

urethra, and for this purpose delicate lithotrites have been constructed; but they all expose the walls of the urethra to danger, and are, practically, unsafe instruments. The best of them is the "brise-pierre uréthral" (Fig. 96) of Reliquet. This instrument can be used as a delicate, hook-like scoop, which is to be inserted behind the fragment, by appropriate manipulation. When this is accomplished, a stylet contained in the male blade is pushed down upon the fragment, to fix it in position. If, now, the fragment cannot be withdrawn without force, a tube, with sharp teeth at its extremity, which slides upon the stylet, is brought to bear upon the fragment, and it is reduced to powder, by turning a screw at the handle of the instrument, and also by rotating the stylet, which acts as a perforator. The male blade, which consists of this hollow tube and its contained stylet, is furnished with a rounded lateral process near its toothed extremity, which serves to push aside the urethral walls, and save them from injury during the crushing. The stylet may be withdrawn entirely, and warm water injected into the urethra to wash away detritus, if necessary.

To get the scoop behind the fragment, let an assistant compress the urethra just beyond it to prevent the convexity of the scoop from pushing it back into the bladder, and then, by bending the penis to a right angle, or even beyond, and at the same time pushing the convexity of the scoop against the lateral wall of the urethra, the beak of the instrument can be inserted between the latter and the fragment which, by a spooning movement, is scooped into its concavity (Fig. 97). Next to this instrument, in safety and efficiency, is the straight "trilabe," or three-bladed lithotrite, used by Civiale, originally employed by John Hunter (Fig. 78). Its mode of use hardly

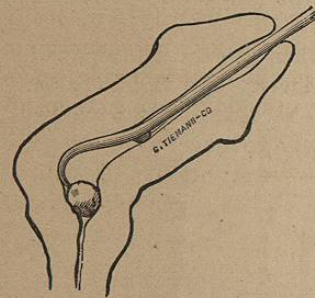


Fig. 97.

requires description. A simple loop of wire, in the absence of other instruments, may be improvised successfully; and, in any case, this contrivance might be useful in aiding to alter the position of the fragment, so as to bring it within the grasp of the forceps.

When the point of arrest of the fragment is found to be just within the orifice of the urethra, or in the fossa navicularis—a form of the accident that occurs most frequently in children, in whom the expulsive power is great, and used without restraint—it is generally advisable at once to enlarge the orifice, with a delicate bistoury, or Civiale's meatotome (Fig. 43).

There are cases of impaction in which the fragment is small enough to pass readily under ordinary circumstances, but is held in place solely by *spasmodic* contraction, so readily provoked in an irritable or unsound

urethra. In such a case, if a very small bougie can be insinuated beside the fragment into the bladder, and left in place a few hours, its presence will often quiet the spasm, and lead to the spontaneous evacuation of the fragment. In any event this manœuvre will tend to relieve retention, which is often so distressing, in cases of impaction; for the urine will generally find its way out alongside of the bougie.

The spasm and retention produced by an impacted fragment in the urethra are liable to be soon followed by rigor and febrile reaction; and these symptoms are often very severe in their character, considering the apparently trifling nature of the obstruction. If the difficulty remain unrelieved, these symptoms persist, and there is danger of local ulceration, urinary infiltration, and abscess. It may become the duty of the surgeon, therefore, if the fragment cannot be withdrawn by the aid of instruments, to cut down upon and remove it at once. When deep in the urethra, this is not an easy operation, and it might be necessary to split the scrotum in order to reach the fragment. In front of the scrotum it is easy enough to cut directly upon the fragment, and to get it out; but, after a wound of this portion of the urethra, a fistulous opening is likely to remain, and this is not easy of cure.

These considerations relating to the possible lodgment of calculous fragments in the urethra, after the operation of lithotritry, are equally applicable to those cases, occurring perhaps even less infrequently, in which renal or vesical calculi are arrested in the urethra during spontaneous effort to escape—no operation of any kind having been attempted.

CHAPTER XVI.

LITHOTRITY.

