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THE EXPLORATION
OF THE
URETHRA AND BLADDER

THE
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THE
EXPLORATION
OF THE
URETHRA AND BLADDER

BY
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WITH 26 ILLUSTRATIONS

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PREFACE.

THIS Monograph is a sort of Second Edition, in English, of a pamphlet which I brought out in German, twelve years ago. In the last twelve years I have gained more experience in these matters, and I trust that the present edition may be an improvement on the earlier one. It may, perhaps, be an improvement also that I have now omitted to describe the bladder in woman, as it hardly differs from that in man.

However, as regards the anatomy of the male urethra, there are still a good many questions which deserve to be discussed, and in operations on and in this canal, or during the introduction of catheters, it is not uncommon to find the descriptions given by most writers insufficient on various points. I have decided to explain the introduction of catheters because I believe this operation is most suitable for making us acquainted with the surgical anatomy of the urethra.

With regard to the bladder, I am so bold as to assert that its anatomy is not well known. If that organ were really well understood, the plan I brought forward, years ago, to lay hold of the ureter in the bladder, would have been received with much less doubt. Partly in consequence of these doubts, so many other methods for the same purpose have since been advocated. In order to lay hold of the ureter for diagnostic purposes surgeons have even found it necessary to cut open the bladder from above the pubic symphysis, and to use the knife outside the bladder in various regions of the abdomen through which the ureter passes in its course from the kidneys to the bladder.

It is not for me to give judgment on these rival proceedings; time and those who know will decide which method deserves to be generally adopted. I may plead here in my favour that the researches on which my proceeding is based have been laboriously

extended over many years. These researches were made on living subjects at the German Hospital at Dalston, and since I have resigned my appointment there, on my private patients. The examinations on dead bodies were almost all carried out at Guy's Hospital. To the physicians and surgeons of that institution I am greatly indebted for the exceeding kindness which they have shown me on this and on many other occasions.

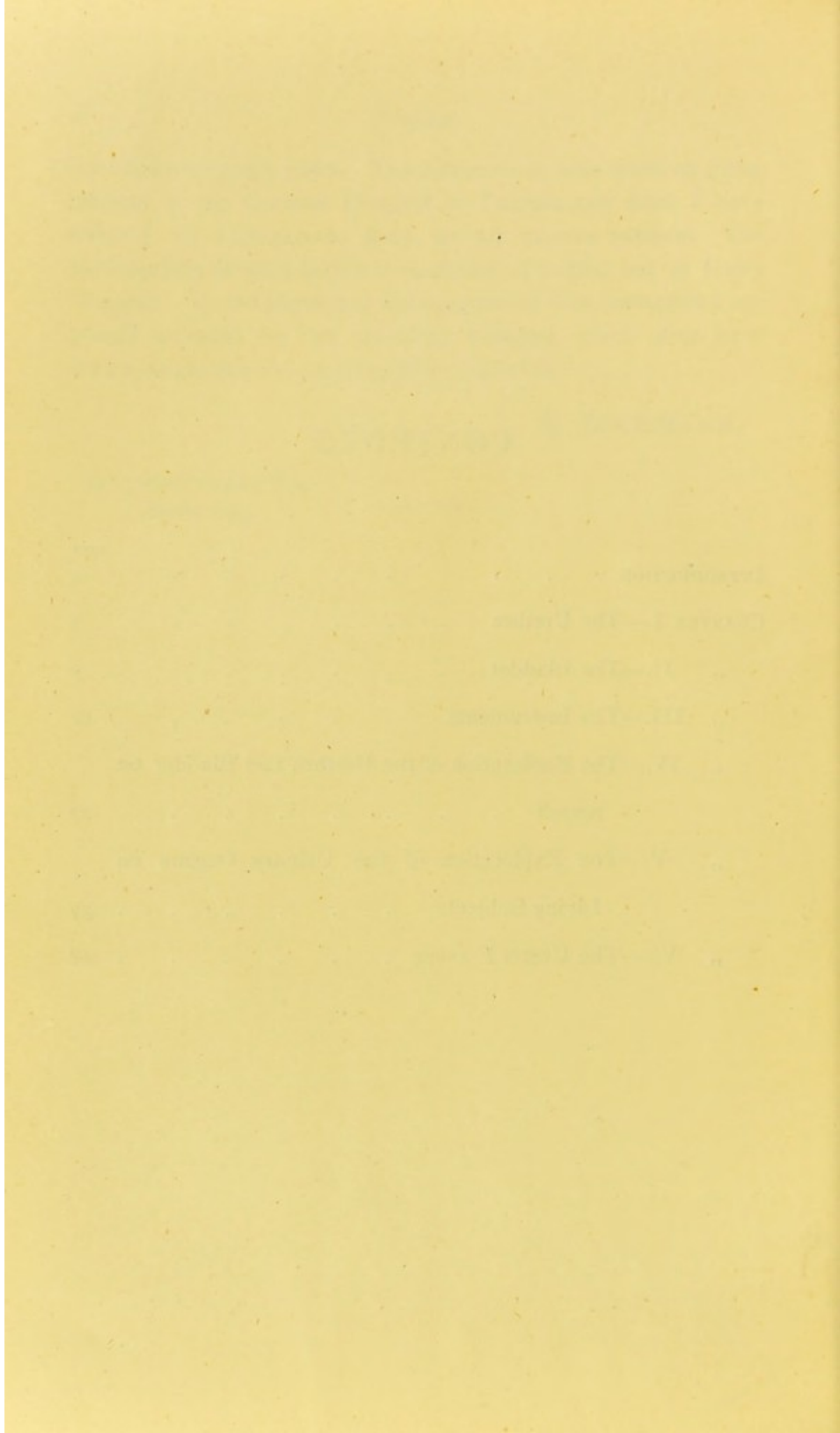
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March, 1899.

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THE EXPLORATION

OF THE

URETHRA AND BLADDER.

INTRODUCTION.

SOME preliminary remarks on the position of the pelvis and the organs contained in it may be not inappropriate.

As the urethra and bladder are fixed to the pelvis, the position of these organs must vary with the position and inclination of the latter bone.

We find it commonly stated that the inclination of the pelvis, the subject being in the erect posture, is between 50 and 60 degrees.

This statement must be pronounced to be more than vague and likely to lead to wrong conceptions.

It is to the credit of the late Professor H. Meyer¹ of Zurich to have shown that the degree of pelvic inclination varies considerably in different people, and even in the same subject, the inclination is not constant, but may in the erect posture, owing to rotation and abduction of the lower extremities, vary between 40 and 100 degrees. This statement of Meyer's that so great a variation in the pelvic inclination is produced by the position of the lower extremities is strongly contested by Lesshaft,² but he also admits, after an examination of only ten dead bodies, that the inclination of the pelvis in different subjects may vary between 56 and 82 degrees.

The exact inclination of the pelvis can be ascertained in the fresh skeleton only; but an approximative notion on living subjects may be gained, as Parrow³ has shown, by observing the inclination of the posterior surface of the sacrum.

The method I employ is to place the patient standing with his back against a wall, and then measure the degree of concavity the lumbar vertebræ make. It has been found that the inclination of the pelvis corresponds to the amount of curvature of the lumbar part of the spinal column.

I could in this way make out very great differences between different individuals. Duchenne⁴ has noticed that a very pronounced lumbar curvature is by no means rare, and is peculiar to some races and families.

I think, however, in drawing comparisons between the position

of the pelvis in different subjects the perfectly horizontal posture on the floor or on a very hard couch is preferable, as in this position they can be brought to a more uniform attitude. Kohlrausch⁶ who has measured fresh dead bodies in this posture found their pelvic inclination was between 50 and 70 degrees. I have examined 200 living male subjects lying quite horizontally with legs and arms extended, and have also noticed in this position very great individual differences, their lumbar vertebræ being more or less raised from the couch. In a few subjects I have found the pelvis greatly elevated, approaching an almost vertical position, whereas in others the lumbar vertebræ and the loins were close to the couch. Between these two extremes all sorts of variation could be observed.

We are therefore justified in concluding that in different subjects lying horizontally, and more so in subjects in the erect posture we must expect a different position of the urethra and bladder, and if we want to introduce instruments through and into these organs, we must give our instruments a different direction.

CHAPTER I.

THE URETHRA.

I do not intend here to give a detailed description of the urethra, but of its curve only.

The subject is supposed to be in a horizontal position.

The urethra since ancient times has been compared to the Roman letter S lying (S), an unfortunate comparison, as it makes the passing of catheters very difficult to understand. We can well believe how astonished the surgeons all over Europe were, when Amussat came forward showing that a perfectly straight metal instrument could be passed through the windings of such a curved canal, as the urethra was generally supposed to be. I am inclined to think that Amussat himself was rather puzzled about his performance, as he gave the curious explanation that the urethra was straight or almost straight.⁶ But this explanation is utterly wrong, and the fact is that the urethra is very far from being straight or almost straight, and at one particular place it is even very decidedly curved. It is true that the anterior curve of the S, formed by the pendulous part of the urethra, can be made quite straight, and can moreover be brought to any direction we wish to give it. And with regard to the posterior curve of the S, we may observe that the concavity of this curve exists only at the lower (rectal) wall of the prostatic part, whereas its upper (ventral) wall, and in front of it, the membranous part, are almost quite straight.

And yet, it must be maintained that the urethra is very far from being straight.

In order to explain the curve of the urethra, I must speak of the famous triangular ligament, the more so as particularly the anterior layer of this ligament is not always clearly described and pictured.

The anterior layer of the triangular ligament should be shown as laterally fixed to the posterior ridge of the ischio-pubic rami. This means that the membranous part of the urethra is situated in the cavity of the pelvis, whereas we see it often mentioned and figured as being below the symphysis pubis and between the anterior and posterior ridge of the ischio-pubic rami. It is not to be denied that the membranous urethra is on a lower level than the pubic symphysis, but at the same time and in its whole length it lies behind the symphysis or rather behind the descending rami of the pubis. If the membranous urethra were simply below the symphysis, the prostate would commence immediately behind that bone, in which position it would lie very conveniently for our examination per rectum; but the prostate is, in fact, a certain distance away from the symphysis, a position which renders its

exploration along its whole length more difficult, and particularly so in fat individuals.

I myself, after I had been taught that the membranous part of the urethra was below the symphysis, hoped at my first operations for external urethrotomy without a guide to hit that part soon after having opened the urethra in front, and to hit it at least between the anterior and posterior ridge of the ischio-pubic rami. But I had to cut much deeper, and search for it longer than I expected, and for many years I have come to the conclusion that, if we want to reach the membranous part of the urethra, we must in every case penetrate to a great depth, and pass by the whole breadth of the inner border of the ischio-pubic rami.

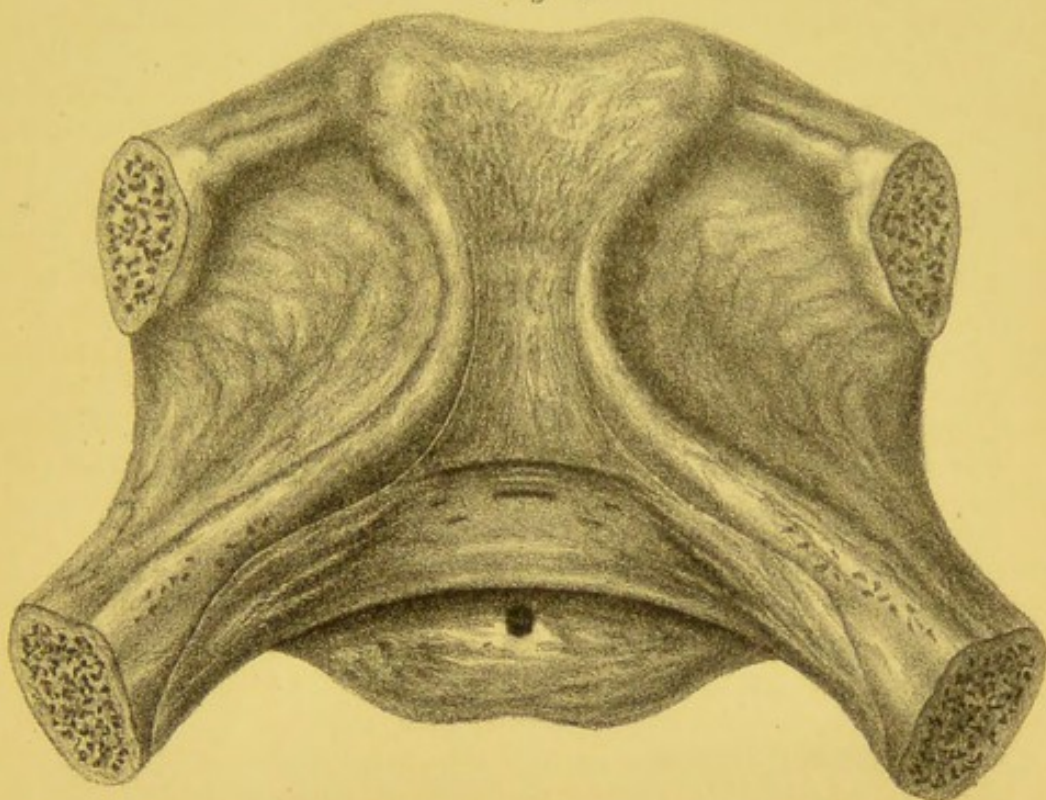
It is immediately in front of the anterior layer of the triangular ligament that the urethra changes its course. Up to the anterior layer the prostatic and membranous parts follow, as I have just mentioned, an almost perfectly straight and horizontal direction in the horizontal pelvis; but immediately in front of that layer the urethra, after having sent off a pouch downwards, the bulbous part, takes a sharp curve upwards, and in a perpendicular direction for about one inch ascends from below to the front of the symphysis very closely connected with the subpubic ligament and with the bone above that ligament. This is the part which Guthrie⁷ pictures very well; Dittel⁸ calls it "*pars accreta*," and Malgaigne⁹ gives it the name of the "*ascending part*"; but the name of "*scrotal part*" is more appropriate, as it is entirely covered and defined by the scrotum; its peculiarities may be explored to a certain extent through the scrotum.

The anterior layer has been variously described by some anatomists as a strong, and by others as a thin piece of fibrous membrane, but I believe we must distinguish between its different portions. Its lower portion extending from below the urethra down to the *M. transversus prof.* is a thin piece of fascia which allows the muscles behind to be seen through it. It is also questionable whether such a thin fascia can for a long time prevent any pus collected behind it to break through it. But the upper portion of the anterior layer, the subpubic ligament* which reaches from immediately above the urethra up to the pubic angle, and in this direction is said to measure between one-third of an inch and one inch, this portion is very firm and thick (fig. 1†). Besides, it is neither a fascia nor a ligament either, and, as I gather from Holl¹⁰, is the tendon of a muscle. This muscle, the *M. ischio-pubicus*, is not

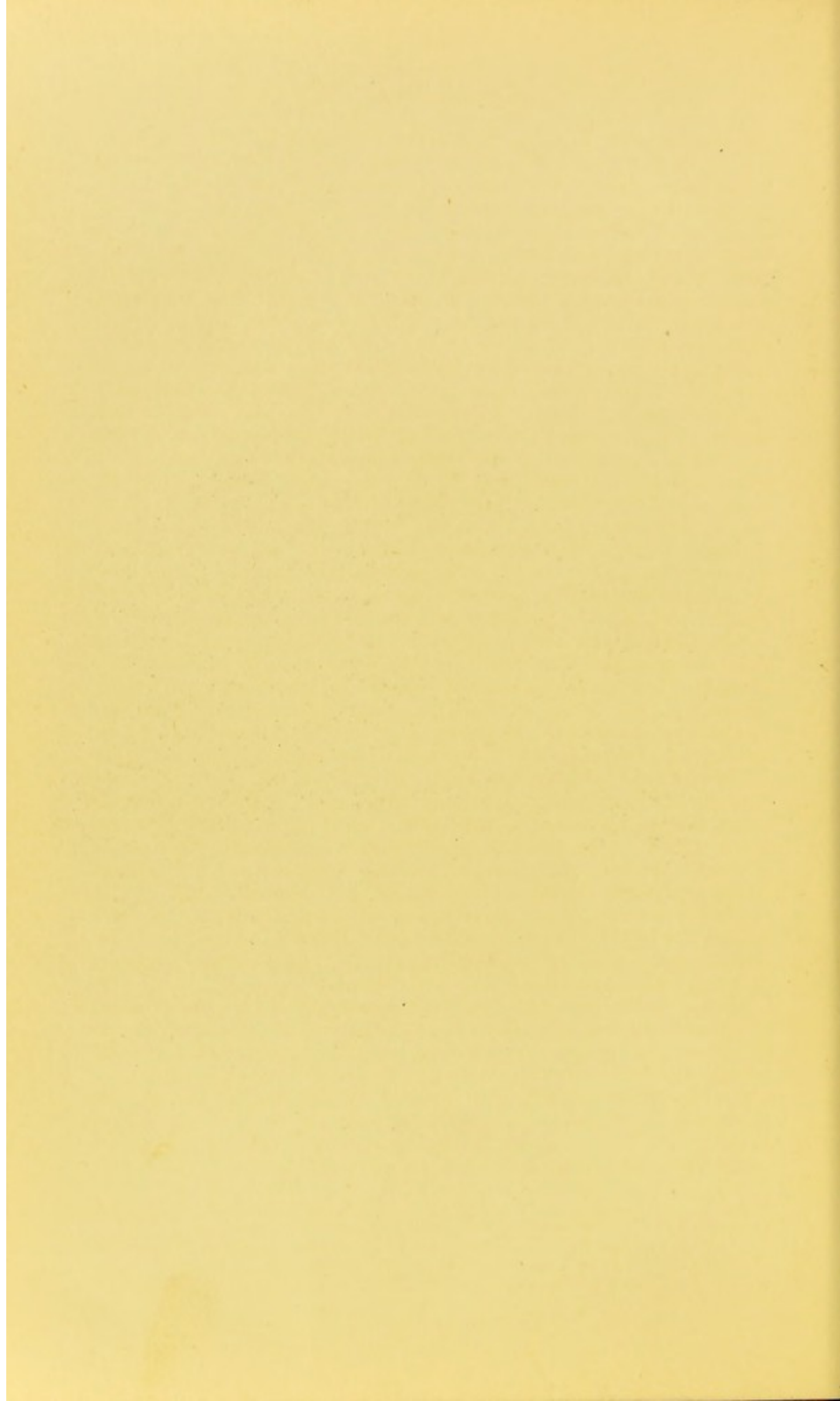
* I use the name of "*subpubic ligament*" for the whole membrane reaching from immediately above the urethra up to the pubic angle, whereas others call it "*Lig. arcuatum*." Other anatomists again, seeing this membrane about the middle perforated by the large dorsal vein of the penis, distinguish between the upper part which they call "*subpubic lig.*" and the lower part which they call "*transverse lig.*" The confusion is increased by others who give the name of *Lig. arcuatum* either to the part above or to the part below the dorsal vein of the penis.

† After a preparation at the Royal College of Surgeons by kind permission of the authorities of the College.

Fig 1.



