissue basement substance particularly rich in elastic fibres to allow for the great distensibility of the canal.

**The Anterior Urethra.**—In the anterior urethra the mucous membrane is surrounded, except in the fossa navicularis, by a very thin longitudinal layer of unstriped muscle-fibres (in direct continuity with the inner fibres of the prostate), and these are in turn surrounded by a circular layer of unstriped muscle. These circular fibres are so few around the spongy urethra that their very existence was denied by Sappey. These muscle-layers are so thin and

weak that they have no clinical significance. (See Spasm of the Urethra.) Finally, the anterior urethra is surrounded from triangular ligament to meatus by the corpus spongiosum, except for the half-inch nearest the bladder, where the corpus spongiosum fails to cover the roof of the urethra and is enlarged below into the *bulb*.

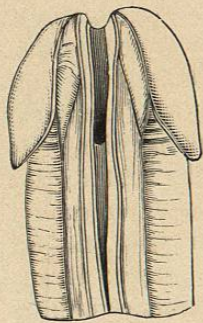


FIG. 3.—CRUVEILHIER.

**Crypts and Glands.**—In the roof of the fossa navicularis lies the *lacuna magna* (Fig. 3), a simple pocket in the mucous membrane with its orifice towards the meatus, and consequently open to entrap small instruments. This lacuna varies greatly in size in different persons, being sometimes entirely absent, and occasionally running as far back as the triangular ligament, forming the so-called double urethra (*q. v.*). A few other smaller lacunæ lie along the roof of the penile urethra. The glands of the urethra, to be distinguished from the lacunæ, are of the compound racemose type, of very small calibre, lined with a cylindrical epithelium. They lie chiefly on the roof of the urethra, are more numerous in its deeper parts, and, in

many instances, pierce the sheath of the corpus spongiosum and extend for some distance within it—an important fact in relation to organic stricture of the canal, since these glands convey the products of urethral inflammation into the corpus spongiosum and so involve it in the subsequent cicatrization. *Cowper's glands* are two small, round, lobular bodies each about the size of a cherry-stone, lying just behind the bulb of the urethra in the transversourethral muscle between the layers of the triangular ligament. Their ducts are sometimes very long, but average a full inch, and open out of the floor of the bulbous urethra. Their fluid is supposed to aid in diluting the sperm.

The urethra has about the same sensitiveness in health as the conjunctiva. In the membranous urethra, however, sensibility is exaggerated. The colour of the membrane is pale pink. In rest its walls are in contact, obliterating the cavity of the canal, so that a cross-section presents a transverse slit instead of an opening (Figs. 154, 155).

The anterior urethra might well be called the *external urinary tract*, and the canals and reservoirs beyond the *internal urinary tract*, for the anterior urethra is in free communication with the surface of the body and harbours all the micro-organisms that may lie thereon. As a general thing it does this with perfect impunity. Its *flora* includes the bacillus coli communis, pyogenic streptococcus and staphylococci, and other less noxious germs without number. All of these flourish and multiply within it harmlessly enough unless the tissues have been already damaged by other agencies. Of these, trauma and the gonococcus stand first. The gonococcus is the only microbe pathogenic to the anterior urethra yet positively identified. That there are others, as yet unnamed, which do cause lower grades of urethral infection there can be no doubt; but, at best, they are relatively unimportant. Such bacteria as flourish normally in the anterior urethra, being constantly washed out by the urine, and entering only through the meatus (except under pathological conditions), are more numerous in the fossa navicularis, and the bacillus coli and the pyogenic cocci are usually found only in that region.

**The Posterior Urethra.**—The posterior urethra, extending from the anterior layer of the triangular ligament to the bladder, presents many notable points of contrast with the anterior urethra. The canal is no longer surrounded by erectile tissue, and, indeed, it could scarcely become erect, for whereas the anterior urethra is freely movable with the penis, the posterior urethra possesses a fixed curve—of which later. Moreover, the posterior urethra is, in its normal state, entirely free from the germs harboured by the anterior urethra; it is the lowest section of the aseptic internal urinary tract.



The posterior urethra is divided naturally into the membranous and the prostatic urethra.

*The Membranous Urethra.*—Of all parts of the canal the membranous urethra is the most fixed, running, as it does, from the aperture in the anterior layer of the triangular ligament to the aperture in the posterior layer. Its mucous membrane, though of a darker colour and much more sensitive, does not differ in structure from that of the anterior urethra. This in turn is surrounded by the thin layer of unstriped muscle derived from the prostate, but instead of being sheathed in the corpus spongiosum, it is embedded in the voluntary muscle that fills the space between the two layers of the triangular ligament. This muscle has had special names given to different portions of it by Guthrie, Müller, Wilson, and others, but it may be considered clinically as one muscle, the *constrictor* or *compressor urethrae*, the *cut-off* muscle, the external or voluntary sphincter of the bladder. The last term best expresses its function. It is the muscle by which the outflow of urine from the bladder is voluntarily opposed. If a catheter is introduced through it no voluntary effort of the individual is able to arrest the stream of urine. Indeed, inhibition of this muscle is the chief act of the will in voluntary urination. It may, however, suffer from spasm, and so