Lithotritry continued.—Position of the Patient.—Introduction of the Lithotrite.—Method of catching the Stone.—Precautions in crushing.—Manœuvres for catching Stone not easily seized.—Subsequent Crushings after one Successful Effort.—How to find Last Fragments.—Complications in Lithotritry, their Significance and Management.

The position of the patient during the operation of lithotritry is of great importance, for upon it depends the position of the stone in his bladder. A movable stone, in a bladder partially filled with urine, will be found, with very rare exceptions, occupying its most dependent point. The patient must be so placed, therefore, if possible, that the lithotrite when introduced may be carried directly to the stone lying at the bottom of the bladder. The shape of the bladder, which changes materially at different periods of life, must be considered before determining what part of its cavity, in different positions of the body, is the most depending. In the child's bladder, in the erect position, the neck is its lowest point.

When full, the bladder—in early life—is pear-shaped, with its broadest part above, vertical in position, and lifted high out of the pelvis. A movable calculus always drops, therefore, into its funnel-shaped neck; hence the more exaggerated pains which the child suffers. When he lies down upon his back in the horizontal position, the stone will necessarily roll backward toward the fundus of the bladder, which has become, by this change of attitude, its most depending portion. And, now, a lithotrite entering the bladder would tend to glide down a gently-inclined plane, at the bottom of which its beak would almost of necessity come in contact with the stone.

On the other hand, the old man's bladder is no longer pear-shaped; the most capacious portion of its cavity is below, and the increased size at its base tends to tilt its vertex forward. In the erect position there is a distinct excavation below the level of its outlet; a stone would, therefore, tend to gravitate into this cavity, and away from the neck of the bladder, which also has now lost in a great measure its conical shape. In the horizontal position a lithotrite, having freed the orifice of the bladder on entering, would no longer tend to glide down an inclined plane; on the contrary, its angle would project over a cavity, and, if pushed forward, the convexity of its beak would come in contact with the posterior wall of the bladder at a point above the level of its floor—the stone occupying the cavity below the shaft of the instrument, and, unless of considerable size, not having been touched by it. If he should elevate the handle of the lithotrite in order to carry its beak into this cavity in search of the stone, the operator would do violence to the neck of the bladder and prostatic urethra—which is to be especially avoided. The difficulty is met by simply elevating the pelvis sufficiently, by means of a cushion placed beneath the hips, to cause the stone to roll out of the lower cavity of the bladder, and along its floor and back wall—now become its most dependent portion—to the point at which the lithotrite would naturally come in contact with this portion of the bladder.

This change in shape of the bladder takes place gradually as life advances. Where the prostate is the seat of enlargement, or where an horizontal "bar" has formed at the outlet of the bladder, elevating its inferior margin, it is more marked. It is in these cases that the "bas-fond" of the bladder reaches its greatest development. Here, then, the elevation of the pelvis is to be carried to the greatest degree—a hair cushion of six inches' thickness being often required, or even more. The pelvis is to be raised absolutely above the level of the shoulders. If the head be flexed forward and supported by a pillow, this position will not be attended by discomfort. It was this power to determine the position of a stone in the bladder by modifying the patient's attitude that led Heurteloup to insist on the value of his operating-table, which could be lifted and depressed at either end, as on a pivot. Thompson finds a couch of somewhat similar construction of great value in searching for stone.

It is obvious, then, that one of the conditions for successful lithotripsy is to place the stone at that point, within the cavity of the bladder, at which it can be found with most certainty by the lithotrite, and with the least necessity of search for it, and of consequent prolonged contact of the instrument with the bladder; and that the surgeon has the power of effecting this by regulating the position of his patient.

