"beak," or short-curved extremity. The point at which the beak joins the shaft of the instrument is its "angle," and this should be somewhat greater than a right angle, but not exceeding 120°, as, beyond this, power would be sacrificed to facility of introduction. Regarding the lithotrite as a sort of sliding forceps, we recognize a "female" (Fig. 85) and a "male" blade (Fig. 86), the former larger, heavier, forming the greater proportion of the instrument at its beak and shaft, which is deeply grooved for the reception of the male blade; the latter, called by some the sliding-rod, more slender, but carrying the screw at its handle, is intended to move backward and forward in the groove of the female blade, and here the finish should be perfect, in order to avoid friction. When the male blade is pushed forward as far as it will go—pushed home—the beak of the lithotrite is closed and solid; as it is moved backward, or withdrawn, the jaws of the instrument are in the same degree opened. A measuring scale marked on the front of the handle of the lithotrite indicates, with exactness, the extent of this opening.

The jaws of a lithotrite vary in strength and structure in accordance with the work required of them. For the exertion of the greatest degree of crushing power, as when brought to bear upon a stone of size and hardness, the jaw at the end of the male blade is narrow and fashioned into deep and sharp angular teeth, while its fellow is broad, heavy, and "fenestrated" (Fig. 87); that is, furnished with a longitudinal slit, or window, at its centre, through which detritus and fragments are forced, as the jaws are closed, thus preventing clogging, or impaction. These jaws are also of as great length as the necessity of their being worked in the limited cavity of the bladder will permit. Hence the calculus upon which their teeth cannot be firmly fixed may be fairly regarded as beyond the reach of the crushing operation.

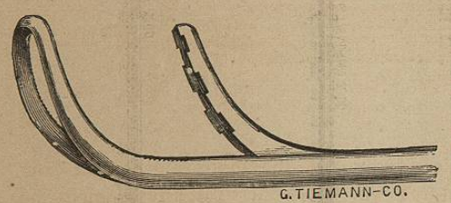


Fig. 87.

Where less power is required, as in crushing small or soft calculi, or in pulverizing fragments, the jaws of the lithotrite are shorter, and less heavy, and their opposing surfaces are simply roughened (Fig. 86). With this instrument, Sir Henry Thompson tells us, he does nine-tenths of the work. In the so-called "scoop" lithotrite, the extremity of the female blade is excavated into a shallow, spoon-like cavity, and both jaws are short and smooth. In the two latter instruments there is a small opening at the angle of the female blade for the escape of detritus; and the angle of the male blade, in all of them, is purposely made its point

of least strength, so that if fracture should possibly occur, it must take place at this point, and the resulting fragment be small and easily removable.

The "beak" of the lithotrite, in all forms of the instrument, should be perfectly smooth and well rounded externally, the jaws of the female blade being in all cases wider, so as to receive that of the male blade into its cavity; and the edges of each carefully beveled, so as to offer the least possible chance of catching a fold of mucous membrane between them as they come together.

The "male blade" can be readily detached from its fellow, for the purpose of cleaning the instrument. In its handle is lodged the power, an endless screw, worked by a wheel which forms a part of it (Fig. 86). The "female blade," in the English instrument, is furnished with a fluted cylinder at its handle, for convenience of manipulation (Fig. 82). Here we find a button (Fig. 87, *bis*), connected with a small cog consisting of a few threads of a female screw movable by applying a thumb to the button, and so constructed that, by this simple movement, it can be thrown into or out of connection with the endless screw in the handle

Fig. 87 (*bis*)

of the male blade. By this simple and ingenious mechanical contrivance, a power is held in reserve which may at any moment be brought to bear upon an object grasped between the jaws of the lithotrite. In the original instrument of Weiss, the screw was worked by hand like a gimlet, and, when screwed home, and the stone or fragment crushed, it was necessary to unscrew it again by the same slow movement, before its jaws could be opened sufficiently to grasp another fragment. The contrivance at present in use was devised by Charrière, the ingenious surgical-instrument maker of Paris, and is called by the French the "écrou brisée." In the French lithotrite the screw-power is thrown in and out of gear by a quarter-turn of a movable disk, attached to the handle of the female blade, and this takes the place of the button-trigger of the English instrument.