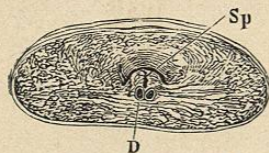


FIG. 4.—CRUVEILHIER.  
Transverse section of centre of prostate: D, ejaculatory ducts; Sp, sinus pocularis.

not only prevent urination, but also present a serious obstacle to the introduction of instruments. This is spasmodic stricture (*q. v.*).  
*The Prostatic Urethra.*—The prostatic urethra tunnels the prostate, sometimes barely covered by that organ above, sometimes deeply embedded in it (Fig. 4). It is fixed only where it joins the membranous urethra. It is fusiform in shape, being closed internally by the internal or involuntary sphincter of the bladder. Into it the ducts of the sexual organs empty. It is lined by squamous epithelium like that of the bladder, and is liable to great deformity and obstruction by hypertrophy of the prostate gland. Beyond this it requires no description here. The detail of its anatomy belongs to the prostate rather than to the urethra, and is therefore better classified under that title.

**Length.**—The length of the urethra, varying as it does in different individuals and in the same individual with erection of the penis and hypertrophy of the prostate, may be set down as averaging 20.5 cm. (8½ inches),<sup>1</sup> and varying in different normal individuals

<sup>1</sup> Keyes, *loc. cit.*

from 18 to 23 cm. (7¼ to 8¾ inches). The posterior urethra is usually 5.5 cm. (2¼ inches) long—2.5 cm. (1 inch) to the membranous portion, 3 cm. (1¼ inches) to the prostatic—and the anterior urethra 15 cm. (6 inches) long, subdivided as follows: 2.5 cm. (1 inch) to the navicular region, 6.25 cm. (2½ inches) to the penile, 3 cm. (1¼ inches) to the scrotal, and 3 cm. (1¼ inches) to the bubo-perineal.

**Diameter.**—The diameter of the normal urethra (Fig. 5) varies even more than the length—it has been estimated at from two to six lines. A fair average is not larger than 0.75 cm. (0.3 inch)—about No. 27 French scale.

But, whatever its size, the urethra is not a tube of uniform calibre from end to end. It has naturally four points of physiological narrowing: the first at the meatus; the second at the peno-navicular junction; the

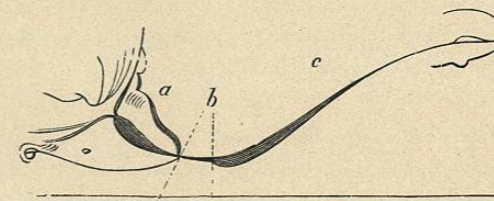


FIG. 5.—THOMPSON.  
a, b, and c represent the prostatic, membranous, and spongy portions of the urethra.

third beginning about half an inch back of this, and becoming most pronounced at about the peno-scrotal junction. The fourth and fifth constrictions are the voluntary sphincter—namely, the entire membranous urethra—and the internal orifice of the prostatic urethra. Of these five narrow points, three, it will be observed, are organic and situated in the anterior urethra, while the other two are muscular and situated in the posterior urethra. The muscular constrictions are widely dilatable, and the calibre of the canal is determined by the meatus, normally the narrowest point. Hence, *the calibre of the urethra is the calibre of its normal meatus*—a rule of great importance in the dilatation of the urethra, and which will be explained farther on. (See Stricture of the Meatus.) The peno-navicular and peno-scrotal constrictions are usually mere irregularities in the canal, besides which there are often lesser contractions at various points, making the urethra, when distended, not a smooth, evenly calibrated tube, but a very irregular one. The three chief *dilatations* of the normal canal are the fossa navicularis (so called from its supposed resemblance to a boat), which is situated just inside the meatus; the bulbous urethra, occupying a position immediately in front of the triangular ligament; and the prostatic urethra (prostatic sinus, Fig. 5). Of these the second is the largest.

**Curve.**—In relation to these variations of calibre Guyon's observations upon the relative qualities of the urethral roof and



floor are of interest far more from a practical than from a theoretical point of view.<sup>1</sup> His observations may be classified as follows:

I. The roof of the urethra (when the penis is erect) forms an uninterrupted curve from the fossa navicularis to the bladder.