Before the patient is placed in position for the introduction of the lithotrite, from four to six fluid-ounces of urine should have been allowed to accumulate in the bladder. This presupposes a capacity of retaining the urine from one and a half to three hours. For a small stone, requiring the smaller lithotrite, the lesser quantity would suffice; but this is the minimum. When the stone is larger, a proportionally greater area is required in the bladder for safe manipulation with the lithotrite. If the patient should be unable to retain his urine long enough to allow the necessary quantity to accumulate, this is the best evidence that his bladder is not yet in a fit condition for the operation of lithotripsy. Nothing is to be gained by the injection of tepid water, with catheter and syringe, as formerly practised. The soothing influence of the warm water is more than counterbalanced by the additional manipulations required for its injection, and the consequent lengthening of the operation. It is better, practically, that the patient should be induced to hold his water for the required period, as he had previously been instructed to do for preliminary explorations; and, in fact, that at the time of the operation he should anticipate nothing more than a preliminary exploration. He will thus be saved, in a great measure, from the increased nervous susceptibility that always attends the anticipation of a surgical operation, which, it may be remarked, affects the bladder more than any other organ of the body.

If, as sometimes happens, the urine should be ejected as the lithotrite enters the bladder, in consequence of the sudden invasion of spasm, the lithotrite should be immediately withdrawn in the gentlest manner, and the operation deferred. It is evident that, for some reason, the bladder is not in a favorable condition; and, under these circumstances it is wiser neither to attempt to coax nor force it, by injecting warm water—for this is the only alternative, if the operation is to be accomplished without delay.

INTRODUCTION OF THE LITHOTRITE.—A suitable instrument having been selected, and well oiled, the operator places himself on the patient's right side and inserts its beak into the orifice of the urethra, drawing the penis gently upon the lithotrite with the right hand, as though it were a glove-finger upon a finger, while he balances the instrument lightly in the left, gradually lifting the handle as its beak advances. The handle is thus slowly raised until the shaft of the lithotrite becomes vertical, and, while it is still held in the left hand, the fingers of the right, thrusting the scrotum aside, follow the prominence of its angle as

the point of the beak advances into the perinæum. The instrument is to be supported in this position until, by its weight, it sinks deeply enough into the perinæum for the point of the beak to engage in the opening through which the urethra traverses the triangular ligament. If there should be any delay here, the fingers of the right hand may assist by slightly changing the direction of the beak, or, possibly, by lifting it a little, if below the orifice of the triangular ligament. When the point of the beak has fairly engaged in this narrow strait, the handle of the instrument should be transferred to the right hand and allowed to fall gradually, by its own weight, toward the feet of the patient. Just before the shaft of the lithotrite has become horizontal, the point of its beak, in the young subject, will have freed the upper margin of the orifice of the bladder and entered its cavity, and, a moment later, the convexity of its angle, having glided meanwhile along the floor of the prostatic sinus, frees the lower margin of the orifice, and a sense of freedom of motion of the beak of the instrument informs the operator that it has fully entered the cavity of the bladder.

In a patient who has passed middle life, the lithotrite does not always enter the bladder so smoothly. A tendency to increasing excavation of the floor of the prostatic sinus, as well as the similar change of shape, already described, in the floor of the bladder, has the effect of elevating the inferior margin of its outlet. In this manner a sort of transverse barrier is opposed to the easy entrance of the beak of the lithotrite into the bladder; and, when it does enter, there is a good deal of friction of the shaft of the instrument against this barrier during subsequent manipulation. This is a condition of very common occurrence after middle life, and not necessarily caused by, or complicated with, an enlarged prostate. When there is enlargement of the prostate, this transverse bar almost always exists to some extent, sometimes in an exaggerated degree; and, in rarer cases, its central portion assumes the shape of a conical eminence which opposes the farther advance of the lithotrite, unless, indeed, it can be made to pass by being carried on either side of this "middle lobe." In addition to the obstruction liable to be thus offered to the passage of the lithotrite, if the lateral lobes should be irregularly or unsymmetrically enlarged, the prostatic portion of the canal, besides being increased in length, becomes also more or less tortuous in its course, and its walls will be found to be comparatively rigid and unyielding. It is easy to understand how the beak of a lithotrite might be impeded in its progress through such a passage, and also that great gentleness must be exercised to avoid abrasion of its delicate lining membrane. Pressure, applied by the operator's left hand at the root of the penis so as to aid in stretching its suspensory ligament, will very greatly assist the passage of the beak in such cases. Indeed, this manoeuvre always aids the passage of the lithotrite while its beak is traversing the prostatic portion of the urethra. Without it the suspen-

sory ligament is stretched entirely by the leverage afforded by the handle and shaft of the instrument, and the point of its beak is presented to the roof of the urethra in an unfavorable direction and with an unpleasant degree of force, altogether incompatible with the easy, gliding movement that is desired.