E. Burgess del.



very often seen in man, but well developed in some animals, especially in the dog; arising on each side on the inner surface of ischio-pubic rami it terminates in two tendons which, before they unite with the tendons of the opposite side, leave room for the dorsal vein of the penis to pass through. The nature of these parts is better understood by what appears to be their real connection with the anterior layer of the triangular ligament: Holl, and other anatomists before him, assert it as a fact that the lower portion of the anterior layer ascends from below the inferior border of the M. transversus prof. right up to and beyond the pubic angle, covering by such an extension the subpubic ligament behind it.

I have gone a little more into details about the subpubic ligament because I have found that this ligament can be very distinctly felt on dead bodies and on living individuals, and may be used as a landmark in operations from the perinæum and in the introduction of catheters. If we pass the finger into the rectum, and push it vertically upwards towards the pubic symphysis, we can, at a distance of about two inches from the anterior border of the anus, touch the lower concave border of the subpubic ligament; in every case we perceive the strong resisting texture of this ligament, and immediately below it the soft tissue of the membranous urethra commencing its course into the cavity of the pelvis.*

The straight and horizontal course which the membranous and prostatic urethra follow, and how nearly opposite the vesical orifice of the urethra lies to the point where the membranous part of the urethra passes below the subpubic ligament, we can make out on the dead body in the following way; if on the dead body of an adult, with the pelvis quiet horizontal, we push a knife with the blade downwards straight through the skin of the perinæum and through the underlying tissues, exactly below the subpubic ligament, holding the blade of the knife quite in the middle line, we reach the bladder through or very nearly through the vesical orifice of the urethra. Langer¹² is quite right when he states that in the horizontal position of the subject the vesical orifice of the urethra corresponds to a plane which passes at a distance of one-half to one inch below the pubic angle, a distance which would be in accordance with the various lengths of the subpubic ligament. Jarjavay¹³ has come to the same conclusion.

Undoubtedly, the vesical orifice of the urethra appears in some cases on an higher level than the inferior border of the subpubic ligament, and the membranous and prostatic urethra take a more ascending course into the cavity of the pelvis. This, I submit, is almost entirely caused by a greater inclination of the pelvis. Langer and Dittel assume that, besides the pelvic inclination, it is sometimes a large quantity of fat accumulated in the pelvis which keeps the vesical orifice in a more elevated position. I do not

* I may mention here, and this may perhaps confirm my statement with regard to the possibility of finding out the subpubic ligament, that according to Quain¹¹, the base of the triangular ligament may be felt through the rectum. If the base of the triangular ligament which is less thick and resistant can be found out, then I must affirm that the lower border of the subpubic ligament is more easily felt.

know whether this can be accepted as proved, and the fat amassed in the higher pelvic region may counterbalance the effect produced by the fat below. Moreover, I have not in stout dead bodies observed a greater quantity of fat just round the prostate.

Nor can I admit that the form of the prostate during health greatly alters the position of the urethral orifice. It is true that the volume and weight of the prostate vary in different subjects, but it may be questioned whether at the same time its form varies in such a way that the position of the vesical orifice is thereby much altered.

Other factors influencing the position of that orifice besides those which I have just mentioned have to be taken into consideration, viz., the various length of the subpubic ligament and, in living subjects, the strength and the tonic contraction of the muscles which support the prostate.

How, then, can we get an idea of the form and curve of the urethra?

An ordinary metal catheter held with its shaft in the vertical position and the great curve forward, the long beak being horizontal, reproduces in a pretty accurate way the form and curve of the urethra, the prostatic and membranous parts corresponding to the beak; the scrotal and the pendulous part (this latter being brought into a vertical position) corresponding to the shaft. Testut¹⁴ has lucidly described the whole urethra as representing in its form two straight lines united by a curve of various degree.

I imagine that the surgeon of the medical school of Alexandria who, about 2000 years ago, invented that very ingenious instrument, the catheter, started with the knowledge in mechanics that two arches of the same curve most easily glide over each other, and then modelled his instrument on the shape of the urethra, with the several parts of which he had made himself thoroughly acquainted. Whether his catheter was quite like that of our own times is not of much importance; the length of the beak and the form of the curve need not be the same in all these instruments. On the contrary, it would be wrong to think that our ordinary catheter could fit everybody, and all attempts to construct such a universal instrument have proved futile. It has been well said that there are almost as many different urethræ as there are individuals, and the successful introduction of the catheter does not depend so much on its form as on the hand that guides it and on the anatomical knowledge of the surgeon.

CHAPTER II.

THE BLADDER.

I AM obliged to give a more detailed description of the anatomy of the bladder, as the manœuvres of the instruments introduced into that organ are not understood without an accurate knowledge of its several regions.

The following description refers almost exclusively to the empty bladder, and to its base only; the other parts not being or hardly being accessible to the instruments which we ordinarily use.

The subject is supposed to be in a horizontal posture.

The base or fundus of the bladder is physiologically and pathologically the most important part of the bladder; the organ with its various ostia and their morbid changes may be aptly compared to the heart, or rather to one of the ventricles of the heart.

The fundus commences at the vesical orifice of the urethra, and hangs down into the pouch of the rectum, "the ampulla recti"; it presents itself as a plane, sloping downwards from before backwards. For the first one-eighth of an inch it is very firmly fixed to the third (or median) lobe of the prostate, and after that it is in close connection with the seminal glands and ducts which in their course forwards approach each other in the middle line; further behind and below where the seminal organs are more distant from each other it is in immediate contact with the rectum.

The fundus may be divided in two parts:—

1. The anterior (superior) part, the region of the trigone, and
2. The posterior (inferior) part, the post-trigonal region.

1. The region of the trigone (A, fig. 2) occupies about two-thirds of the whole fundus; it commences at the vesical orifice of the urethra, and reaches as far as the ridge (*a* to *a*) which is formed by the ureters and their muscles. This ridge is well worth our attention, and will, I am sure, in future play a more important rôle than it has hitherto done.

The ureteric ridge, with its concavity turned backwards, extends transversely from one side of the fundus to the other. It is more or less distinct over the regions in front and behind, and is especially prominent at each side where it contains the vesical portions of the ureters.

These portions (*a* to *b*) quite deserve the name of "ureteric valves," as they prevent the regurgitation of urine into the ureters when the bladder contracts to evacuate its contents.

If we look a little more closely at either of the ureteric valves, we notice that the ureters, after penetrating in a somewhat oblique direction the muscular coats of the bladder, reach the fundus, and

there become submucous; then creeping along from the lateral wall of the bladder, under the mucous membrane, towards the middle line, the ureters lie very superficially, and as they are loosely attached to the underlying parts, they can be easily grasped with a pair of forceps. After having run a distance of two-fourths of an inch, they perforate the mucous membrane with a slit-like opening, the size of a small pin's head, or to speak more accurately, of a size corresponding to No. 3 to 8 (Charrière).

But it is not sufficient for the ureters to find an exit in the bladder; they have to take a very firm root there.

This they do in the following way: some of their muscles pass transversely across the fundus to meet in the middle line the same muscular fibres from the opposite ureters, forming with them a bar or band (from *b* to *b*) to which some anatomists have given the name of "*Ligam. interuretericum*." Other portions of the muscles

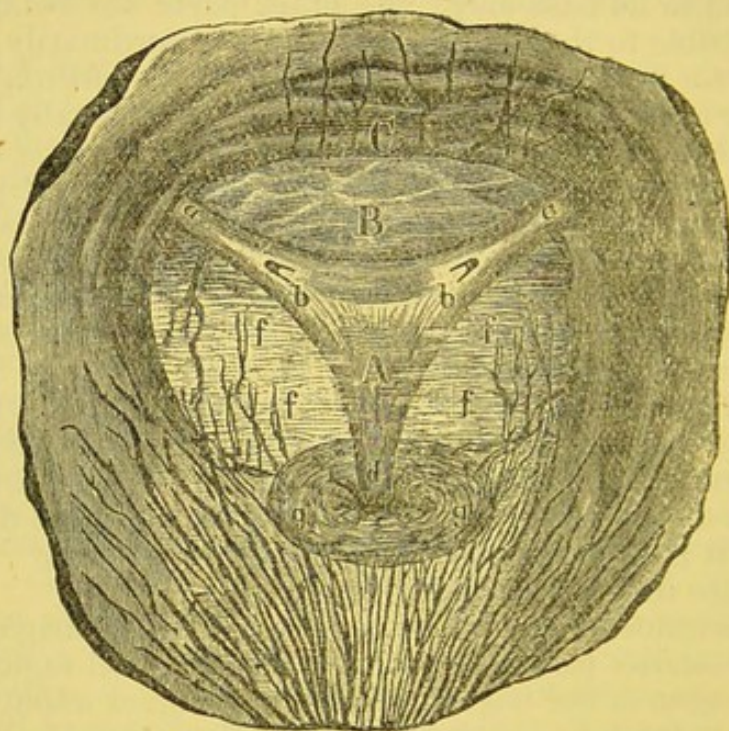


FIG. 2.

of the ureters under the name of "*Bell's muscles*" pass forward towards the vesical orifice of the urethra, and in the urethral orifice they approach each other very closely and unite, forming the uvula (*d*), after which they run together through the orifice to the veru montanum where they become inserted.

In this way, by the continuation of the muscles of the ureters from each side towards the middle line, and to the front towards the vesical orifice of the urethra a triangle is formed, the "*trigone*" which, with the mucous membrane very firmly attached to it, presents a smooth and shining surface. That the trigone is really formed by the muscles of the ureters can easily be made out by dissecting the parts, and is, as Luschka¹⁶ observes, proved by the fact that in cases of congenital defect of one kidney and its ureter the half of the trigone, corresponding to the defect, is absent.

In the structures underneath, the trigone finds a ground firm enough to get safely implanted. This part under the trigone is a strong whitish looking membrane, broader behind, towards the base of the trigone, but smaller in front, towards the vesical orifice of the urethra; it consists of closely packed, unstriped muscular fibres with some elastic and very little conjunctive tissue. In the larger (posterior) portion of this muscular membrane (at *f, f, f, f*) the fibres mostly follow a transverse direction, whereas more anteriorly, towards the vesical orifice of the urethra, they are decidedly circular (*g, g*). The latter fibres, the "*Planum circulare ostii urethralis*" (Barkow) blend in front with the *M. sphincter prostatæ int.*, forming together with this stratum the *M. sphincter vesicæ int.*, which muscle extends into the prostatic urethra as far as the *veru montanum*, and advances only for a quarter of an inch into the interior of the bladder. I do not think it right to include also the fibres behind (*f, f, f, f*) in the name of *sphincter vesicæ int.*, as they are not at all circular, and as in that region which is comparatively distant from the urethral orifice they cannot in any way contribute to the closure of that orifice. The principal function of these fibres which Barkow¹⁶ has called "*Planum uretericum*" is evidently to serve as a firm base for the insertion of the muscles of the ureters. As we have seen, some of these muscles cross over to the middle line, and others pass forward towards the urethral orifice. It is, indeed, difficult to conceive how the ureteric openings could have been better fixed, and could have found in the bladder a better locality for the unimpeded entrance of the urine. No spot in the bladder is less disturbed, and owing to the action of its closely united muscles, it always keeps the same dimensions, whether the bladder is empty or full.

I have now to speak of the relations of the ureteric openings to each other and to the urethral orifice. The distance between the two ureteric openings is usually one inch in the empty bladder. The distance of the middle of the interureteric ligament from the opening of the urethra measures seven-eighths of an inch, but may vary between one-half and one and three-quarter inches. I attach, however, very little importance to these measurements, and especially to the measurements made in distended bladders, for which the average distance of the ureteric openings from each other is given as one and a half inches. Some time ago, I measured more than 150 of such bladders, but gave it up when I noticed one day that, immediately after the bladder had been removed, the interureteric ligament became elongated, and the distance between the two openings was increased under my eyes. I am, therefore, obliged to look upon the difference of the measurements made on bladders, not even in situ, as due to post-mortem changes. We shall see, later, that even the measurements I gave for the empty bladder must also be somewhat corrected by what we find in the living subject, and that in the full bladder the ureteric openings are much less distant from each other than one and a half inches. Luschka¹⁷ has shrewdly foreseen this when he says that in the bladder, when it is full, the

openings are no further separated so that the urine at all times finds an easy entrance from the ureters into the bladder.

Some of the transverse muscular fibres coming from the body of the bladder are attached to the under surface of the muscular layer consisting, as we have seen, of the *Planum uretericum* and the *Planum circularē ostii urethralis*. Beneath these transverse fibres we see the longitudinal fibres which descend from the apex of the bladder, and pass between the third (or middle) lobe of the prostate and the *M. sphincter vesicæ int.*, to which muscle they become connected. This longitudinal layer is the principal and most direct antagonist of the *sphincter vesicæ int.*; its action according to Kohlrausch¹⁸ is to open the *sphincter vesicæ int.*, "in the same way as we with our fingers open a purse closed by a string."

This last muscular layer is covered by the folds which the pelvic fascia, under the name of "recto-vesical fascia," sends down between the rectum and bladder. The recto-vesical fascia at this locality, between the seminal glands and ducts, is moreover strengthened by some unstriated muscular tissue, the "*M. compressor vesiculæ and ductus seminis*" of Ellis.

Considering the strong attachments of the trigone to the parts beneath it, viz., the seminal organs and the rectum, it is difficult to believe this region undergoes, when the bladder is full, the changes of situation described by some authors. I shall on the contrary try to prove, further on, that the region of the trigone and the whole fundus do not alter their position during distension of the bladder, but it is the upper parts of this organ which change their situation. I am, however, far from denying that the fundus undergoes a great alteration in its position by the accumulation of fæcal matters in the rectum and by the passage of these matters during defæcation.

2. The part of the bladder wall which I have called "*Regio post-trigonalis*"* (B in fig. 2) occupies about one-third of the fundus, and reaches from the ureteric ridge to the bundle of muscular fibres presently to be described.

The post-trigonal region differs in some ways from the other parts of the bladder. It is loosely covered by mucous membrane, and as Guthrie¹⁹ has stated, is one of the thinnest parts of the organ. Indeed, it contains comparatively little muscular tissue, and the most superficial of the various muscular layers constituting the body of the bladder, the submucous layer, is here almost entirely absent, while also the transverse layer in this region is represented solely by thin and small bundles. Only at the posterior border, the transverse fibres are collected into a thicker bundle (C) which by its size strongly contrasts with the small bundles in front, thus making a very distinct boundary for the

* This name of "*Regio post-trigonalis*" is not a new name, and Macalister²⁰ has already used the name of "post-trigonal pouch." Before him it has been employed by various English writers when they wanted to designate this particular region as the seat of pathological changes. Waldeyer²¹ calls it "*Regio retro-ureterica*."

post-trigonal region. This is the place where the fundus terminates, and the corpus vesicæ commences, the latter ascending from below, and forming the posterior wall of the bladder. I have found this prominent bundle which is more distinct after the mucous membrane has been removed constantly present in all subjects, and even in children; it courses forward, and passes just outside and over each of the ureteric valves, surrounding the post-trigonal region behind and at its sides. Thus, with the prominent ureteric ridge in front, the post-trigonal region presents itself as a valley of an oval shape with the long diameter in a transverse, and the short diameter in the antero-posterior direction. The former diameter is one and three-quarter inches long, the antero-posterior diameter measures half an inch.

The sub-mucous and transverse layers being so little developed, the wall of the post-trigonal region consists principally of the longitudinal fibres descending from the apex of the bladder. This, the most external layer, is covered by the recto-vesical fascia which at this spot is not usually duplicated, but as a single layer it is very firm and strong.

The peritoneum between the fundus of the bladder and the rectum usually reaches only a short distance behind the post-trigonal region. Cruveilhier²² and others have given it as their opinion that the peritoneum dips down as low as the base of the prostate; but this is certainly quite exceptional, and in dissecting the organs, after they have been removed from the body, or on examining them in a pelvis sawn in half, we can distinctly see that the fundus vesicæ and the rectum are almost always attached to each other by more or less dense cellular tissue.

CHAPTER III.

THE INSTRUMENTS.

I AM convinced that for anyone wishing to learn the introduction of instruments into the urinary organs of living subjects it is absolutely necessary to practise first on dead bodies; otherwise he will never become sufficiently acquainted with the topography of these difficult organs. It may be objected that the organs after death are altered in their position. There is some truth in this objection, but it does not diminish the value of the practice on dead bodies, and I shall now point out the differences in the position of the dead and living organs.

There are two instruments, viz.:—

A. The ordinary catheter with its long curve (*cathéter curviligne*), and

B. The catheter with the abrupt and short beak (*cathéter coudé*)

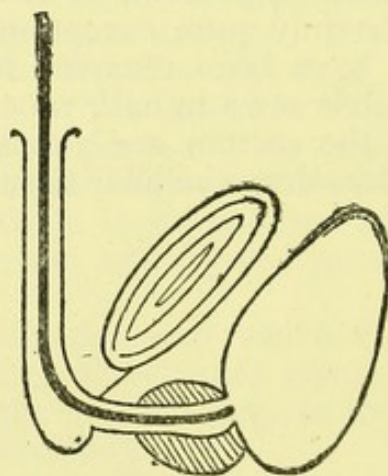


FIG. 3.

on which I must make some comments, and call attention to their position in their passage from the urethra to the bladder.

If on the dead body, lying in a horizontal posture, we introduce an ordinary metal catheter into the urethra, holding the shaft at first horizontal and parallel to the abdominal wall, and then pass it along the urethra, at the same time bringing the handle away from the abdomen, we shall find the point of the instrument has already reached the bladder, when the shaft has been brought into the vertical position (fig. 3); after this we need only depress the shaft a little, if we wish to introduce the beak of the catheter further into the bladder. Thus, with one movement the point of an ordinary catheter reaches the bladder; the second movement, viz., the depression of the handle would be impossible, if the point of the catheter were not free in that organ. I must, therefore,

contradict Dittel,²³ Gueterbock,²⁴ Delefosse²⁵ and Gross,²⁶ when they say that, with the shaft in the vertical line, the point of an ordinary catheter has only arrived in the membranous urethra. I well know that in the dead body the membranous and prostatic urethra are often shorter, lower down and nearer the perinæum than in the living subject, but my observations were made on dead bodies, before the abdomen was opened, while rigor mortis was present, when the parts are usually not much altered in their position. If under these circumstances the point of an ordinary catheter, when the shaft is quite vertical, projects into the bladder, then we may assume that in the living subject the ordinary catheter, the beak of which measures $2\frac{5}{8}$ inches, is long enough to reach the vesical orifice of the urethra, when the shaft is in the vertical line. If we reckon the length of the prostatic urethra as $1\frac{1}{4}$ inches, that of the membranous urethra as $\frac{3}{4}$ inch, and the length of the scrotal urethra, as far as it lies below the pubic symphysis, as $\frac{3}{8}$ inch, then $2\frac{5}{8}$ inches ought to be long enough for the beak to be in the bladder. We can prove this by the following experiment. Let us pass an ordinary catheter into the urethra, and on bringing the shaft to the vertical position, it will be found that the urine can with a syringe be sucked out of the bladder. We also find this in our operations for lithotomy from the perinæum, when we instruct the assistant to hold the staff quite straight; if in this position the beak of the staff, which has the same length as the ordinary catheter, were not in the bladder, we could not reach this organ with our knife, and would do irreparable damage in front of the vesical orifice of the urethra.