II. All the variations of calibre, except the fossa navicularis, are produced at the expense of the floor, which is, in consequence, very irregular.<sup>2</sup>

III. The mucous membrane of the roof is more closely adherent to the subjacent structures than that of the floor.

IV. The mucous membrane of the floor of the urethra is much more elastic than that of the roof.

Therefore, not only is the floor of the urethra more irregular than the roof, but its irregularities may be increased with much greater facility by any object introduced into the canal, as well as by disease. In other words, instruments, especially if small and rigid, may, with their points, furrow the floor of the urethra until, finally, they become pocketed (usually in the bulb), and so are brought to a full stop, while an instrument whose point impinges always on the roof avoids these obstructions and glides easily into the bladder. Therefore this eminent French surgeon has termed the roof the surgical wall of the urethra—the wall, namely, which is the guide to the instrument in entering the bladder. That fistulae and false passages always occur in the floor and lateral walls, never (practically) in the roof, and that the orifice of a stricture is usually nearer the roof than the floor—these two facts make the roof the surgical wall in disease even more than in health.

#### THE CURVE OF URETHRAL INSTRUMENTS

From these considerations it follows that *the curve of the urethra is the curve of its roof*. Now the entire anterior urethra is freely movable with the penis, and can be made to assume any curve. Not so the posterior canal. The membranous urethra, bound tightly at its extremities by the two layers of the triangular ligament, is the real fixed point of the urethra, and runs at a distance of from 1 to 2 cm. ( $\frac{2}{8}$  to  $\frac{4}{8}$  inch) below the symphysis pubis. In front of this the bulbous urethra tends slightly upward because of the tension of the suspensory ligament and of the skin and fascia, while a similar elevation is given to the pros-

<sup>1</sup> *Op. cit.*, ii, 309 *et seq.*

<sup>2</sup> Though not absolutely accurate, these two observations are clinically correct.

tatic urethra behind by the pubo-prostatic ligaments and the anterior fibres of the levator ani muscles. Thus is formed the so-called fixed curve of the urethra—not a true fixed curve, for by depression of the bulbous and the prostatic urethra to the level of the membranous portion it can be, and often is, transformed into a straight line, as when a sound is pushed home until its shaft is in line with the patient's body, or when straight metal instruments are introduced. (This latter proceeding, sometimes difficult, often painful, is never absolutely necessary.) The curve varies slightly with different persons, and in the same person at different periods of life, being shorter and sharper in the child, longer in the old man. A distended bladder or an enlarged prostate lengthens the curve.

The proper average curve, as recognised by Sir Charles Bell and insisted on by Sir Henry Thompson—the one which will mathematically accord with the greatest number of urethrae—is that of a circle 8.125 cm. in diameter; and the proper length of arc of such a circle, to represent the subpubic curve, is that subtended by a chord 6.875 cm. long.<sup>1</sup> An instrument made with a short curve of this sort will readily

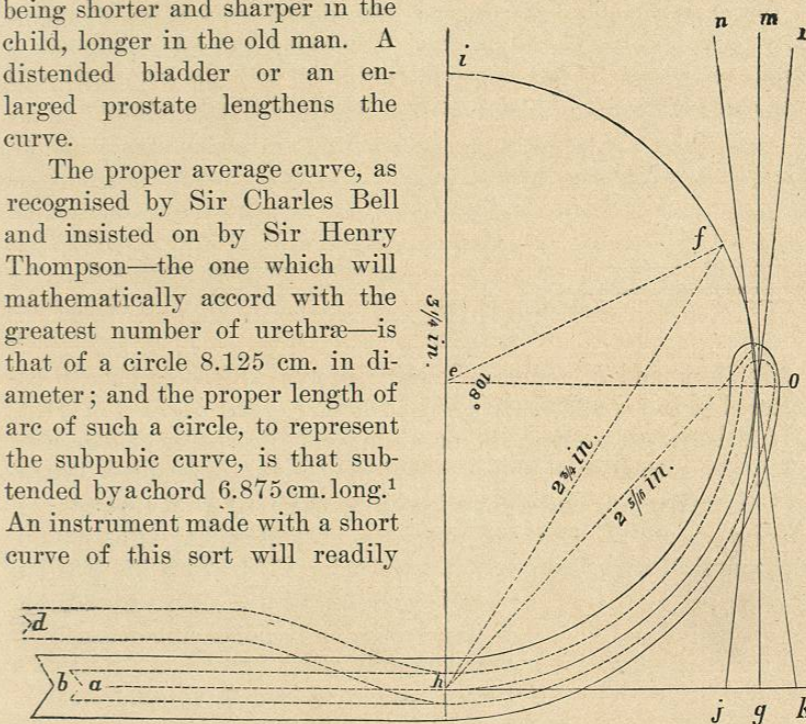


FIG. 6.—Instruments as ordinarily made, with faulty curve, *Oa, Od* (Béniqué). Correctly curved conical instrument, *Ob*. Length of natural curve of urethra, *fOh*. Length of chord of curve of sound, *hO*,  $2\frac{5}{8}$  inches (5.812 cm.).

find its way through the normal urethra into the bladder without the employment of any force. It is very desirable that instruments in-

<sup>1</sup> In the winter of 1852-53, assisted by the late Dr. Isaacs, I made a series of careful experiments upon sections of frozen subjects, as well as by injecting the urethra with numerous substances afterward carefully cutting out the casts. I found the average curve to be identical with the one given above.—VAN BUREN.