When the urethra is surrounded by an enlarged prostate and narrowed from side to side by the encroachment of its lateral lobes, it is at the same time correspondingly increased in its vertical diameter; and this peculiar change of shape in the prostatic urethra, together with the delay in reaching the bladder in consequence of the increased length of the passage, is likely to lead to the error, on the part of the operator, of depressing the handle of the lithotrite too soon. For the greater depth of floor and height of ceiling of the prostatic urethra under these circumstances will readily permit the beak of the instrument to rise into its cavity, and the operator, regarding only the depth to which his lithotrite has penetrated, may readily deceive himself with the idea that its beak has entered the bladder, when, in reality, it is still in the prostatic sinus. The difficulty experienced in inclining the beak of the lithotrite from side to side, by rotating its handle, will at once correct this wrong impression. By again elevating the handle of the instrument, so as to depress its beak, and very gently urging it forward, with patience and care it will probably soon glide into the larger cavity of the bladder. The great depth to which the lithotrite penetrates, in cases of enlarged prostate, before its beak is fairly lodged in the bladder, will pretty surely surprise the young operator. In this connection it is well to consider the very great lever-power developed by depressing the handle of the lithotrite when its beak is deeply lodged in the urethra. If this movement should be attempted prematurely—for example, before the beak had engaged in the narrow passage through the triangular ligament—there would be danger of forcing it with dangerous violence against the roof of the urethra, perhaps of producing laceration. But, after the beak has entered the prostatic sinus, the leverage is still greater, for the lower margin of the opening through the triangular ligament would now serve as a fulcrum to the lever, while the length of the shaft of the lithotrite and the weight of its handle give dangerous power to its longer arm. It behooves the operator, therefore, to manage it with a light hand, and much caution.

Although obstacles may be encountered in introducing the lithotrite where there is an enlarged prostate, it is proper to remark that, in many of these cases, the enlargement of the prostate affects mainly its outer circumference; it is "peripheral" rather than "central," and the urethra may be as free and capacious as could be desired.

When the sense of freedom of motion conveyed to the hand of the operator announces to him that the beak of the lithotrite has fairly entered the bladder, he still maintains the shaft at the same angle with

the patient's body it had when entering, and allows the beak of the instrument to glide slowly onward, as far as it will, listening intently, so to speak, with his fingers, for its contact with the stone. When the calculus is movable, and the position of the patient has been judiciously adjusted, with the proper quantity of urine in his bladder, it will generally happen that, before the convexity of the beak of the lithotrite is arrested in its progress by the posterior wall of the bladder, the stone will have been touched by it; and the operator should be able to say, at once, on which side of the instrument the stone is lying. He now very cautiously turns its beak a little away from the stone, and, by gently withdrawing the male blade, opens the jaws of the instrument widely enough to grasp it. The beak of the lithotrite is rotated away from the stone before moving the male blade, in order to prevent the concavity of its jaw, as it is being withdrawn, from striking the stone and thus altering its position; and the previously-ascertained size of the stone determines, by reference to the graduated scale on the handle of the instrument, how widely its jaws are to be opened. It is to be observed that the female portion of the lithotrite is held lightly but steadily in its place by the left hand of the operator, while the instrument is being opened, the convexity of its jaw pressing gently against the posterior wall, where this latter meets the floor, of the bladder; the male blade only is moved, and by his right hand. The jaws of the lithotrite being now open, are to be turned toward the stone, by rotating the handle of the instrument, so as to incline them to the horizontal position, or until further rotation is resisted, and gently closed upon it. As soon as the stone is felt to be fairly and firmly grasped between the jaws of the lithotrite, the instrument is rotated back again until its jaws are vertical, as before they were opened, and the button-trigger, at its handle, is pressed back by the thumb of the right hand, thus fixing the male blade, and at the same time bringing the screw into gear; then, by slowly turning the wheel, the screw-power is applied to the stone. Before turning the screw, the operator should satisfy himself, by the slight withdrawal and partial rotation of the lithotrite, with the calculus in its grasp, of the perfect mobility of the instrument in the bladder, and that no portion of the lining membrane of the latter has been included between its jaws. This caution, formerly very much insisted upon, has lost much of its force since the construction of the lithotrite has been made so perfect that the nipping of the bladder is almost impossible. Still, it should not be forgotten. Usually the practised hand will receive satisfactory evidence of the absence of entanglement with the walls of the bladder, while turning back the jaws of the lithotrite to their original position, after picking up the stone, and in withdrawing it a trifle so as to insure the safety of the posterior wall of the bladder from contact, while the screw is being turned.