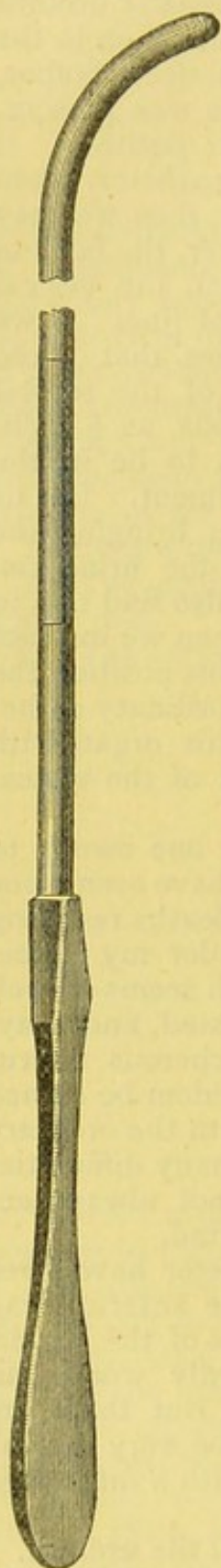
But although it seems such a simple affair with one sweep to introduce the ordinary catheter into the bladder, I have seen some very good surgeons not succeed with it, and many deaths resulting from false passages made by others have come under my notice. The ordinary catheter with its gradual curve which seems so well adapted to the urethra is not to be implicitly trusted, and may, owing to the length of its beak, prove rather a treacherous instrument; once it has entered a false passage, it can seldom be turned into the right path again. We must be prepared with the ordinary catheter to meet, in the normal urethra, almost as many difficulties as we do with the coudé, and although these are not always encountered, nevertheless we ought to bear them in mind.

Some obstructions to the free passage of the catheter have been mentioned by various writers, viz., the valves at the anterior wall of the pendulous urethra, or sometimes the openings of the lacunæ Morgagni; these obstructions, however, are hardly worth our attention, they are easily noticed and avoided. But there are three localities in the urethra where we have to be very careful, and where with a metal instrument we may meet with a difficulty.

These localities are:—

1. The commencement of the membranous part of the urethra.
2. The upper (ventral) wall of the prostatic urethra; and
3. The lower (rectal) wall of the prostatic urethra behind the veru montanum.

As these difficulties are more frequently found when using the coudé catheter, I shall endeavour to explain them especially with the help of this instrument.



The coudé catheter which I used for these investigations on the dead body has a beak of $\frac{5}{8}$ inch; its shaft is $8\frac{1}{2}$ inches long; the angle which the beak makes with the shaft is 125 degrees; the thickness of the instrument corresponds to No. 16 (Charrière). A solid sound of the same shape and length may be used as well (fig. 4).

Considering the shortness of the beak, and comparing it with the beak of the ordinary catheter which is two inches longer, we must, when we hold the shaft in a vertical direction, expect to see the point of the beak of the coudé catheter two inches less advanced in the urethra than the beak of the ordinary catheter.

If on the dead body, with the pelvis horizontal, we pass a coudé catheter of the above description into the urethra so that the shaft becomes perfectly vertical, we find that the point of the beak has only arrived in the membranous part of the urethra, and here has only advanced $\frac{1}{4}$ inch. I mentioned above, in the same position of the shaft, the point of the beak of the ordinary catheter has already reached the bladder (figs. 3 and 5).

The beak of the coudé catheter having entered $\frac{1}{4}$ inch into the membranous urethra has already passed the first obstruction, viz., the difficulty which the bulbous part of the urethra offers to the progress of the instrument. But if we have not been careful, if we have omitted to pull the penis well over the catheter while we were passing it, and especially if after we have brought the instrument into the vertical line we allow the staff to sink down from this position, we lose our way, and the beak sinking lower and lower gets into the bulbous part of the urethra where it may work great havoc. We are, however, able to find out our mistake by feeling with the index finger of the other hand the point of the beak low down on the perinæum, and after having passed the finger into the rectum we feel the point of the beak more or less distant from the subpubic ligament, and sometimes even quite close to the anterior border of the anus, whereas it should be immediately below the subpubic ligament and at a distance of about two inches from the anal border.

The danger of losing our way in the neighbourhood of the bulbous urethra is even greater with the ordinary catheter. The point of this instrument should, as

FIG. 4.

I have already mentioned, reach the membranous urethra long before the shaft is vertical. Consequently, we must on the least suspicion of a difficulty feel with the finger on the perinæum whether the beak has penetrated beyond the inferior border of the scrotum, and gone down in the direction of the anus, or has, as it should have done, advanced horizontally towards the cavity of the pelvis.

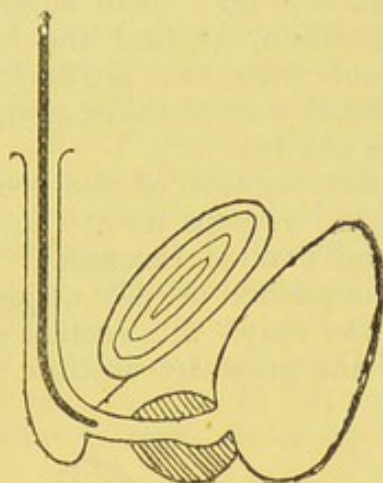


FIG. 5.

Returning to the coudé catheter which we have left with the shaft vertical, $\frac{1}{4}$ inch of the beak having passed into the membranous urethra, we have thereby carried out the first movement. Now, if we want to advance further, we must execute the second movement by which the shaft is brought down from the vertical position into a more horizontal one (fig. 6), and moved nearer the legs of the subject.

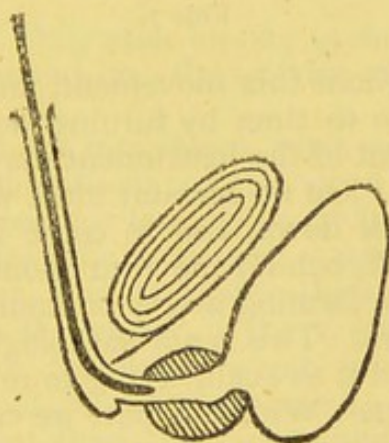


FIG. 6.

With this movement the point of the catheter is brought into contact with the upper wall of the urethra, and, at the same time, the beak penetrates more or less deeply into the prostatic part of the canal.

Now, if we depress the shaft too much, we may meet with the second obstruction, *i.e.*, we may strike the upper (ventral) wall of

the prostatic urethra, and lift up the whole gland with the point of the instrument.

When we have thus carried the second movement too far, we notice the instrument does not advance. Here, however, a rectal examination does not help us much, as we find the shaft in its proper place, *i.e.*, in the membranous urethra; the point of the instrument cannot be felt, and yet the catheter has not reached the bladder. If a dissection on a dead subject is made, with the catheter left in this position, we find the instrument, instead of lying loosely in contact with the prostatic urethra, is pressed against the upper (ventral) wall of that canal, and raises the whole prostate into the pelvic cavity.

The contact with the upper wall of the prostatic urethra should be very slight, and should remain so at the time when the third movement is begun and carried through. With this movement (fig. 7) the instrument is pushed deeper along the urethra so that the point of the beak may reach the vesical orifice. The contact with the upper wall of the prostatic urethra, although slight, must

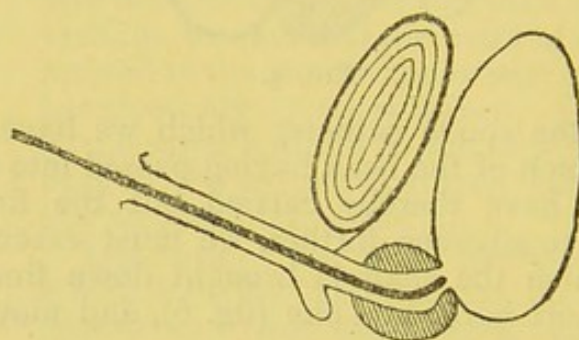


FIG. 7.

be maintained throughout this movement, and we must even emphasize this from time to time by turning down the shaft a little more, so that the point of the instrument may not miss the vesical orifice of the urethra. On no account must we allow the point of the instrument to sink down, and to come into contact with the lower wall. This wall, behind the *veru montanum*, in some cases rises sharply upwards, forming a very pronounced angle in the floor of the prostatic urethra. This is not pathological, although Mercier has taken and treated it as such, trying to remove it by operations with disastrous results. With this part we can easily collide, may impale it with the point of the instrument; persisting in our faulty manœuvre we may tear it, causing a false passage. There is no need for introducing our finger into the rectum, in order to find this out: with the finger pressing outside on the perinæum we can follow the shaft of the catheter to an unexpectedly long distance inside the pelvis; for further proof passing the finger into the rectum we feel the shaft lying along the floor of the prostatic urethra, deep in the pelvis and in close contact with the prominent posterior portion of the prostate. In order to get out of this wrong

position, we must withdraw the instrument, and depress the shaft so that the point enters the vesical opening of the urethra.

In using the ordinary catheter, unless we keep its point in contact with the upper wall of the prostate, we are equally likely to meet with this, the third obstruction, viz., the lower wall of the prostatic urethra behind the *veru montanum*. It must, however, be admitted that the upper wall of the prostatic urethra hardly presents any impediment to the progress of the ordinary catheter: the slight curve of that instrument fits that wall much better than the more abrupt beak of the *coudé* catheter.

Thus we have seen this instrument advance as far as the vesical orifice of the urethra. From observations on the dead body we might judge that this is about all what is required for introducing the *coudé* catheter into the bladder. But the three movements I have described are certainly not sufficient in living individuals; they enable us to introduce only the point of this instrument a little way through the vesical orifice; there still remains a fourth movement, in order to bring the entire beak into the bladder.

This movement (shown in fig. 8) of depressing the handle elevates the beak so that it rises above the ridge at the vesical

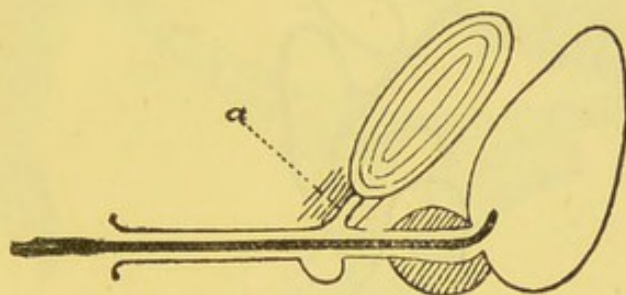


FIG. 8.

orifice of the bladder. Only after having performed this movement we can push the instrument into the interior of the bladder without doing any injury.

I shall again refer to this movement, when explaining the passage of the *coudé* catheter on patients; on the dead subject, even during *rigor mortis*, the movement is less distinctly indicated.

We may now consider how it is that a perfectly straight metal sound or *coudé* catheter, also straight in the shaft, is able to enter the bladder in spite of the curve of the urethra. If it were the suspensory ligament of the penis which alone maintained that curve, the question could be easily answered. But it is much less the suspensory ligament than the firm connection of the scrotal part of the urethra with the underlying structures, as Guthrie insists, which renders that curve almost immutable. What happens during the introduction of the straight instrument is the following: after the instrument has passed the curve, we cause, in moving the shaft away from the abdominal wall, the urethra to be bent in front of its attachment, and an acute angle to be formed at the upper wall of the canal, whilst its lower wall is depressed by the instrument. I have tried to represent this in fig. 8 at *a*.

Having introduced the coudé catheter into the empty bladder we proceed to the exploration of this organ.

The coudé catheter, with its beak $\frac{1}{8}$ inch long, can in the empty bladder easily be turned to either side of the fundus, and freely moved in every direction.

If we turn the beak of the catheter sideways so that it lies transversally, with its point directed to the right, at the same time keeping the shaft horizontal and in the middle line, and in this position of the instrument we now try to pull it out of the bladder, we find we are soon arrested in our movement coming towards the vesical orifice of the urethra; the beak of the instrument has encountered an obstacle on the right side of the vesical orifice of the urethra, the elbow of the instrument lying in the vesical orifice of the urethra. I must say that this is a movement which only succeeds in the dead body; in the living subject, with healthy

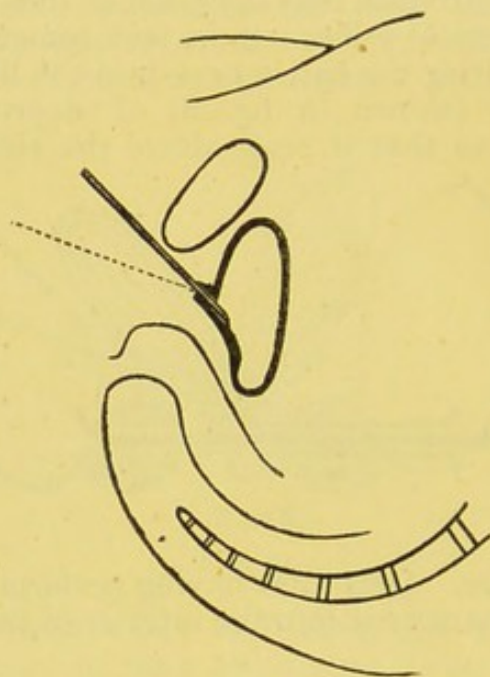


FIG. 9.

urinary organs, the vesical orifice of the urethra is not thus quietly distended by the elbow of the coudé catheter. But even in the dead body, and with the shaft in the horizontal position, there is some difficulty in retaining the instrument in the bladder; especially with the slightest elevation of the shaft, the beak slips out of the bladder, and escapes into the prostatic part of the urethra. Still, if we are a little careful, and if we do not pull too hard, we are able to keep the catheter in the bladder, and, at any rate, we may proceed from this point, the neighbourhood of the vesical orifice of the urethra, to the further exploration of the bladder.

For this purpose the shaft of the catheter must be sufficiently raised (fig. 9) so that the beak may come into touch with the fundus. The fundus, as we have seen, presents itself as a plane sloping downwards from before backwards; in the dead body this plane is even more inclined than in the living subject, and for the

beak to come into close contact with it, the shaft must be so much raised, that, in some cases at least, it lies nearly vertical. Thus, with the beak in intimate touch with the region of the trigone, and the point turned to the right, the instrument on being pushed deeper into the bladder is made to glide down upon the smooth surface of that part.

Having thus proceeded a little way into the bladder we push the instrument further along the fundus; we feel the catheter is now passing a rough surface, and it seems to come to an obstruction like a cord drawn across its path over which it passes with a jolting movement. After having crossed this it makes a slight downward movement, and then comes to a stop. It has now reached the posterior boundary of the fundus, and can go no further.

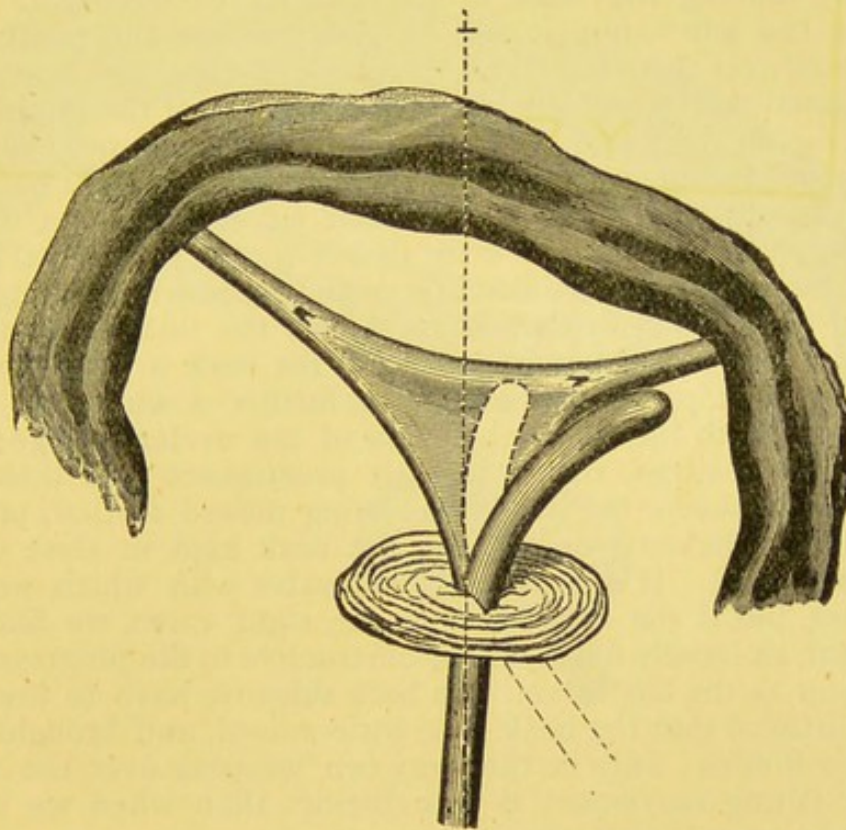


FIG. 10.

After having explored from before backwards the whole extent of the right half of the fundus we may proceed to its left side. We now turn the beak to the left so that it lies quite transversal, and draw the instrument towards the vesical orifice of the urethra till it is arrested by the left side of the orifice, and then, after having raised the shaft sufficiently, make the beak glide down on the region of the trigone, holding the shaft quite in the middle line. But on the left half of the fundus, in our progress towards the deeper parts, we do not find the catheter is passing over an uneven surface, as noticed on the right half; we only feel that after having gone a short distance we are being arrested by some impediment which prevents the instrument from being moved further down.

If now, with the instrument held firmly in its present position, the bladder is opened, we can see what causes the obstruction: as the ureteric ridge is unsymmetrical, and is more towards the right side, the left ureteric valve, being longer, lies nearer the middle line than the right valve. The instrument is pushed against the left valve, and if more force is used, the beak is driven under the loosely attached valve pushing it backwards, and may even tear it (fig. 10).

In order to avoid the left valve, and to produce the same sensation of jolting over a rough surface we experienced with the beak turned to the right, which informed us we were passing over the interureteric ligament, we must alter the position of the beak: first withdrawing it a little we bring the shaft over to the left (fig. 10), thus moving the beak in the bladder to the right. Now, avoiding the left valve, it will be easy to pass the point of the instrument over the left half of the ureteric ridge, and to reach the post-trigonal region and the posterior boundary of the fundus.

If on the dead subject we notice the parts passed over, when the beak of our instrument is investigating the left and right half of the fundus, we can find out how it is that we experience a different sensation on either side. We see that it is only the central part of the ureteric ridge, viz., the interureteric ligament which, being firmly attached to the underlying tissues, allows the instrument to pass over it; it may arrest the movement of the beak a little, but after a momentary stoppage the beak glides further down. We find it is otherwise with the lateral portions of the ureteric ridge: these portions, the valves, owing to their prominence and their loose attachment, prevent the beak from being moved further, provided the shaft is sufficiently raised, and the beak kept in close contact with the fundus. It is usually the left valve with which we come in contact, but if the beak touches the right valve, we find it as prominent, as loosely fixed, and as obstructive to the progress of the instrument as the left valve. On both sides we have to lower the shaft a little so that the beak is a little raised, and brought away from the fundus; only in this way can we pass over the valves, and the jolting movement is less distinct than when we crossed over the interureteric ligament.

Thus, since on either half of the fundus it is immediately to the outside of the ureteric opening that the beak is arrested by the ureteric valve, and just to the inside of the opening the beak moves with a distinct jerk over the ureteric ridge, we are able, before the body and bladder are opened, to find out the exact position and length of the ureteric ridge, of the interureteric ligament and of the ureteric valves. We are thereby further enabled to ascertain, before the body is opened, that in most cases the interureteric ligament is unsymmetrical, as it is drawn over more to the right; in some bodies it is quite symmetrical, and in exceptional cases it is dragged more to the left.

The above statements are denied by G. Simon, who contends that the ridge cannot be made out with the catheter, but I may add that Civiale,²⁷ Dittel²⁸ and others have noted the fact that, in

some cases of hypertrophy of the muscles of the bladder, they could feel the ureteric ridge, and Reliquet²⁹ in describing his method of exploring the bladder remarks that the sound on being drawn from behind forwards may with its beak impinge upon the ureteric cord. However, I can emphatically state that after sufficient practice the ureteric ridge, in the empty normal bladder, can be distinctly felt in every case without exception, in men, women, and children (living or dead) with the coudé catheter. On the dead subject, when the bladder is full, the jolting of the instrument over the interureteric ligament is more distinct than in the empty organ. In the full bladder the valve is not so prominent, so that

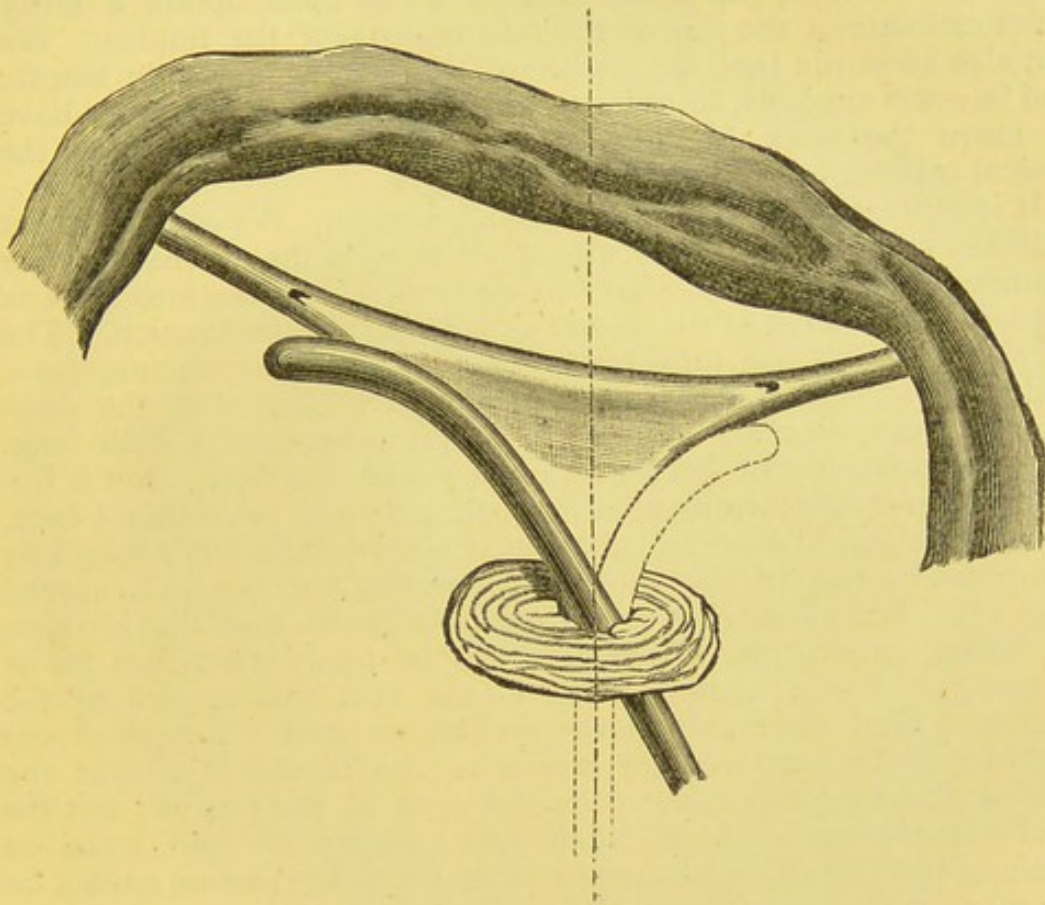


FIG II.

the point of the catheter is not so easily entangled in it, the ureteric openings are more widely separated, the ureteric ridge more stretched, the interureteric ligament flattened, and the jerk which the catheter makes when passing over it can not only be clearly felt, but sometimes the movement can be seen. It should, however, be noticed that in the full distended bladder, with the greater divergence of the ureteric openings and their unsymmetrical position, the part of the interureteric ligament next and inside the ureteric openings which gives rise to the jolting of the catheter has on the right side markedly deviated to that side. For this reason, if we wish to touch exactly the part inside the ureteric opening, we are obliged to use an instrument with a longer

beak, or if we use an instrument with a beak of $\frac{1}{8}$ inch, we must give its beak a different direction, and in moving this beak to the deeper regions of the bladder we must hold the shaft to the left side so that the beak is turned more to the right side (fig. 11).

On the other hand, the left ureteric opening and the portion of the interureteric ligament next to it which gives the distinct jolting are, in the distended bladder, drawn over so much to the centre of the fundus that the beak, with the shaft held exactly in the middle line, touches that part directly, and passes over it with a very distinct jolting movement (fig. 11).

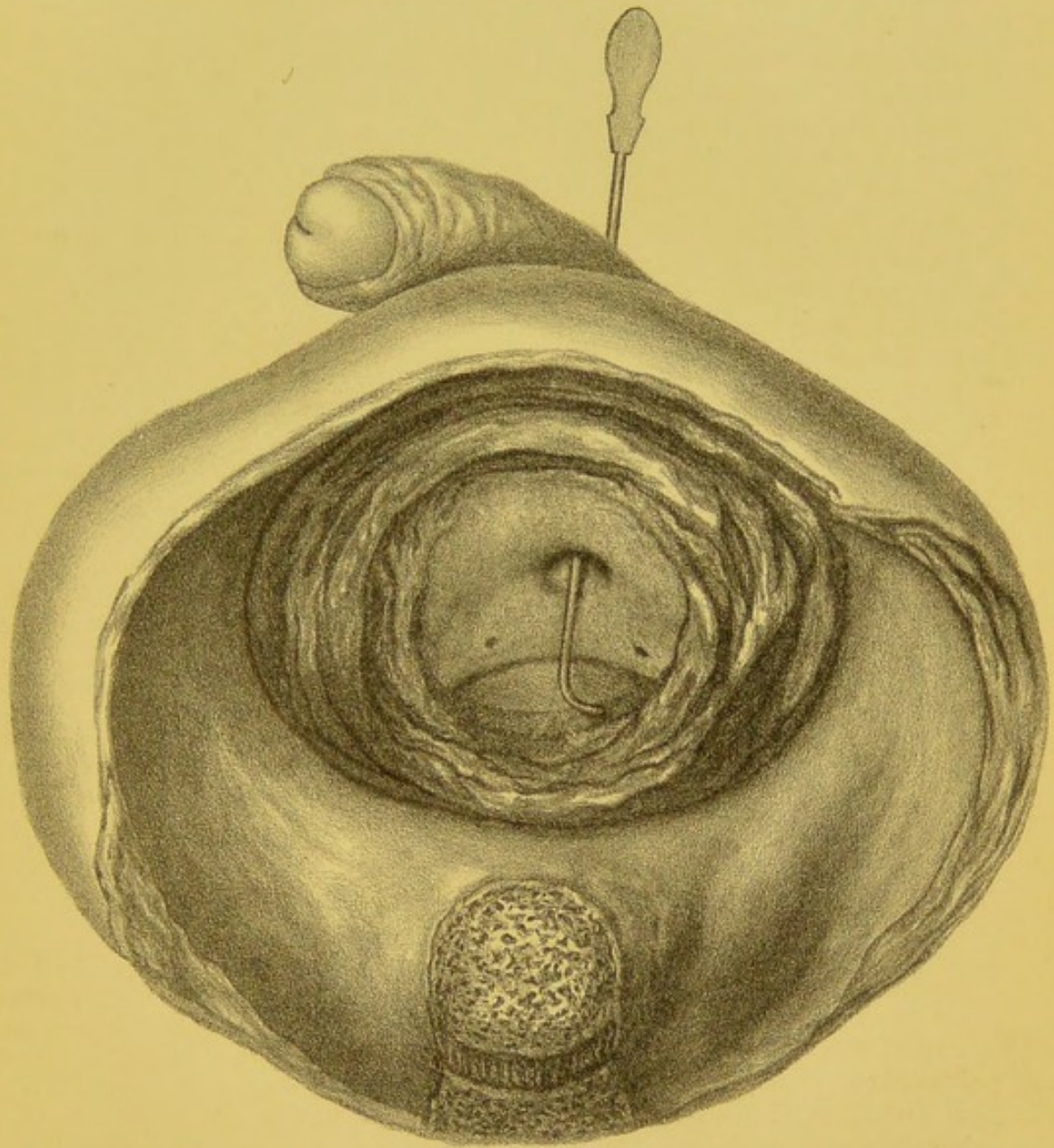
Thus being enabled to ascertain the position of the ureteric ridge we can also, before the bladder is cut open, obtain a fairly exact estimate of the size of the two regions of the fundus. We can also ascertain that the region of the trigone varies in length, and in some subjects, in order to touch the ureteric ridge, we have to move the beak of the catheter a greater distance from the vesical orifice of the urethra than in others.

It is different with the post-trigonal region. We can make out with the catheter how uniformly small it is in the antero-posterior diameter, and how soon, after having passed over the interureteric ligament, we arrive at the posterior boundary of this region. The region of the trigone may vary very much in different subjects—and I have found it between $\frac{1}{2}$ and $1\frac{1}{4}$ inch long—but the post-trigonal region in all subjects is never more than $\frac{1}{4}$ inch long. Using a great deal of force we cannot make the beak, after it has stumbled over the interureteric ligament, advance more than $\frac{1}{4}$ inch, even in the full bladder; further on, it will be definitely stopped by the posterior wall of the bladder, where this wall begins to ascend (fig. 12). Kohlrausch⁹⁰ is wrong, when he states that the bladder, on filling with urine, allows itself to be freely distended in its antero-posterior diameter, if he means that this applies to the fundus. With the finger in the rectum we find the beak of the catheter in its transverse position at the posterior part of the fundus about 1 inch distant from the apex of the coccyx; but the post-trigonal region is so small and inextensible that, even on pushing the catheter with considerable force, the rectum cannot be completely compressed, and the beak of the catheter remains some distance away from the anterior surface of the coccyx. This region is so firm and rigid that in the dead body, where the fundus may be pressed down so much that it appears almost outside the anus, we are absolutely unable, with the beak held in a transverse direction, to break through it.

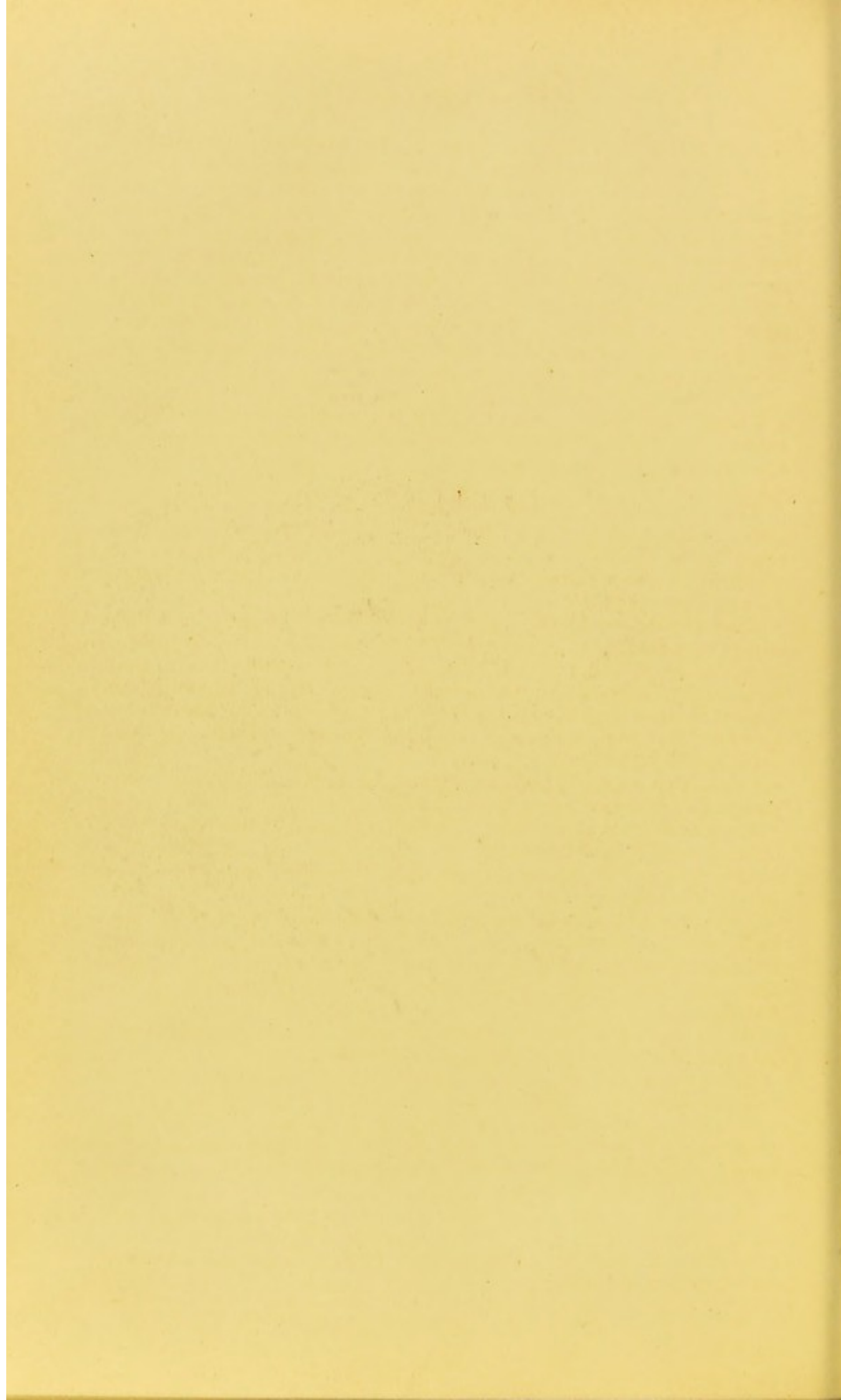
This condition of the post-trigonal region contributes to the steadiness of the ureteric openings. It would, indeed, be strange, if when the urine is filling the bladder the parts immediately behind the ureteric openings could be displaced to the same extent as the body of the bladder. The scarcity of muscles and the strength of fascia in the post-trigonal may explain the rigidity and firmness of this part.

In the transverse direction the fundus is no less remarkable in size than its antero-posterior dimension. We can feel with the

Fig 12.



E. Burgess del.



beak of the catheter that the region of the trigone is very small in its transverse diameter; nor is the post-trigonal region much wider, and its greatest width does not measure more than $1\frac{3}{4}$ or 2 inches. In both regions we very soon strike with the beak against the lateral boundaries of the fundus, and after having opened the bladder we see that the fundus is suspended in a part of the pelvis which in the transverse direction is the narrowest part of this cavity.

Immediately above the fundus the bladder is larger in every direction; but as long as we remain in contact with the fundus, we always find it the smallest part of the bladder in the transverse as well as in the antero-posterior direction.

I shall try to show, further on, that the instrument which I have named the "ureter-forceps" is well adapted to the anatomy of the bladder and the ureteric ridge. I now proceed to explain its use.

The use I make of this instrument is to close for a short time either of the ureteric valves, thus allowing the urine to flow into the bladder through only one ureter at a time. In this way the secretion of either kidney may be separately collected, and tested for any sign of disease.

After several modifications the ureter-forceps (fig. 13, A) I now use is very similar in appearance to a lithotrite; they are, however, lighter in construction and more easily handled than that instrument. Instead of the powerful screw of the lithotrite, my forceps have a small spiral steel spring which keeps the blades together, and they also differ from the lithotrite in allowing the urine to flow through it.

On further examination we notice the ureter-forceps are constructed of two metal tubes, one contained within the other.

Each tube ends in a blade. The outer (female) tube has a hole on each side; this begins at the elbow, and extends down the shaft for $1\frac{3}{8}$ inches; through these holes the urine enters the inner (male) tube (fig. 13, C).

This tube has also on each side a hole, corresponding in size and position to the hole on the outer tube. The urine thus passes from the bladder through the outer tube to the inner tube, and thence it is let out by the side pieces on each side of the handle (*e, e*).

At its upper end the inner tube is quite open, and divided into two leaf-like parts which closely fit the outer tube.

The beak of the instrument is curved to the shaft at an angle of 115 degrees; it consists of two equally thick blades, the curved ends of the two tubes. The posterior blade corresponds to the outer tube; it is $\frac{5}{8}$ inch long; the anterior blade corresponds to the inner tube, and only to one of the leaves into which this tube has been cut; it measures but $\frac{1}{2}$ inch in length.

(In the woodcuts representing the instrument the blades are figured longer than those I now use, and I have found it more convenient to work with forceps with blades shortened to $\frac{5}{8}$ inch and $\frac{1}{2}$ inch respectively).