As the jaws of the lithotrite are slowly closing upon the stone, the

operator will recognize, possibly both by hand and ear, a sharp cracking, or a softer crushing sensation, according to the nature and degree of hardness of the calculus. Having screwed the male blade well home, he then slips the trigger forward by a motion of his right thumb, and opens again the jaws of the instrument. And now, as experience has demonstrated that when a calculus is large enough to make several fragments, under the crushing of the lithotrite, they all fall together at the bottom of the bladder, it is only necessary for the operator to turn the open jaws of the instrument toward the same spot at which the stone was first seized, and, on closing them, he will almost inevitably seize a fragment. This manœuvre may be repeated again and again, from once to three or four times, or even more, according to the skill of the operator, and the tolerance of the bladder; but the whole proceeding should not occupy a longer time than from three to five minutes, the former for first crushings and sensitive subjects, the latter where the tolerance of the bladder has been proved. This is a rule that the lithotritist should always respect. It would involve possible risk of injury if an instrument were simply allowed to remain in an ordinarily healthy bladder for the space of five minutes; how much more when all the manœuvres of lithotripsy are superadded in a bladder already irritated and diseased!

PRECAUTIONS IN CRUSHING.—To accomplish as satisfactory a result as possible, with the least risk of injury to the bladder, in crushing a calculus, there are other rules to be observed. In opening the jaws of the lithotrite by withdrawing the male blade, the operator should be cautious in limiting this movement to the assumed size of the stone or fragment, and never, if possible, bring the concavity of its jaw in contact with the neck of the bladder, as this contact always occasions pain, and might cause spasm. Always open the jaws of the lithotrite in the vertical position before rotating them in quest of a stone or fragment. It is a common error to use the lithotrite as a sound, or searcher; and, when a stone or fragment has been struck, to open the jaws of the instrument in close contact with the stone, through fear of losing it. This is bad practice. In withdrawing the male blade, to open the lithotrite, the stone or fragment thus sought is very likely to be moved out of reach by contact of its jaw. Where the stone has not been brought within the grasp of the jaws of the instrument by skillful management of the patient's position, there are well-trying rules for finding it, with which every good operator must be familiar; these will be shortly given in full.

Again, all the movements of the lithotrite thus far described, viz., the opening and shutting of its jaws, the rotation of its shaft, and the application of the screw-power, are to be managed without altering the direction of the shaft of the instrument in its relation to the axis of the patient's body. Any deviation from the direction assumed by the

lithotrite after entering the bladder, is unnecessary for the successful performance of the manœuvres which have been described, and it will certainly involve friction or undue pressure upon, and possible injury to, those sensitive parts—the prostatic urethra and neck of the bladder—by which the shaft of the instrument is most closely embraced. It is to be remembered that the urethra is occupied by a perfectly straight, unyielding instrument, which causes tension of the suspensory ligament of the penis, and impinges forcibly upon the lower lip of the outlet of the bladder; and that every change of direction at the ends of the instrument, which are free, bears almost entirely upon that portion of the canal included between the opening in the triangular ligament and the neck of the bladder. The operator, therefore, cannot be too careful to observe extreme gentleness and smoothness in all his manipulations, and to avoid every thing like jar or sudden motion.