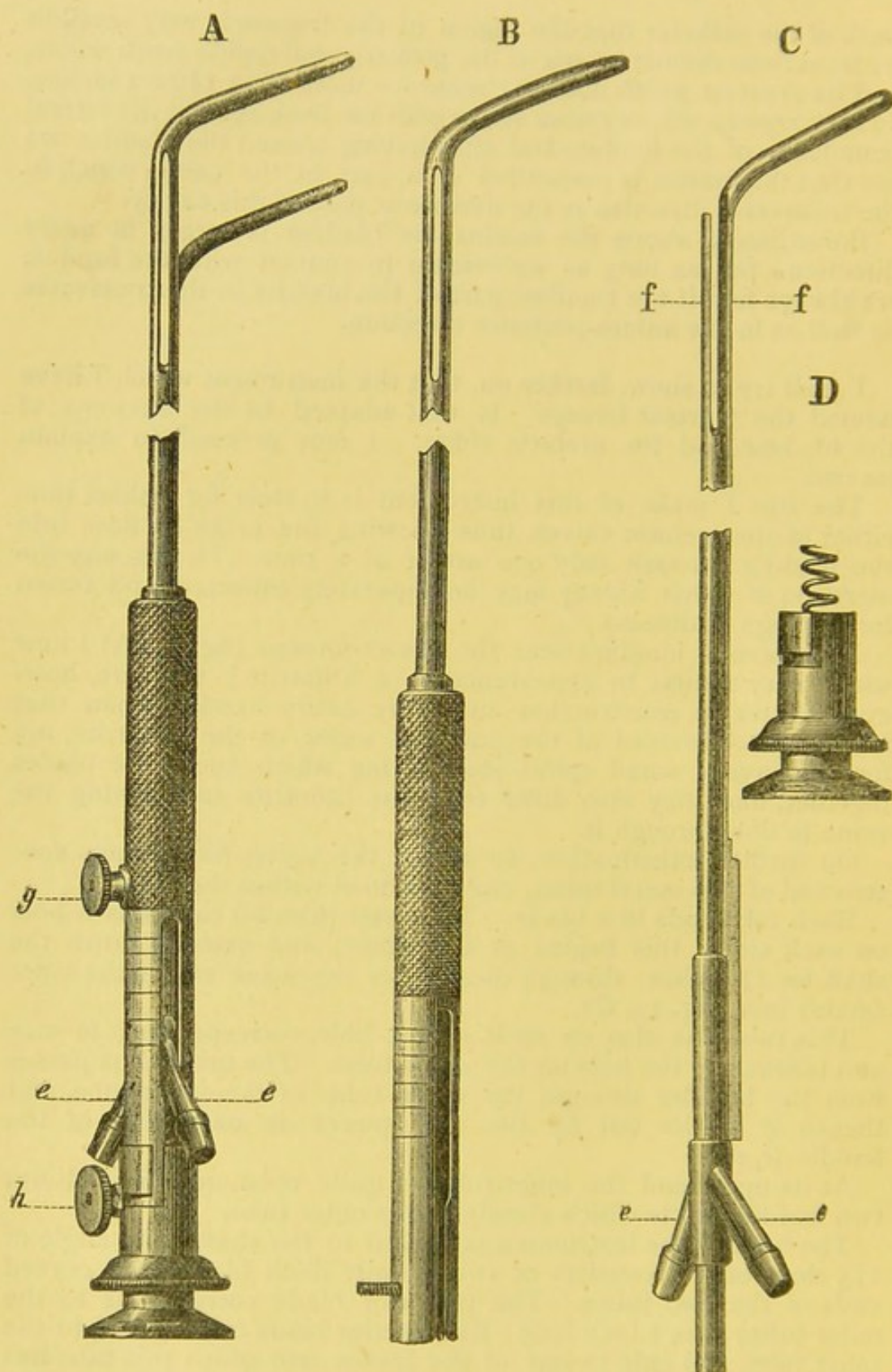


FIG. 13.

The two blades are blunt at their sides and points, and the interior surface is flat, but slightly serrated.

When the two blades are completely drawn apart, their inner

surfaces can be separated to a distance of $\frac{1}{2}$ inch, and the blades can be fixed in this distance by the screw "*g*." The shaft is 8 inches long.

The shaft and beak correspond in thickness to No. 19, Charrière.

The handle of the instrument measures $3\frac{1}{2}$ inches in length.

The side-pieces (*e*, *e*) which are the outlets are also used as handles for drawing the blades apart.

The steel spring (*D*) which is enclosed in the handle is very weak, and only strong enough to keep the blades in the position they are brought to, when the handle is moved. The distance between the blades is measured by a scale engraved on the handle.

By loosening the screw (*h*) the spring may be removed, and the whole instrument taken to pieces to be washed and disinfected.

The instrument I use is made of German silver.*

On the dead body the ureter-forceps can be used in the following way. Suppose we intend to close the right ureteric valve.

After having introduced the instrument into the empty bladder we draw the two blades apart to their greatest distance ($\frac{1}{2}$ inch), and make them fast with the screw "*g*." We then turn the blades to the right side of the bladder so that they are quite transverse, and after that draw the instrument towards the vesical orifice of the urethra till the anterior blade is arrested by the circumference of the orifice. Now, by rotating the handle, we turn the points of the blades downwards, and the handle is then lifted up sufficiently to make the points of the two blades touch the fundus of the bladder. In this position the instrument is pushed deeper into the cavity of the organ till the posterior blade is arrested by the firm, rigid posterior wall of the bladder. If during this movement we have kept the instrument well in contact with the fundus, the ureteric ridge will come to lie between the two blades; owing to the small longitudinal diameter of the post-trigonal region, the two blades, separated $\frac{1}{2}$ inch from each other, cannot both lodge there.

This relation of the blades to the ureteric ridge is more marked, when we perform the next movement which brings the blades sideways and close to the origin of the right ureteric valve. This is done by moving the handle of the instrument as much as possible to the opposite (the left) side till the blades are arrested by the lateral wall of the fundus.

Now the blades have to be brought in closer contact with the fundus. To do this, we still further raise the handle, and press the points of the blades downwards against the fundus.

If in this position (still keeping the handle raised, and to the opposite side of the body) we bring the blades together, we shall find the ureteric valve closed by them.

It will be noticed that during all these manœuvres with the ureter-forceps I have not shown how to ascertain the exact position of the ureteric valve. To do this, and to feel the valve before and during these manœuvres is, indeed, quite unnecessary; the

* Messrs. Krohne and Sesemann, 8 Duke Street, Manchester Square, have made the instrument for me.

ureter-forceps is so constructed that the valve is seized by it without any searching at all.

The details with woodcuts given in Chapter VI. will help to explain the several acts which I have just described, but I may observe that on the dead body it is more difficult to lay hold of the ureteric valve than on the living subject. A much distended bladder cannot be used for such experiments, and even an empty bladder presents greater difficulties than during life. After death the empty bladder is not so well supported, and does not offer so much resistance as during life. Besides, the comparative shortness of the right ureteric valve is an unfavourable circumstance; and in every case, after having opened the bladder, we find that the collapse of the posterior wall deprives us of the help it would otherwise have given us in keeping the instrument steady. In other cases, when the instrument is brought with some force against the vesical orifice of the urethra, the widely opened orifice allows the anterior blade to slip into the prostatic urethra, an accident which I believe is impossible on the living subject. But, with all these drawbacks, after a few trials the experiments on the dead body will be quite successful.

CHAPTER IV.

THE EXPLORATION OF THE URETHRA AND BLADDER ON MYSELF.

I BEGAN these explorations on myself by introducing, every other day, an elastic, olive-headed bougie No. 15 (Charrière) into my urethra and bladder. As this instrument passed through the urethra, it caused different sensations to be felt in the anterior and posterior portions of the canal.

On introducing the bougie the first time, I felt an unpleasant pricking pain which was particularly noticeable, while the bougie was passing through the anterior five inches of the urethra. After it had passed deeper, this pricking pain subsided a little, to be followed in the deeper portion of the canal by another sensation, viz., a very strong desire to make water, a desire which grew painfully intense, when seven inches of the bougie had passed into the urethra, the penis being pulled over the instrument to a moderate extent. This desire to pass water lasted with me as long as the bougie was kept in the bladder; it increased so much that I was quite unable to retain the small quantity of urine I had in my bladder (I had passed water half an hour before), and several drops of urine escaped between the bougie and the wall of the urethra. I was unable to bear this longer than one minute, and had to withdraw the instrument.

On manœuvring the bougie the seat of the various sensations could be fairly accurately made out. The desire to pass water lasted only as long as the bougie remained in the deeper parts of the urethra, and on further withdrawing the instrument, this sensation entirely disappeared; only a slight burning pain was felt in the anterior portion of the canal, as the bougie passed along this part; this lasted a few minutes, and then went off.

On introducing a catheter for the first time into a patient's bladder, we shall probably produce similar sensations on him, *i.e.*, a pricking pain in the anterior portions of the urethra, and a strong desire to make water when the instrument is passed deeper.

However, to continue: two hours after I had withdrawn the bougie, when passing water, I felt a severe cutting pain in the urethra; this lasted for a few minutes, after I had emptied my bladder, and then gradually subsided. Large quantities of water which I drank helped to relieve that unpleasant pain felt during micturition; but whenever I omitted to drink a good amount of water, the concentrated urine caused the pains to reappear with almost the same intensity as before. After drinking large quantities of water we are obliged to empty our bladder more frequently; but this produces much less discomfort than the passage of con-

centrated urine, although the evacuations in the latter case are less frequent.

After a few days this painful micturition passed off, and I then introduced the bougie again. This time I hardly felt a pricking pain in the anterior portions of the urethra, but in pushing the bougie into the posterior portion of the canal, the desire to pass water was as strong as on the first occasion. I tried to allay this by pushing the bougie further into the bladder, and 11 inches of the instrument were lying in the urinary organs; but this did not help me much. I found that all my efforts to retain the urine in the bladder would be powerless, and I, therefore, withdrew the instrument. I then drank freely large quantities of condensed milk and water, and noticed, after two and a half hours, I could pass my water fairly comfortably.

After passing the bougie, once daily, the pains in the anterior portion of the urethra disappeared; but the desire to make water, when the instrument reached the posterior part of the urethra, was still felt, and only after I had introduced the bougie nine times, could I endure it for several minutes. A half sitting, half lying position I found most comfortable for allaying the irritating feeling of bladder tenesmus.

Before the urinary organs had with me become completely inured to foreign bodies, I began to pass steel instruments on myself. I am, therefore, able to reply to the often asked question, "which instruments are more painful, stiff metal instruments or soft gum instruments," that on myself I certainly found metal instruments produce less discomfort, probably because these instruments can be conducted with greater accuracy: the softer instruments cannot be so easily controlled, their points striking against the walls of the urethra in the curves of the canal. Van Buren and Keyes²¹ have expressed the same opinion on this question.

On myself I used a steel sound, the same shape and calibre as that described in the last chapter; but the beak of the instrument which I used was $\frac{1}{4}$ inch shorter, and so measured only $\frac{3}{8}$ inch in length. I always emptied my bladder before I introduced the instrument:—

Anyone passing a similar metal instrument on himself, who will take the trouble to observe carefully, will find he has to go through the following movements:—

1. I had to push the instrument deeply into my urethra, holding the shaft at first parallel to the abdominal wall, and gradually raising it so that it became vertical, and then passed beyond the vertical line.

2. I had to turn the shaft from the last position into one a little more horizontal, bringing it down the legs.

3. I had to push the instrument further into the urethra, and

4. I had to turn down the shaft again till it became quite horizontal.

Considering the shortness of the beak on the one hand, and the inclination of my pelvis during the introduction of the instrument on the other hand—I was reclining on an easy chair—and compare

it with what we notice in trials on dead bodies, lying in a horizontal position, I am justified in concluding that with the first movement which is partly a pushing, partly a turning movement, the point of the beak reaches the commencement of the membranous urethra. With the second (turning) movement the beak reaches the prostatic urethra, touching its anterior wall with the point. The third (pushing) movement brings the point of the beak into the vesical orifice of the urethra, and with the fourth (turning) movement the entire beak beyond the elbow is brought into the bladder.

I first tried a sitting position, but found half reclining much more convenient for watching the progress of the sound. At any rate, if we occupy the sitting posture, we should not bend forward because with such an increased pelvic inclination the shaft has ultimately to be turned down so much that it is almost out of view. For the same reason it is impossible or, at least, very inconvenient to pass a *coudé* catheter on oneself in the erect posture; in this attitude the last (turning) movement by which the beak of the sound is brought into the bladder cannot be executed, unless we bend forward; but the more we bend forward, the more the outlet of the pelvis with the sound in the urethra moves backwards till at last the distance is too great for carrying out the turning movement; to do that, and to bring the whole beak into the bladder, we should be obliged in this uncomfortable attitude, half standing, half bent forward, to grasp the handle between the thighs from behind, and to bring it up in the direction of our back.

In the next place, I tried to determine the length of my urethra by passing a gum elastic catheter with a hole at its point into my bladder, when this organ was filled with urine. I measured how far the instrument passed, the penis not being drawn over it, before the urine first began to flow, and also noticed the length of the instrument in the urethra, when on withdrawing it the flow of urine stopped. In this way I found my urethra measured six inches. I confirmed this by passing a steel sound into my bladder, and withdrawing it till the beak held transversely touched the lateral circumference of the vesical orifice, and then measured the length of the shaft in the urethra. I thought, at different times, the length of the urethra would vary in the same individual; but I have found the greatest amount of variation not to exceed $\frac{1}{4}$ inch. These methods of measuring the length of the urethra which have been proposed by Civiale appear to be fairly exact.

If we remember the measurement of 6 inches, and pay attention to the movements of the sound, while we pass it through the urethra, and also closely observe the direction of the shaft which by its position indicates the locality touched by the point, we can pretty accurately define the place where the desire to make water is excited. This place has been described by van Buren and Keyes and others to be the membranous urethra, an opinion with which I do not agree; touching or dilating the membranous urethra with an instrument never awakened in me the least desire to pass water. Finger³² maintains that the urine penetrating into the prostatic part of the urethra, and pressing on the walls of this

part stimulates the nerves there, and especially in the region behind the veru montanum to produce the desire to pass water; he asserts that, when the bladder is quite full, the prostatic urethra also contains urine, and forms a part of the bladder so that the urethra would be one inch shorter than when the bladder is empty. Against this theory our daily practice shows that in cases of retention of urine we are obliged to introduce the silver catheter right into the bladder, before the urine flows out of the instrument; the measurements which I have made on myself and on patients likewise refute Finger's opinion. I have always found the urethra equally long, whether the bladder was full or empty.

Charles Bell⁸⁸ declares the spot over the junction of the muscles of the ureters with the inner sphincter of the bladder to be the seat of the desire to micturate. It is, however, difficult to understand why this small spot, at the posterior circumference of the vesical orifice of the urethra, should be the seat of this sensation.

Uffelmann⁸⁴ and others believe that the smooth fibres of the M. sphincter int., owing to their tonic contraction, keep the orifice of the bladder closed; "this muscle when in danger of being overpowered is helped by the striated muscles in front (especially the M. constrictor urethræ) which muscles by their contraction cause us to become conscious of the desire to make water." I do not deny that the striated muscles in the neighbourhood of the membranous urethra effectually help us for a time to retain the urine, when this is required; but it may be doubted whether the desire to micturate is felt only, after the striated muscles of the membranous urethra have begun to contract, and, besides, we cannot induce that specific desire by voluntary contraction of those muscles.

I believe that the inner sphincter (by its nerves) excites the desire to pass water, that under physiological conditions it is the dragging of the M. detrusor vesicæ at the inner sphincter, and under pathological conditions, the spasm of this muscle which is the primary cause of the sensation to pass water; further, that the contraction of the striated muscles in front is only secondary, and in its energy and duration entirely dependent upon the action of the inner sphincter.

Each time when I had introduced the sound into my urethra for $5\frac{3}{4}$ inches (it seldom varied more than $\frac{1}{8}$ inch), and when by the third (pushing) movement I came within reach of the inner sphincter, expanding the muscle by this and the fourth movement, a very strong desire to pass water was started. On my first trials with the sound I distinctly felt the quick and strong contractions which the inner sphincter made on the passage of the sound. I shall presently have to refer to certain things which took place during the time I explored the bladder on myself, and particularly of what happened when I forcibly distended the inner sphincter. After these experiences I have become satisfied that the inner sphincter is the seat and origin of the sensation of micturition.*

* Another question different from the question of sensibility, discussed above,

After having introduced the sound into my bladder I turned its beak so that it was quite transverse, with the point directed to the left side of the bladder. In this position of the beak, and with the shaft a little raised, I pulled the instrument towards the vesical orifice of the urethra with the intention of taking there a firm position, and starting from there to explore the fundus. But after I had in this way moved the instrument towards the vesical orifice, I experienced suddenly a very strong desire to pass water; the beak, as I could see from the movement of the handle, was being turned from the left to the right till the point was looking directly upwards, and then the instrument was quickly ejected from the bladder (fig. 15). Although with my finger on the handle I tried to retain it in its place inside the bladder, the instrument was pushed so far into the urethra that the shaft became nearly ver-

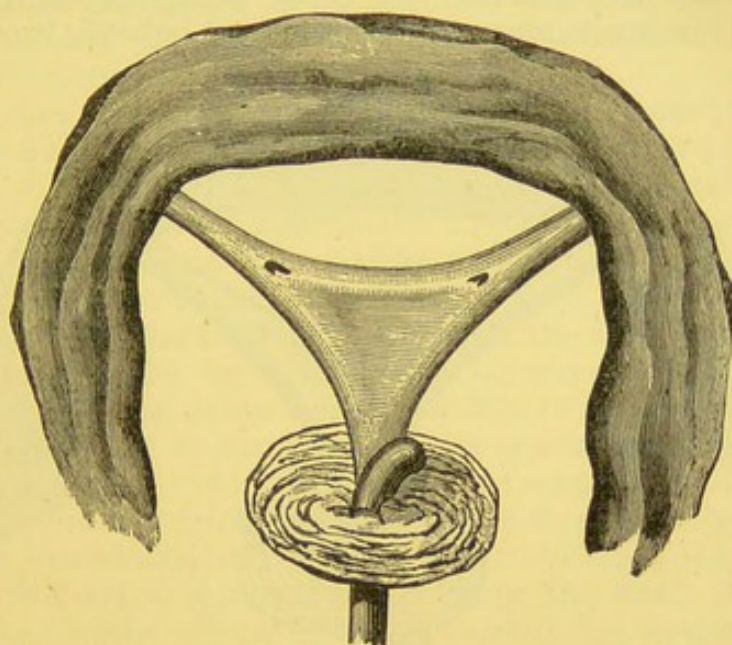


FIG. 15.

tical. Evidently, in pulling the sound forward, I had brought its elbow within reach of the inner sphincter; the muscle being much distended by the elbow of the instrument, its sensory nerves exciting the most intensive feeling of micturition, reacted with a strong contraction against its forcible expansion, and so turned the instrument round, and forced it beyond the *veru montanum*.

I have already pointed out that on the dead body it was not easy to keep the beak in a steady transverse position, whilst it was held against the lateral circumference of the urethra. On living subjects, however, the contractions of the inner sphincter are, at the first trials, so strong that it is either quite impossible, or exceedingly painful to keep the beak in that position for any length of time. Even in moving the sound away from the vesical orifice,

is whether, and how long, the inner sphincter is able to retain the urine in the bladder without the assistance of the striated muscles in front. After experiments on animals little strength has been attributed to the inner sphincter, and even the existence of the muscle has been denied.

and pushing it deeper into the bladder, I could feel how the elbow, as long as it was within reach of the inner sphincter, was being convulsively embraced by that muscle, and how the beak was inclined to be turned round from the transverse position into the vertical direction; it could comfortably be held in the transverse direction, only after it had been pushed deeper into the bladder, and beyond the inner sphincter for $\frac{1}{4}$ inch, beyond that part of it to which Barkow has given the name of *planum circulare ostii urethralis*.

The desire to make water during the introduction of the sound disappears, after the instrument has been passed more often; but the irritation, caused by the elbow stretching the inner sphincter, when the beak is in the transverse position, and is drawn against the vesical orifice, remains, even after repeated trials; several times I could not prevent the urine being expelled from my bladder. This involuntary micturition is, I believe, brought about

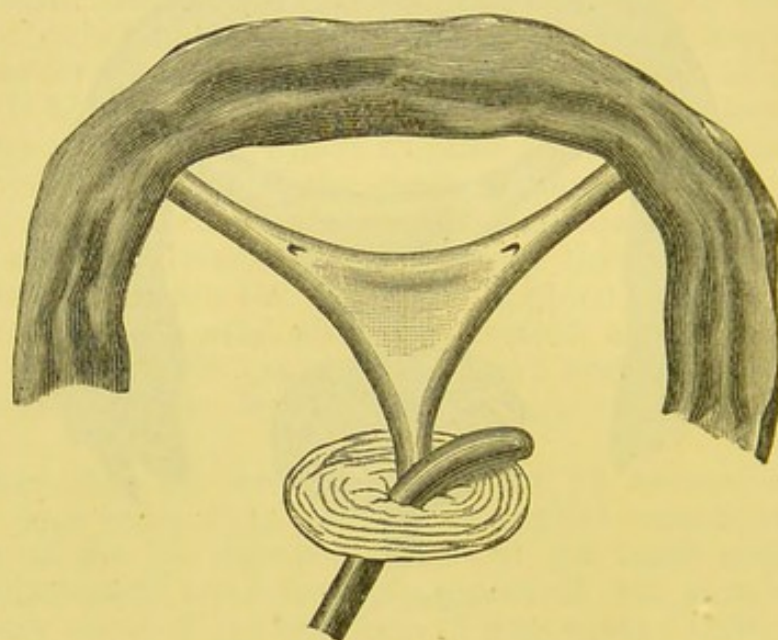


FIG. 16.

by the elbow distending the inner sphincter, and preventing its complete contraction so that the urine can issue through the partially opened orifice.

The following movement makes it possible to avoid this violent action of the sphincter: in drawing the beak of the instrument towards the vesical orifice of the urethra, we depress the handle, and, at the same time, move it towards the opposite side. Thus, if the beak is in the bladder, and its point turned to the left side, we must move the handle downwards and to the right side (fig. 16). In this manner the elbow is kept away from the inner sphincter, and we are able to steady the beak, and to keep a firm position from which we may start our exploration of the deeper regions of the fundus.

To do this, I brought the sound, with its point directed to the left, a trifle deeper into the bladder, then moved the handle back

to the middle line, and lifted it up as much as possible, thus bringing the beak in contact with the fundus. In this systematic way we should carry out our movements, and be careful not to draw the instrument against the vesical orifice of the urethra, before and after we have raised the handle. Only in this way we are able to move the beak safely beyond the *planum circulare ostii urethralis*, to that part of the trigone to which after Barkow I have given the name of *planum uretericum*.

This region has been described as highly sensitive, and I expected to find it so.

I believe, however, that the region in front, viz., the *planum circulare ostii urethralis* which is highly sensitive has been mistaken for the *planum uretericum*. It seems reasonable to suppose that if the whole fundus of the bladder were very sensitive, it would be quite impossible for us to retain urine in the bladder for some hours, and the contraction of the muscles would make micturition a very painful process.

Civiale³⁵ has tried to obtain information on this question by passing his finger over the whole inner surface of the bladder after suprapubic lithotomy, and in cases of vesico-vaginal fistula, by touching the fundus with instruments which he introduced through the fistula into the bladder. After these investigations, Civiale concludes that the bladder, with the exception of the inner orifice of the urethra and its immediate neighbourhood, is not very sensitive, it tolerates the light contact of instruments, and becomes painful only on being pressed upon, or otherwise roughly treated.

I have been able to confirm this statement of Civiale. In testing the sensibility of these parts I did not commence my observations till I no longer felt the urgent desire to pass water when the sound was introduced into the bladder. When I then raised the handle of the sound sufficiently to bring the beak (lying transversely) into contact with the regions behind the vesical orifice of urethra, I hardly felt any pain with the instrument lightly held, but with greater pressure, and while the instrument was passing over the *planum uretericum* and post-trigonal region, I experienced a sensation of heaviness. When I arrived at the posterior boundary of the fundus, I tried to push back this posterior wall of the bladder, and this produced a pricking pain. I also found the ureteric valves rather sensitive under certain conditions: directing the beak more to the side of the fundus, and in this way pushing the valve backwards produced a peculiar pricking, burning pain.

All these sensations diminished, after I had repeatedly touched the parts, and after a time, without undergoing great discomfort, I could bring the beak down upon the fundus with some amount of force; but a certain degree of sensitiveness remained to the last.

Of all the structures the interureteric ligament and the ureteric openings (which are touched when we glide over the ligament) proved themselves only slightly painful, and the closure of the ureteric valve by the ureter-forceps, even the first time, gave me no discomfort.

Before I had introduced the sound into my empty bladder, I

thought the empty organ might contract round the sound, and so greatly impede the movements of the instrument. Statements made by various writers, principally by Reliquet, seemed to justify such apprehensions. Reliquet³⁶ distinctly expresses the opinion that a coudé sound, with a beak of 16 millimetres ($= \frac{5}{8}$ inch) in length, becomes enveloped by the empty bladder so that it cannot be rotated, and turned sideways. I have, however, found quite the contrary, and in the perfectly empty bladder, I could, without the least difficulty, direct the point of the beak either to the left or right side, and in this transverse position move the instrument quite freely from one end of the fundus to the other. Even instruments with longer beaks can quite easily be rotated, and moved about in the empty bladder. The tonic contraction of the detrusor muscle of the bladder appears to be inconsiderable. We observe the same feeble action of the detrusor muscle when we inject liquids into the bladder, and under physiological conditions, when the bladder is being filled with urine. The empty bladder is rather flaccid, and certainly is not contracted as in rigor mortis. I have, however, found that a sound, the beak of which measures more than one inch, cannot be turned about in the empty bladder, and the walls of the organ vary in their extensibility in different parts: the posterior wall, immediately where it begins to ascend into the pelvic cavity, never expands; higher up again the posterior wall is moveable, and by raising the beak it is possible to carry the instrument further into the bladder.

I next proceeded to investigate the length of the antero-posterior diameter of my bladder, and measured the length of shaft in my urethra, when the beak of the sound had reached the posterior boundary of the fundus.

On myself I found the fundus measured 1 inch long. This is, however, only apparent, and nearly $\frac{1}{2}$ inch has to be added to it. We must not forget that the beak, before I moved it away from the position, represented in fig. 16, was not lying quite at the commencement of the fundus, but on account of the great sensibility of the inner sphincter had to be held a short distance away from the vesical orifice of the urethra; the beak was already on the planum uretericum, before I began to move it, and would therefore reach the posterior boundary of the fundus sooner than we should be inclined to expect it. It would also touch the ureteric ridge shortly after we have left the vesical orifice of the urethra.

To find out the peculiarities of the separate portions of the ridge is not at all difficult on the living subject, and provided we remain in contact with the fundus, it is not easy to avoid the ridge.

In the former chapter I have already mentioned how we are enabled to ascertain the distance of the ureteric openings from each other: the beak of the sound, when moved on the fundus into the deeper regions, is arrested by the prominent ureteric valve, and becomes entangled in it, whilst it easily glides over the ureteric ligament. On myself, at first, and as often as I used an instrument with a beak of $\frac{5}{8}$ inch in length, I could not obtain the

jolting sensation which indicates that we are passing over that ligament; after having started from the vesical orifice of the urethra, I soon struck against something which prevented any further downward movement, and over which I only passed when depressing the shaft I loosened the contact of the beak with the fundus. But on using an instrument with a beak shortened to $\frac{3}{8}$ inch, I could easily glide over the interureteric ligament, with a jolting movement, and penetrate as far as the posterior boundary of the fundus.

With this short beak I could pretty accurately define the place outside the ureteric opening where the valve commences its course towards the lateral wall of the bladder: I had only to direct the shaft to the opposite (right) side to get the beak entangled in the left valve.

Thus the left half of the interureteric ligament presented itself as $\frac{3}{8}$ inch long. I found it of the same length on the right side; here also I was obliged to use a sound with a beak of only $\frac{3}{8}$ inch, and I had to keep the shaft of the instrument exactly in the middle line, if I wanted to pass uninterruptedly over the ligament.

In this way it became clear to me that the interureteric ligament in my bladder is perfectly symmetrical with regard to the middle line of the body.

I think it necessary to state here that these investigations on myself were undertaken in 1874, and published soon afterwards.³⁷

In order to obtain more accurate information about some points, I again passed instruments on myself in 1878, and the present description is the result of these last researches; it differs only slightly from the former description.

In 1874 I repeatedly introduced the ureter-forceps into my bladder. Before that time I had not used it on any living subject, and consequently was not very expert in handling it. I was then not cognizant of the various landmarks which now make it easy to close the ureteric valve after very little manœuvring in the bladder. At that time I tried to feel the ureteric ligament with the beak of the ureter-forceps noting its exact situation on the shaft of the instrument; then after having brought the forceps in front of the valve, I pushed the posterior blade backwards depressing the shaft at the same time so that the posterior blade should find its proper place behind the valve. The instrument I used was different in many ways from the present one, and much less handy; its spring was much stronger, and it took considerable force to bring the blades together. Notwithstanding this, I felt no pain, and was in no way inconvenienced by this strong compression of the ureteric valve.

Withdrawing the instrument from the bladder was, however, owing to the sensibility of the inner sphincter, as unpleasant in 1878 as in the years before. On pulling the elbow of the sound through the sphincter, I still became conscious of a very intense desire to pass water, often combined with a feeling of painful contraction so that I looked upon the withdrawal of the instrument as more disagreeable than its introduction.

In the course of time, however, I contrived to remove the instrument from the bladder with less discomfort by the following manœuvre: strongly depressing the handle I very slowly withdrew the instrument, and even tried to hold it back at the moment when the convulsive contractions of the sphincter and the impulse to pass water became too strong.

CHAPTER V.

THE EXPLORATION OF THE URINARY ORGANS ON LIVING SUBJECTS.

I HAVE in a former chapter pointed out the difficulties we meet with on passing catheters on dead bodies. I shall endeavour now to show how to avoid these in living subjects.

The first and chief difficulty we encounter with all instruments is to find the opening of the membranous urethra (immediately below the subpubic ligament) where that canal turns into the pelvic cavity. It is so easy for the point of the instrument to strike against the hard resisting parts above that opening where probably not much harm would be done, but the parts below could be readily injured, even before we turn round.

Let us take first the ordinary catheter. I have shown that the point of the instrument reaches the membranous urethra long before the shaft is vertical; with this inclined position of the shaft, the part of the beak next to the point is in front of the subpubic ligament, and in bringing the shaft to the vertical position the whole beak revolves round this ligament.

I have found the following method useful in introducing an ordinary catheter. As soon as we reach the scrotal part of the urethra, keep the instrument exactly in the middle line, and raise the shaft so that with the point we feel the hard anterior surface of the pubic symphysis, and lower down the resisting surface of the subpubic ligament. As long as we feel these hard structures, we may push down the instrument; but we must remain in slight contact with these structures by raising the shaft more and more. Proceeding slowly in this manner, always raising the shaft before we push, we at last feel the soft opening of the membranous urethra which the instrument now enters.

After that is done, it is better to bring the shaft very slowly into the vertical position; for if the opening of the membranous urethra is missed, the point of the catheter being in contact with the soft structures of the perinæum, a false passage may easily be made.

With my finger in the rectum, and the patient lying horizontally, I have tried to follow the movements of the catheter in the deeper parts of the urethra. I find in thin subjects with the index finger we can reach as far as the base of the prostate, and sometimes even touch a large portion of the fundus vesicæ. In this way we can make out that with the completion of the turning movement which brings the shaft of the catheter into a vertical direction the point has reached and passed through the vesical orifice of the urethra. We can also make out how easily the gradually curved

beak of the ordinary catheter glides along the anterior wall of the membranous and prostatic urethra; but we must keep the beak in contact with the upper wall of these parts, and must not allow the instrument to sink down; otherwise we are likely to impinge upon the the posterior prominent border of the prostatic urethra behind the veru montanum.

The ordinary catheter can only be employed for emptying the bladder; it is a therapeutic instrument, but for the exploration of that organ it is almost entirely useless: its long beak cannot be turned sideways so that it is impossible to examine the fundus with it; the coudé catheter is, however, well adapted to examining the bladder.

On living subjects I have used the coudé catheter of the same shape and size as the sound I passed on myself. The beak, $\frac{3}{8}$ inch long, has one hole in its concavity, and another small one at its point, (fig. 17.) This latter hole allows the instrument to be thoroughly cleansed, and has other uses, as I shall show presently. On the shaft, which is $8\frac{1}{2}$ inches long, are two marks, one being $7\frac{1}{2}$ inches and the other $6\frac{1}{2}$ inches distant from the elbow. Thus, with one glance we can find out how many inches of the shaft are introduced into the urethra; this I find, cannot be done so easily when there are a number of lines engraved on the shaft. The handle is flat, as with such a handle we can accurately notice to which direction the beak is turned. The instrument is made of silver, and I would insist that the silver be hard and well hammered so that the instrument is very strong. I have seen, in some cases of prostatic enlargement, thin silver catheters bend in the urethra, and could be easily broken.

I have found the four movements, detailed in a previous chapter, necessary in every patient for introducing the coudé catheter. The first movement may be emphasized, and the shaft brought down beyond the vertical line, nearer the legs, as in this way we can with the point of the beak quite easily make out the hard structures above the membranous part of the urethra, and gliding along we enter that part of the canal.

By the second (turning) movement the whole beak is made to enter the membranous urethra.

The third movement which is principally pushing—although the shaft has at the same time to be kept turned down to some degree—brings the point of the beak to the vesical orifice of the urethra.

These three movements are exactly the same as on the dead body. In performing these movements, in order not to lose our

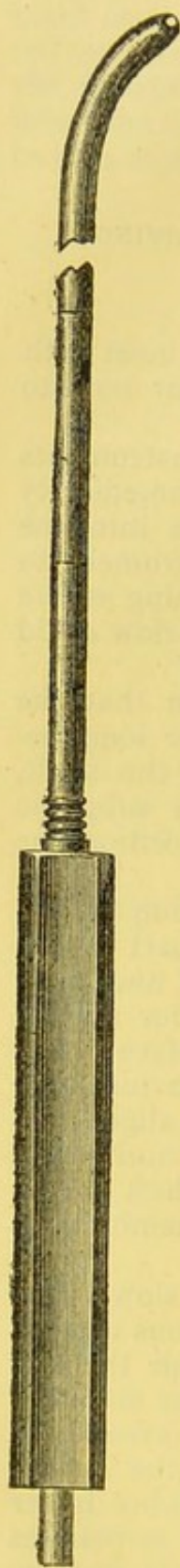


FIG. 17.

way, we should manœuvre in the same manner as on the dead body. So far, practice on the dead body during rigor mortis, with the abdomen not opened, will prove instructive enough and certainly not misleading.

It is, however, different with the fourth movement. This movement which brings the shaft down, and thus lifts the beak into the bladder is not necessary on the dead subject, and particularly after the vesical orifice has been once dilated by instruments; but on the living subject it is of the greatest importance, especially when using instruments with an abrupt and long beak. It has happened to me that when I forgot properly to carry out this movement, I struck the elbow of the catheter against the lower wall of the vesical orifice of the urethra, and on proceeding scraped off the mucous membrane causing the parts to bleed.

In patients, lying horizontally on a couch, we feel, with the finger in the rectum, that (the shaft being vertical) the point of the coudé catheter, the beak of which is $\frac{3}{8}$ inch long, has reached the membranous urethra. But in cases where the pelvis is more inclined forward the surgeon must, with the shaft still vertical, expect to find the point of the beak more or less distant from the opening into the membranous urethra. And as the position of the deep parts of the urethra varies in different individuals, it would be wrong to lay down hard and fast rules as to the extent to which the several pushing and turning movements should be carried out; but the advice may be given to execute all the movements slowly, one after the other, and when one movement is finished, and ceases to help us in our progress, to try another movement.

We have previously noticed how greatly the position of the deep parts of the urethra varies in different individuals with the inclination of the pelvis. This was especially noticeable when using a coudé catheter on patients in the erect position, the degree of pelvic inclination in this position being more variable than when they are lying horizontally. I have found in some patients, standing erect, for the passing of the coudé catheter right into the bladder it is only necessary to lower the handle forty-five degrees out of the vertical, while in others, in the same position, we are obliged to bring the shaft down to a line parallel with the legs. I think, however, in health, this is the utmost to which the handle of such a catheter is to be depressed: when we have to go beyond that line, we should suspect hypertrophy of the third lobe of the prostate or a tumour near the vesical orifice of the urethra. Under such pathological circumstances I have found it necessary to bring the shaft from the line parallel to the legs more or less backwards, and in one case so much backwards that the shaft was nearly ninety degrees away from the legs, and was almost horizontal. The hole at the end of this catheter which permits the urine in the bladder to flow out indicates that we have safely reached the bladder with the point of the instrument, and that we can proceed with the fourth movement which brings the whole beak into the bladder.

Having arrived in the bladder, and after the urine has flown out

through the catheter, we must turn the point sideways, and then draw the instrument towards the vesical orifice of the urethra. Turning the catheter with its point sideways, and drawing it forward is very easy in a completely empty bladder, but the last act of this movement always demands great care. In every case I had to direct the shaft downwards and to the other side (fig. 18), and especially I had to look carefully to the index lines on the shaft, before I lifted up the handle. If whilst we raise the handle, the instrument is drawn against the vesical orifice of the urethra, the elbow and gradually the whole beak will slip through the orifice and into the prostatic part of the urethra; several times under the wrong impression that the instrument was still in the bladder, I moved its beak forwards and backwards in the prostatic urethra injuring the mucous membrane of that part.

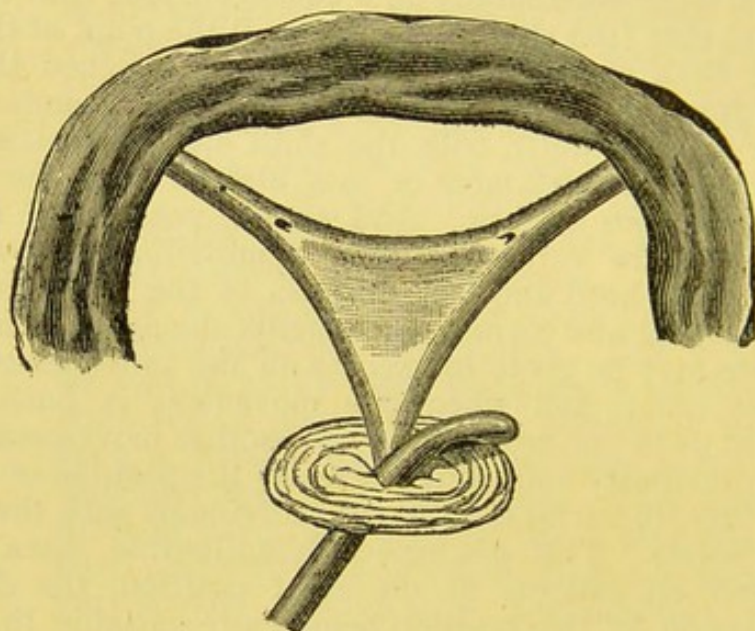


FIG. 18.

On the other hand we must not push the catheter into the bladder, before we lift up the handle, as in this manner we should bring the beak too near and even beyond the interureteric ligament, and would get a wrong estimate of the dimensions of the fundus.