MANŒUVRES FOR CATCHING FRAGMENTS. — Sir Benjamin Brodie's favorite manœuvre of gently striking the handle of the lithotrite in order to make the stone roll between its open jaws, although a successful expedient, has been justly criticised because it rarely fails to elicit an expression of pain from the patient. The practice of jarring the pelvis by a slight blow, applied to the crest of the ilium for the same purpose, is open to a similar objection. The increasing safety and certainty of modern lithotrity seem to be due largely to the fact that greater caution is exercised in guarding against mechanical lesion by using more perfectly-made instruments, and handling them with extreme gentleness. The principle has been established that it is safer for the surgeon to seek the stone, in a locality already ascertained, by a series of systematic, well-practised manœuvres with his instrument, than to sink the convexity of his lithotrite into the floor of the bladder, open its jaws, and then jar the instrument, or the patient's pelvis, in order to get the stone between them. In short, it involves less danger to the bladder, for the surgeon to go after the stone with his lithotrite, than to compel the stone to come to the lithotrite, held in a fixed position. The latter has been the English practice; the former, the method finally adopted by Civiale, and for this Sir Henry Thompson, the highest authority among living lithotritists, after fairly trying them both, expresses a decided preference. But, in truth, lithotrity as practised at the present day includes the advantages of both of these methods, their faults having been, in a great measure, eliminated by the teachings of experience. By careful adjustment of the patient's position, the exact point occupied by the stone is determined with so much accuracy, and it is brought so near to the jaws of the lithotrite, that very limited movements of the instrument are required in order to grasp it. The precise character of these movements is now to be described, and they are to be carefully studied by the operator who desires success, for he should have the details of all necessary manipulation clearly in his

mind, and through practice upon the dead body should have acquired the ability to apply them with precision as required.

It has been already stated that in a patient judiciously prepared for the operation and properly placed in position, the lithotrite will strike the stone in a majority of cases, when introduced according to the rules which have been given. When the expected contact of the stone does not take place and the beak of the lithotrite has reached the most depending point of the bladder without detecting any evidence of its position, then the operator proceeds as follows: He opens the jaws of the instrument, by withdrawing the male blade to the required extent, and inclines them first to one side, to an angle of about 45° , and then closes them; failing to catch the stone, he inclines them to the same degree on the other side, and closes again. By one or the other of these movements the stone is almost certain to be caught. If not, the manœuvre is to be repeated, inclining the open jaws of the lithotrite to a greater angle, even to the horizontal position, if no resistance is encountered, and carefully closing them, first on one side of the bladder, then on the other. If it should happen, as is rarely the case, that the stone is not caught, or even touched, by any of these movements, and if the larger lithotrite, generally required for a first crushing, has been employed, then it is wiser that the surgeon should very quietly withdraw the instrument, consider the whole proceeding as an exploration, and take time for further study of the requirements of the case—some of these not having been properly met. It is better that he should stay his hand and accept momentary disappointment, than incur the slightest unnecessary risk—especially to be dreaded after a first crushing—of unpleasant consequences from prolonged contact of the instrument with the bladder. Here the advantage is apparent of not having previously announced that the crushing operation was to be performed at a time fixed for the purpose, as already suggested; for the patient will have been spared not only its anticipation, but also the demoralization which might follow a suspected failure. And there are other contingencies, such as the occurrence of an unusual amount of pain or of sudden spasm of the bladder on introduction of the lithotrite, or difficulty in seizing a full-sized stone with the lithotrite of largest curve, where postponement of the operation until another day would be judicious, the possibility of which confirms the wisdom of this policy. The experienced surgeon knows that it is useless to contend with the bladder in certain moods, and his tact leads him to defer action without hesitation, when necessary, and await a more favorable opportunity.

When it has been ascertained during the preliminary study of a case that there is an excavation at the base of the bladder, behind the inferior margin of its outlet, where a stone, if present, would almost invariably be found, and especially when there is enlargement of the prostate, an additional manœuvre may be required. In this, the beak of the