Thus without pulling or pushing the instrument, we must return the handle to the middle line, and lift it up sufficiently to bring the beak into contact with the fundus.

It is of great practical importance to know how far we must lift up the handle of a coudé catheter, in order to bring the beak of the instrument in contact with the fundus, and this I propose to discuss hereafter in a separate chapter.

ON THE POSITION AND DIRECTION OF THE FUNDUS VESICÆ.

I have tried to elucidate the question of the position and direction of the fundus by examining a great number of healthy individuals in the erect posture: they were all standing with their heels, buttocks, shoulder blades, and heads touching the wall, their legs parallel, their feet rotated a little outwards.

In the living subject we can more easily feel the fundus of the bladder. The bladder during life is suspended by the powerful muscular ligament, the Urachus, and supported by the *M. levator ani*; consequently, the fundus presents to the instrument a hard firm surface which is more rigid than after death. This feeling of resistance is, however, not sufficient for us to accurately measure the parts; but the sensation of jolting or jerking which we get when passing over the interureteric ligament can be used as a sure sign that we are in contact with the fundus. If at the same time

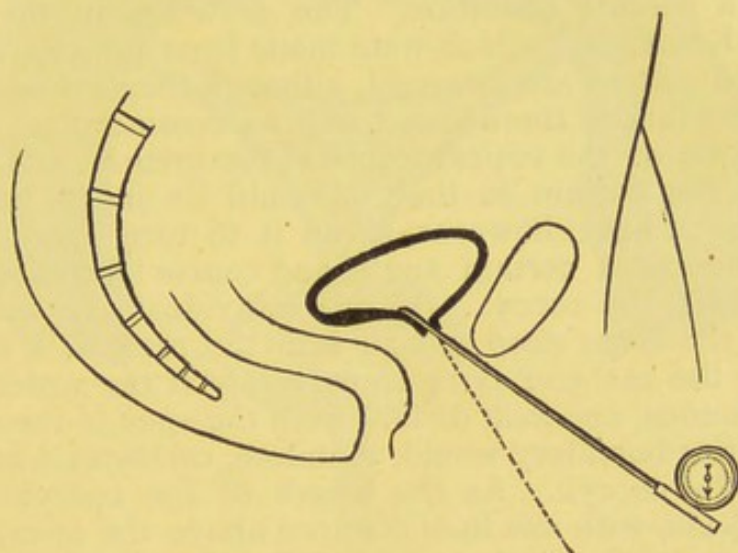


FIG. 19.

we take care to only slightly touch the ligament, it cannot be reasonably objected that the fundus during these explorations is being unduly pressed down by the coudé catheter, and pushed away from its natural position.

For these measurements I have used a coudé catheter, to the handle of which a clinometer was fixed (fig. 19).

According to the varying pelvic inclination I have noticed varying positions of the fundus in different individuals. In some individuals the fundus was nearly horizontal; but in others (standing erect in the same attitude) I have found it in a much more inclined position, and rising in front from the vesical orifice of the urethra upwards and backwards to an angle of forty-five degrees. Between these two extremes all sorts of variations were found.

We might enquire whether there are any other factors besides the pelvic inclination influencing the position of the fundus.

The fundus, when the bladder is quite full, has often been described as lying in a lower position than when the organ is empty. Other surgeons again give a contrary opinion, and affirm that, in the full bladder, the fundus is raised higher up in the pelvis than in the empty bladder.

On examining the fundus in the way detailed above with the clinometer, I have not found any difference in the position of that region, when the bladder contained 10 ounces of urine, or was quite empty.

I do not think either the length, or form of the healthy prostate, or a large quantity of fat accumulated in the pelvis greatly influences the position of the fundus.

But in individuals with very feeble muscular tone or in patients under chloroform, when the muscular supports of the bladder become relaxed, the fundus, it seems to me, sinks down a little, and is not so firm and resisting.

On the other hand, there is no doubt that a large quantity of fæcal matter accumulated in the rectum may raise the fundus of the bladder. This, however, must be looked upon as a temporary or, at least, a passing condition. The drawings in the Atlas of Braune and Kohlrausch which were made from subjects with a full and distended rectum are incorrect, although they are often copied by others; the fundus there is pictured as commencing almost in the same plane as the vesical orifice of the urethra, and terminating opposite the sacrum so that it would lie in an unnaturally high position. I have, however, found it to turn down from the urethral orifice at a certain angle, and course backwards to terminate opposite the coccyx. In thin individuals, on whom I was able to pass the finger deep enough into the rectum, I could feel the beak of the catheter lying transversely at the posterior boundary of the fundus, one inch distant from the apex of the coccyx.

The posterior boundary would, therefore, correspond to the first vertebra of the coccyx. As the length of the coccyx varies in different subjects, with one inch distance above the apex, the posterior boundary of the fundus may be placed a little higher or a little lower opposite the first vertebra of the coccyx; but it would certainly not lie as high as to be opposite the sacrum.

The French surgeons who have studied the question of the position of the fundus greatly differ in their opinion about it. Mercier³⁸ holds that the fundus is hung up in rather a low part of the pelvic cavity. Civiale³⁹ seems to think that, in healthy urinary organs, the fundus follows a direction hardly below the plane of the vesical orifice of the urethra. Guyon⁴⁰ goes so far as to maintain "that in the male bladder there is no bas-fond," and Reliquet⁴¹ is quite definite, when he says that under normal conditions, especially in young individuals, the beak touches the fundus, if the catheter, on being pushed deeper, is held in the same direction as it followed, when it passed through the vesical orifice of the urethra.

These opinions of Civiale, Guyon and Reliquet I think are wrong. I believe that, during health, in young and in old subjects

the fundus lies low down in the pelvic cavity, and that if the catheter is pushed into the bladder in the same direction as it followed, when it entered that organ, the instrument would never and in no case of healthy urinary organs come in contact with the fundus.

How much, then, is the shaft of a catheter, such as I have described, to be lifted up, if we want to bring the beak, held in a transverse direction, into contact with the fundus? When do we perceive that jerking movement which informs us that we are in contact with the fundus?

I believe that in order to effect this, the shaft has to be lifted up at least fifteen degrees from the plane it lies in, when it passed through the vesical orifice of the urethra; some parts of the fundus occupy a position even lower than that.

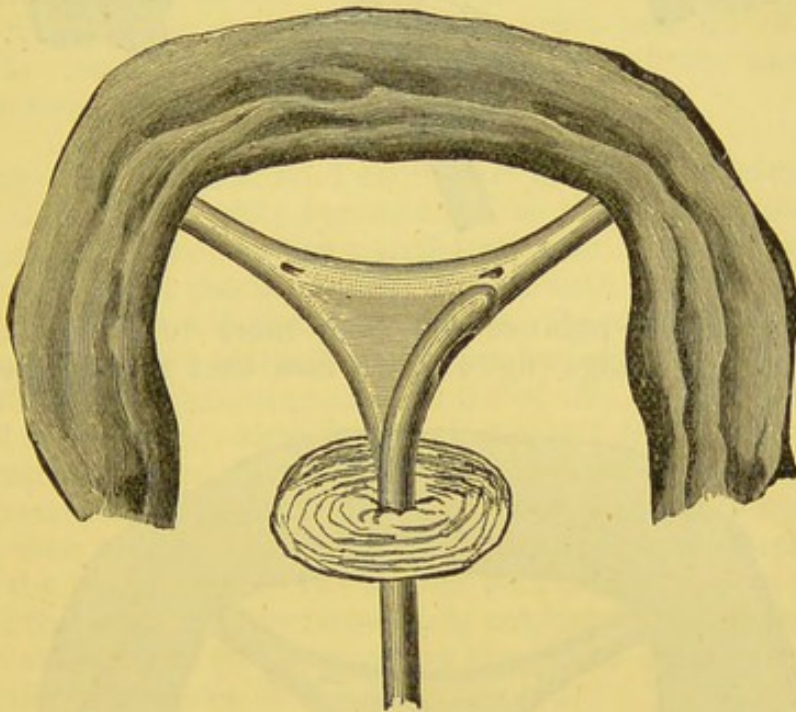


FIG. 20.

The following may be noticed:—

In lifting up the handle to fifteen degrees, and moving the instrument into the deeper regions of the fundus, the jerk which we perceive in passing over the interureteric ligament is just distinct enough to make it clear that we are in contact with the fundus. Lifting up the handle more than fifteen degrees, and holding it exactly in the middle line causes that jerk to be very strongly felt (fig. 20).

If now we bring the handle to the other side of the body so that the beak inside the bladder is turned more to the lateral part of the ureteric ridge, or if we employ an instrument with a longer beak than $\frac{3}{8}$ inch, we shall find the jolting movement is just perceptible.

If, however, in this position, with the handle on the opposite side of the body, we lift it up more than fifteen degrees, the movement

of the beak is soon stopped; it being caught by the left ureteric valve becomes entangled in that prominent fold (fig. 21).

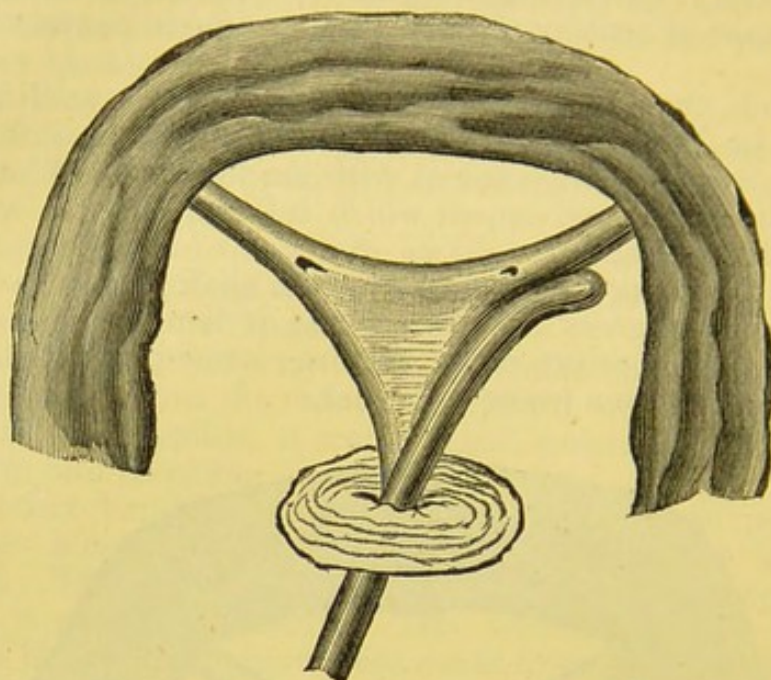


FIG. 21.

But if we turn the point of the beak more towards the middle line of the ureteric ridge (fig. 22), we find that raising the handle

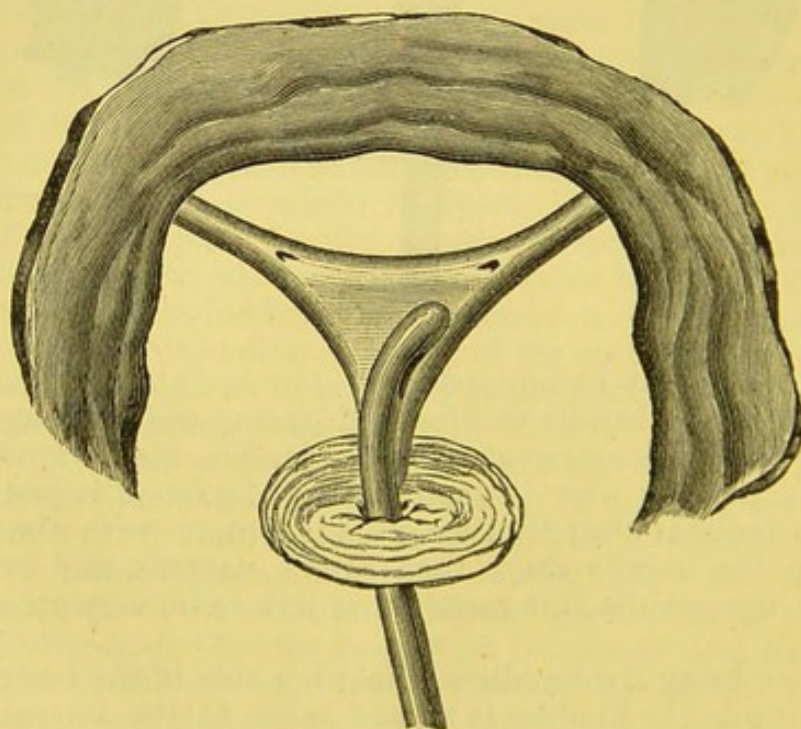


FIG. 22.

to fifteen degrees is not sufficient, that this central portion of the ridge lies deeper, and requires the handle to be lifted up to at least twenty degrees.

The position of the parts behind (*i.e.*, the post-trigonal region) is still lower than the regio trigoni: the post-trigonal region forms a valley, and to come into contact with it we have, after passing over the interureteric ligament, to raise the handle of the catheter more than before. It must not be imagined, however, that during health, the post-trigonal region forms a deep pouch hanging down into the rectum. That region in the empty, as well as in the full bladder, is only a few degrees lower than the regio trigoni, and on raising the handle of the catheter a little higher, we soon become conscious of touching a hard surface, the resisting wall of the post-trigonal region. This region is evidently almost as well suspended and supported as the regio trigoni.

To sum up my opinion on the position of the fundus, I have come to the conclusion that this part of the bladder commencing at the vesical orifice of the urethra slopes down to a comparatively low part of the pelvic cavity, and in the erect posture of the subject, in its course backwards only ascends a little, except in a greatly inclined pelvis.

In every case, I have found each half of the interureteric ligament $\frac{3}{8}$ inch long and quite symmetrical to the middle line; in all my patients, whenever I used a catheter with a longer beak, and whenever I brought the beak into contact with the fundus, I struck against the part outside the ligament, *i.e.*, the ureteric valve which offered an irresistible obstacle to the further progress of the instrument. At first, not knowing the nature of the obstacle I tried to overcome it by using some force; but this I found was painful to the patient, and I nearly tore away part of the ureteric valve. I should, therefore, strongly advise the use of a catheter with a short beak of $\frac{3}{8}$ inch for these explorations, and to be very careful when directing the beak towards the lateral wall of the bladder: if this is done, and the beak kept in immediate contact with the fundus, the ureteric valve is sure to be raised on the point of the instrument, and partially torn away, if any force is used.

As already mentioned, the whole interureteric ligament measures $\frac{3}{4}$ inch in length, and is symmetrical to the middle line of the body. It is also symmetrical to the vesical orifice of the urethra and in the pelvic cavity: starting from the vesical orifice of the urethra we have to move the instrument to the same extent on either side, and we have to lift up the handle to the same height to get the sensation of the jerking which informs us that we are in contact with the ligament. Thus, in being shorter and by its perfect symmetry the interureteric ligament in the living subject is different from what it is after death. It is also to be noted that during life the ligament measures $\frac{3}{4}$ inch in both the full and empty bladder.

The fundus in the perfectly empty bladder **when no instrument is moved about in it** must be looked upon as the widest part of that organ. We may verify this in laparotomies, and also by examination from the rectum in very thin subjects, immediately

after they have passed water, when we can pretty accurately make out the dimensions of the fundus. But this proportion is greatly changed **when we move a coude catheter about in all directions in the empty bladder.** Under such conditions the fundus of the empty bladder, compared with the higher regions of the organ, appears to be smallest in every direction. In the post-trigonal region, and especially in the regio trigoni, we are, when moving the beak sideways on the fundus, soon stopped by the lateral wall of the bladder, whereas immediately above the fundus the instrument can be moved laterally to a greater distance, the bladder wall there readily receding before the point of the beak.

But also in the longitudinal direction the fundus, with the catheter on it, appears to be the smallest part of the bladder: the post-trigonal region in every individual, without exception, never measures more than $\frac{1}{2}$ inch in length, and its rigid posterior boundary remains a certain distance away from the anterior surface of the coccyx. With regard to the region of the trigone, it is true that its antero-posterior diameter is usually longer than that of the post-trigonal region, and so the whole of the fundus in the empty bladder is fairly extensive in the antero-posterior direction; but compared with the higher regions, when explored with the catheter, it appears as the shortest part of the organ: as soon as we move the instrument off the fundus, and raise it a little higher, we can without difficulty introduce it much further.

In the full bladder especially, the fundus occupies in both the transverse and longitudinal directions a smaller space than the body of the bladder; it then really deserves the name of the neck of the bladder; this name, however, has been given to the prostate, or more often to the vesical orifice of the urethra for which parts it is not at all appropriate.

I have just mentioned that the longitudinal diameter of the regio trigoni is usually greater than that of the post-trigonal region. It must, however, be maintained that the former region either does not allow very wide movements in the longitudinal direction, in some subjects at least: firstly, it has to be remembered that the elbow of the catheter must be kept away from the vesical orifice of the urethra, and that the beak is beyond the planum circulare ostii urethralis, before we begin to move the catheter deeper into the bladder; and secondly, the planum uretericum, the part of the trigonal region on which the beak held transversally is pushed along till it passes with a jolting movement over the interureteric ligament, this planum is, in a certain number of cases, rather short. It usually measures $\frac{5}{8}$ inch, but may vary from $\frac{1}{4}$ inch to one inch. With such a small diameter of the planum uretericum, unless we have previously kept the beak near enough to the vesical orifice of the urethra, we might not only miss the interureteric ligament, but we might also find the whole fundus very short. But starting with the catheter from a point nearest to the vesical orifice I have always observed that the fundus of the bladder, even when quite empty, allowed the instrument to be fairly freely moved from before backwards and *vice versa*.

It is the same with the movements of the catheter in the lateral direction, although, as I mentioned above, in this as in the antero-posterior diameter the dimensions of the fundus are smaller than those of the body of the bladder. If we move the instrument, with its beak held transversely, towards the lateral wall of the bladder, we can also carry it to a certain moderate extent in that direction. We can in this way make out that the space behind the ureteric ridge is, on each side of the middle line, one inch wide. Of this one inch we have seen that $\frac{3}{8}$ inch corresponds to the length of one half of the interureteric ligament, and the remaining $\frac{5}{8}$ inch is the length of the valve.

With regard to the sensibility of the urethra and bladder, I have noticed that the impression made upon patients by the instruments which I introduced into their urinary organs varied in different individuals. Some few patients belonging to the hospital class of patients seemed hardly inconvenienced by the instrument. But by far the greatest number of hospital and private patients complained at first of a pricking pain in the anterior portions of the urethra, and then of an intense desire to make water, when the instrument had reached the deeper portion of the canal. After the instrument had been introduced a few times, the patients made no complaints during its passage through the urethra. With regard to the bladder, as long as the beak of the catheter was kept away from the fundus, or only lightly touched it, the patients suffered no inconvenience; but as soon as the beak was pressed a little more firmly against the fundus, then all patients began to show signs of uneasiness, and complained of a cutting or pricking pain. After repeated trials they became more accustomed to the pressure of the instruments against the fundus; but a certain degree of sensitiveness remained to the last, even in cases where the fundus had been subjected to pressure for a long time.

It is, perhaps, not superfluous to say a few words on the best way to withdraw coudé instruments from the bladder. If these instruments are not carefully removed, the patient, whose internal sphincter would be violently stretched by the prominent elbow of the coudé catheter, may suffer very severe pains during that act. The advice which has been given to withdraw the instrument inversely to the way it has been introduced is very good, but rather vague. Guyon's⁴² instructions on this manœuvre are more precise. If I may express an opinion on this point, I may say that I have found it best to withdraw coudé instruments in the following way: the instrument and its beak has to be drawn forward towards the vesical orifice of the urethra, but during this act the shaft (in the erect posture of the patient) must be brought low down and parallel to the legs of the patient; by this movement the beak is prevented from slipping into the vesical orifice, and with the next movement, by which the shaft is gently pulled forward, and as much as possible upwards, the beak and the elbow are drawn round the vesical orifice without distending it too much.

CHAPTER VI.

THE URETER-FORCEPS.

THIS instrument I have introduced into the bladder of living subjects more than 1000 times, and as many times have tried to close the ureteric valve.

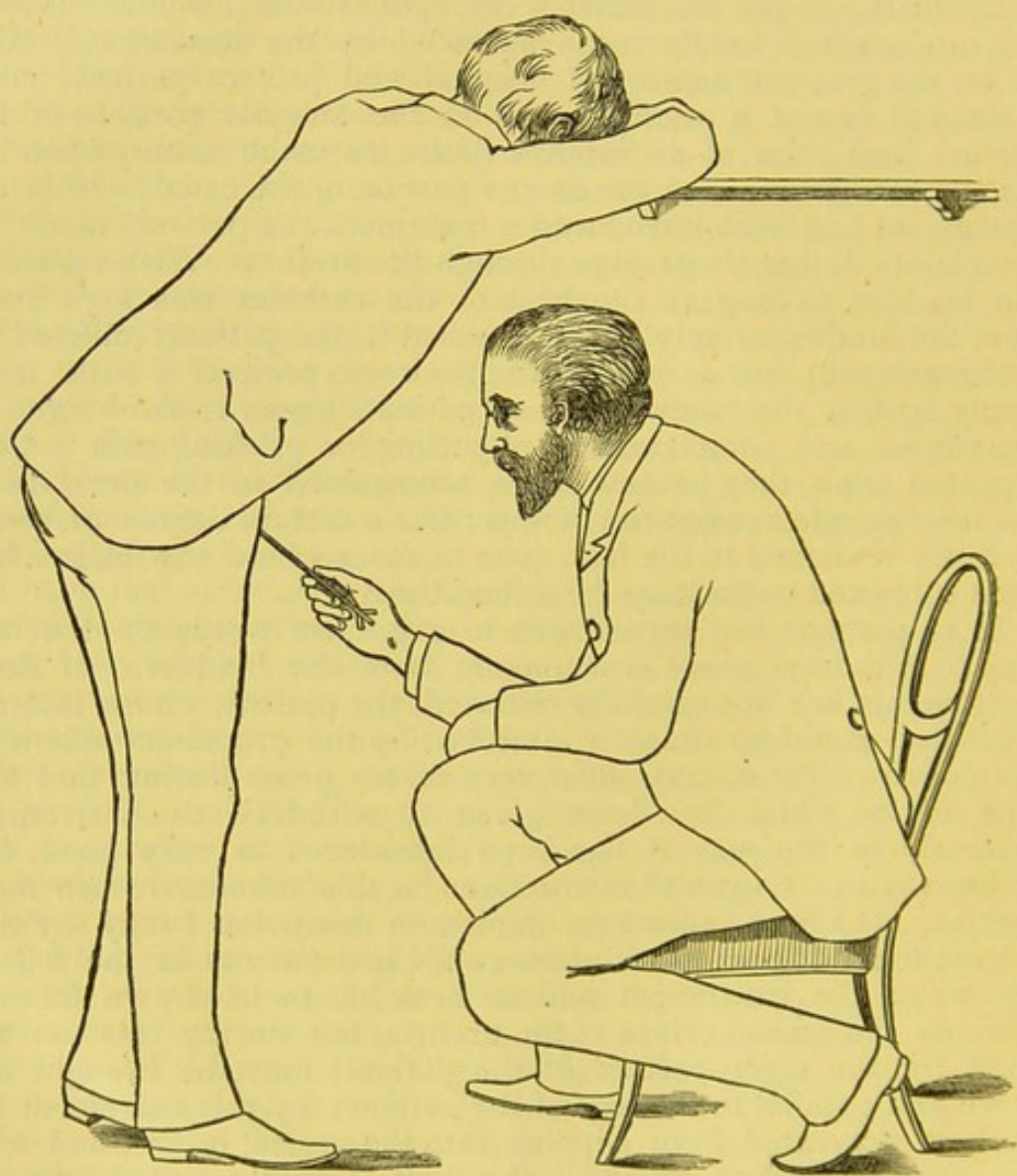


FIG. 23.

The introduction of the ureter-forceps in the living subject is as easy as passing a coudé catheter; the abrupt elbow of both require

a certain amount of care when passing through the prostatic urethra and the vesical orifice of the urethra: the shaft has to be lowered as much as possible to make the beak ride easily over the posterior border of the vesical orifice.

The patient is in the erect position, when the instrument is being passed into the bladder; I then get him to lean forwards in order to raise the fundus ves., and so accelerate the outflow of the urine. In former years I made the patients lean forwards on the mantel-shelf or on a chest of drawers, about $4\frac{1}{2}$ feet high, whilst I was sitting in front on a low chair (fig. 23); but, lately, I found the patients felt more comfortable in an elevated knee-elbow position, kneeling on a chair with their arms and head on another chair which had been put on an ordinary table.

The ureteric valve may be seized and closed by using this instrument in different ways; after various trials I have found the following method the best and least painful.

Suppose we intend to close the right ureteric valve.

Before I describe the movements to be carried out for that purpose, I must expressly state that at no time before and during these movements the valve, or any part of the ureteric ridge, need be felt with this or any other instrument. In former chapters I have tried to show how on examining with the coudé catheter we can ascertain the situation and dimensions of the various portions of the ureteric ridge, and the size and position of the fundus. I have done this to make it clear how far the ureter-forceps are adapted to the anatomical details; but for the closing of the valve such an examination is quite superfluous, and the valve will be found to lie between the blades of the ureter-forceps, after we have pushed the instrument along the fundus far enough to be stopped by the commencement of the posterior wall of the bladder. The distance of the posterior wall of the bladder from the ureteric ridge is never more than $\frac{1}{2}$ inch, and the distance between the two blades when drawn apart is $\frac{1}{2}$ inch, to which we must add $\frac{1}{8}$ inch, the thickness of the posterior blade; for these reasons, provided we are in contact with the fundus, the anterior blade is necessarily in front of the ridge, whilst the posterior blade is at the posterior wall of the bladder and behind the ridge.

First movement:—

After the ureter-forceps (previously lubricated with glycerine) has reached the bladder, the urine is allowed to flow out. The instrument is then pushed deeper into the cavity of the organ, and its beak, by rotating the handle, is turned to the right side of the bladder. After that, the two blades are drawn apart as far as possible, viz., $\frac{1}{2}$ inch from each other; they are then made fast by the screw "g."

In the empty bladder I have always found it easy to turn the beak sideways, upwards, and downwards, and to bring it into any position I wished, and I have never had any difficulty in a perfectly empty bladder in opening the blades.

With the blades drawn completely apart, and their points turned to the right side, the instrument is gently pulled forward till the

anterior blade is arrested by the right circumference of the urethral orifice (fig. 24).

Although so near to the vesical orifice of the urethra, there is no chance of the blades, separated as they are to $\frac{1}{2}$ inch, slipping out of the bladder.

Second movement :—

We now turn the blades vertically downwards, lowering the shaft, and so avoiding the fundus. But after having performed this rotation, we must lift up the handle sufficiently to come with the points of the two blades into contact with the fundus, a contact which has to be maintained to the last. There is, however, no need to measure exactly the degree to which the handle has to be raised; the hardness and resistance offered by the fundus enables us to feel distinctly when, with the two blades, we are in contact

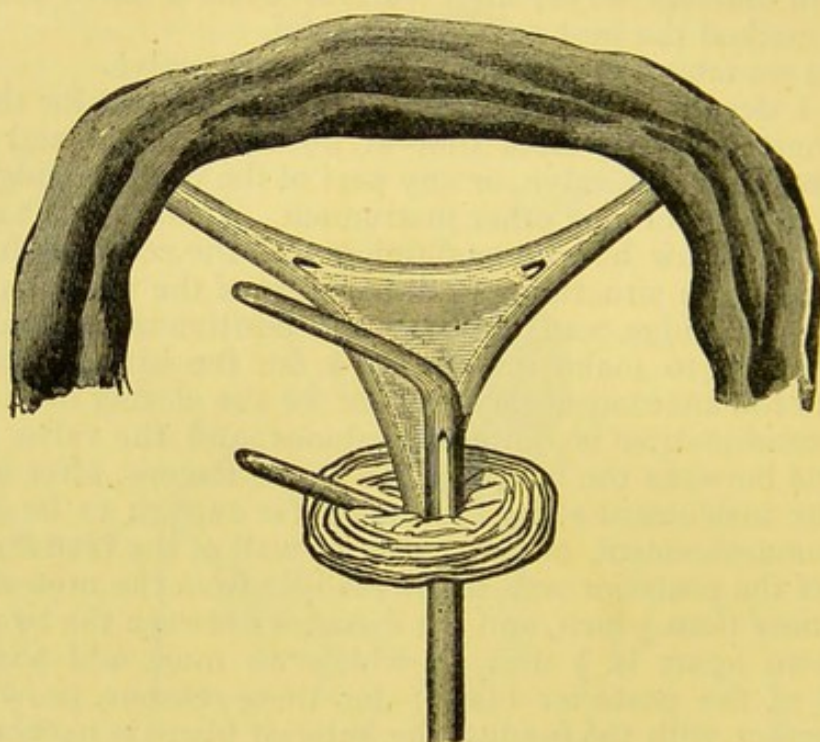


FIG. 24.

with that part; and that is all that is necessary during this and the next movement; at no time have we to raise the handle so much that the fundus is forcibly pressed upon by the blades.

With the blades in this position the instrument is pushed deeper till it is arrested by the posterior wall of the bladder (fig. 25).

This movement can in no case be very extensive; with the separated blades we must expect to be very soon stopped by the posterior wall of the bladder. In cases with a moderately long fundus, even before this movement has been started, the posterior blade is already beyond and behind the ureteric ridge, and in those with a very short fundus, the instrument, with its two blades drawn completely apart, covers the entire length of the fundus. It is therefore advisable, before the second movement is begun, to keep as near as possible to the urethral orifice.

Third movement :—

The blades, their points being held directly downwards, and well in contact with the fundus so that we distinctly feel its resistance, have to be carried to the right lateral wall of the bladder, from which the ureter issues, and forming the ureteric valve, follows, for at least $\frac{1}{2}$ inch, its course towards the middle line. But although the valve, with its length of $\frac{1}{4}$ inch, can easily be laid hold of anywhere by the blades of the ureter-forceps, I think it safest to seize it as near as possible to its origin from the lateral wall of the bladder. We should, therefore, move the blades, or rather the posterior blade, right into the corner behind the valve, and should feel the lateral bladder-wall.

This movement is performed by moving the handle of the instrument from the middle line as much as possible to the left side of the body till the blades are arrested by the lateral wall of the bladder. In this position of the instrument, with the handle raised and to the left side, the two blades, after the screw "g" has been

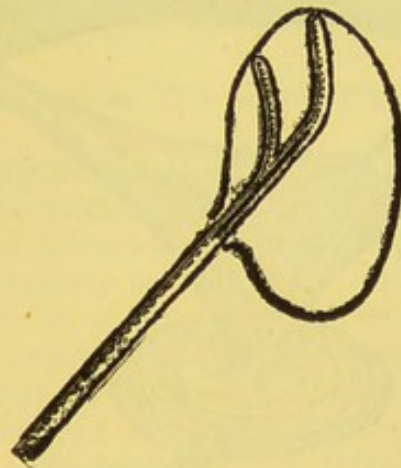


FIG. 25.

loosened, are drawn together (fig. 26). Towards the end of this movement, when the blades have approached each other, and are separated by only $\frac{1}{4}$ inch or less, the handle has to be raised a little more. In this way the points of the open blades are brought into very close contact with the fundus, and can pick up the valve which is loosely attached.

After the completion of the third movement, the instrument which up till now had been held with the points downwards is to be turned from the right to the left so that the blades are brought more horizontal.

All the three movements together do not occupy more than one minute, and with a little practice can be easily learnt. I am sure, seizing the valve with the ureter forceps is much easier than with the lithotrite to find a small stone in the bladder because the valve is always in the same place, and cannot slip away from the instrument as a stone often does. I can even go so far as to assert

that if we keep well in contact with the fundus, and at the last moment are near enough to the lateral wall of the bladder, it is impossible to miss the valve.

I have found it most convenient to have the posterior blade $\frac{1}{8}$ inch longer than the anterior one: as the post-trigonal region is on a lower level, and forms a little depression behind the regio-trigoni, the longer blade reaches this depression, and remains in this position when we bring the handle to the opposite side of the body.

It will be instructive to observe the small extent to which we can move the handle to the opposite side. I have in former chapters pointed out the smallness of the transverse diameter of the fundus, and how soon we reach its lateral wall. Therefore, whenever we find we can bring the handle to a greater distance to the other side, we must suspect that the blades have left the fundus, and are in a higher region of the bladder.

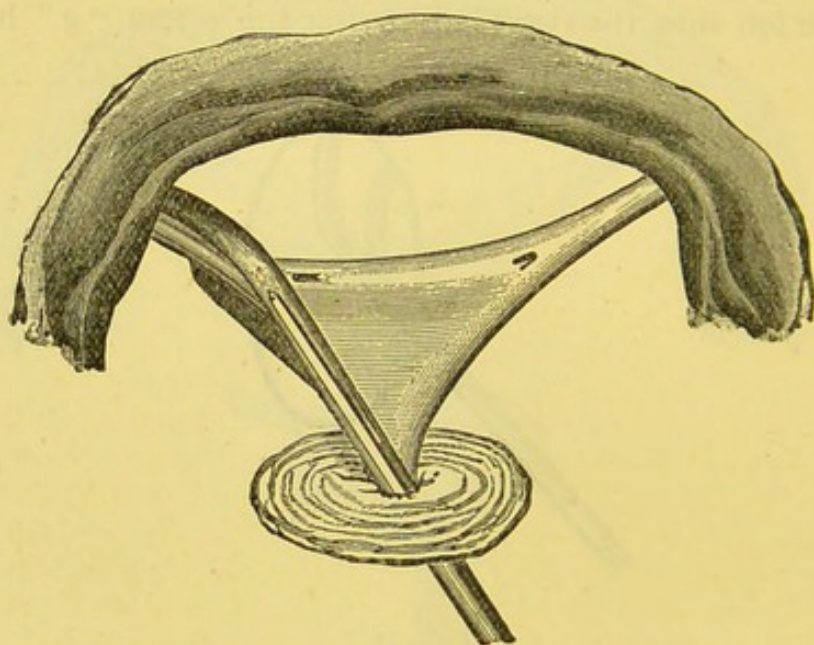


FIG. 26.

We have other signs showing that we have succeeded in grasping and closing the ureteric valve: we find the instrument quite immovable, embracing with its blades a fold $\frac{1}{16}$ to $\frac{1}{8}$ inch thick. A fold of such a size is hardly ever developed on the fundus, even in a hypertrophied bladder: the trigonal region remains perfectly smooth, however hypertrophied the bladder may be, and in the post-trigonal region, with its thin muscles, it is very rare that such a thick bundle is formed.

But a far better proof is the quantity of urine collected in healthy individuals. If the valve is really closed, then the quantity of urine coming out of the instrument should be much smaller than before, and when after an interval of 15 minutes we let loose the valve, and find the flow of urine very markedly increased, we can only conclude that previously we were closing one valve. At the commencement of my investigations this sign helped me to

find out the various movements best adapted for closing the valve, and any failure was thus at once ruthlessly revealed to me. I may say, during the third movement, I most often made a mistake, when, in drawing the blades together, instead of keeping them close to the lateral wall of the bladder, I involuntarily took the handle back, nearer to the middle line, and so left the corner behind the valve.

I have, of course, been careful to see that the ureter forceps are properly constructed for the outflow of the urine from the bladder, and that retention of urine does not take place. The holes at the bladder-end of the instrument being $1\frac{3}{8}$ inch long, reach as far as the vesical orifice of the urethra, however much the fundus may differ in length. In this way every drop of urine readily enters the inner tube, whilst in the knee-elbow posture the inclination of the fundus facilitates the flow of the urine into and through the tube. It is advisable, before we close the ureteric valve, to wash out the bladder with some warm antiseptic lotion; the urine coming down from the other ureter is then not mixed with any pus or blood lying on the regio trigoni. Should it happen that the inner tube becomes stopped up by a clot of blood, an injection of warm lotion will remove this.

We can thus examine the urine secreted by either kidney separately.

The question may be asked whether the use of this instrument does not cause the patient great inconvenience? If the ureter-forceps were at once introduced into the bladder, and left there for 15 minutes, most patients would not be able to stand it. But it is much the same with all instruments, whether they are soft or hard: the desire to pass water, excited the first time, or the first few times, is unbearable to almost all patients. For this reason, before the ureter-forceps are introduced and put on, the patients must by repeated introductions of a bougie or metal catheter get accustomed to the use of instruments and the distention of the inner sphincter caused by them. After this, the ureter-forceps can be borne, and left in the bladder closing the valve for 15 minutes, or longer. It is true, the contact of the blades of the instrument with the fundus is unpleasant to the patient; but since I have employed an instrument with a longer posterior blade, I have, excepting at the last moment, been able to use far less pressure, and the whole proceeding has become much less painful. With regard to the closure of the valve, I have at all times found it perfectly painless.

It may be objected that this is a dangerous proceeding, and may lead to serious complications, especially in patients with congested or inflamed kidneys. I can affirm that this little operation is not more dangerous than an examination with a metal sound for stone or prostatic enlargement, and that the ureter-forceps with its perfectly smooth and blunt points can by a few well regulated movements be easily brought to its proper place on the ureteric valve.

But may it not during the 15 minutes during which it holds the valve embraced pinch this delicate part to a dangerous degree?

If the spring contained in the handle is not too strong, the instrument cannot pinch the valve, and the spring should be so weak that it does not bring the two blades together; the surgeon must do that, and may do it without fear. He should first try the strength of the spring on his own arm (the skin on the forearm on the flexor surface is a good place). To prevent the urine coming through, whilst the instrument is on the ureteric valve, a very weak spring is sufficient. To prove this, if we remove from the body a bladder with the ureters attached, and connect either ureter with a syringe, we find a very light spring is quite sufficient to keep the valve completely closed, although we may use considerable water pressure.

Undue pinching of the valve is also prevented by the anterior blade being fixed to the inner tube in such a way that it cannot forcibly compress the parts enclosed between it and the posterior blade.

Lastly I may say I have never seen any bad results follow the use of this instrument, and I have repeatedly passed it on the same patient, and have now had it in continuous use for 25 years.

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