In studying the instruments employed in lithotrity it must be borne in mind that the object of the operation is to reduce a stone to powder, with the least possible risk to the bladder or urethra. This risk comes from contact of the necessary instruments, and of fragments of stone as they escape. In the construction of the modern lithotrite, the avoidance of injury by contact has been kept scrupulously in view, while preserving

enough strength to accomplish its purpose. Hence its greater lightness as at present used; the force of contact is materially diminished. The beveling of the edges of the jaws of the lithotrite, to prevent nipping of the mucous lining of the bladder, the slenderness of its shaft, to obviate friction against the walls of the urethra, and its general smoothness and accuracy of finish, all conduce to this general object. It is obvious that, the greater the power of the instrument, the greater the risk to the bladder. For this reason the heavier lithotrite is resorted to only in case of absolute necessity, almost all the work being accomplished by the lighter one. When a stone or fragment is seized by one of these, and its power proves insufficient, the stone will slip from the grasp of the instrument; the comparative smoothness of its jaws favors this result. In the rare cases where too hard a stone is fairly between the dentated jaws of the lithotrite of greatest power, the operator will distinctly recognize the recoil and spring of his instrument as he turns the screw, and he must use his tact and judgment in not urging it too far. Yet, cases in which a lithotrite has broken in the bladder are singularly infrequent, especially so since lithotrity with modern instruments has been so generally employed.

It will be evident, from what has been said, that the lithotrites of the present day are designed to crush calculi in the bladder, and to reduce their fragments to coarse powder, so that the *débris* thus produced may readily pass with the urine. Formerly it was a part of the operation to remove the *débris* after crushing, and scoop-lithotrites, made especially for this purpose, were employed. As experience has increased, it has come to be regarded as a principle essential to the success of the crushing operation to avoid officiousness in the use of instruments, and to trust as much as possible to the efforts of Nature. Hence the surgeon confines his efforts to thoroughly reducing the calculus to powder, and confidently leaves the result to the expulsive power of the bladder—which experience has shown to be fully adequate to this end.

There are cases, however, in which the tolerant condition of the bladder invites lithotrity, but where the bladder's contractile and expulsive power is defective; where an obstruction or dam has been formed at its outlet by an enlarged prostate; or where both of these disabilities coexist. Here, if the patient has already learned to pass a catheter for himself, an instrument—flexible, or of silver—of larger calibre and with larger eyes may be substituted for that in ordinary use, and, if sufficiently docile, he may be taught to wash out his bladder with tepid water (p. 196). Otherwise, after the stone has been crushed, the evacuating catheter (Fig. 88) must be employed by the surgeon. This instrument is made, preferably, of polished iron, of as large calibre as the urethra will admit, with a large, oval opening at its convexity, and provided with a jointed stylet (*a*), terminating in a roughened head—by means of which a fragment, accidentally lodged in the instrument or at its eye,

may be promptly crushed or forced back into the bladder, if the current of water should prove insufficient to dislodge it. The caoutchouc bag (*b*) is better than any form of syringe; it can be used with one hand, by the patient himself, and with less risk of violence to the bladder.

There is a certain advantage in teaching a patient to use instruments for himself; where atony exists, this *must* be done sooner or

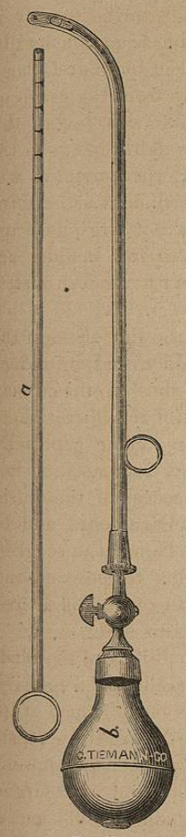


Fig. 88.

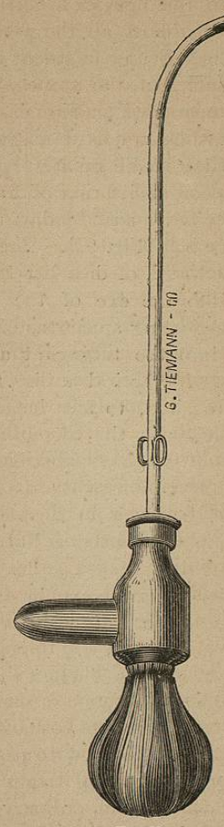


Fig. 89.

Fig. 90.

later, and the sooner the better. But, if time presses, or the patient be slow in learning, it may be necessary for the surgeon to act, and, in any case, he should lead the way.

The evacuating catheter is better introduced while the patient is on his back, and a little tepid water thrown in—a four-ounce bagful, if the bladder will receive it. Then let him get into the upright position and

lean a little forward, while as much more water is injected as will bring on a slight sensation of distention, or desire to urinate ; at this moment withdraw the catheter a very little, so that its eye is just at the outlet of the bladder, and then disengage the nozzle of the injecting-bag and let the water escape. If gently managed, this manœuvre can be repeated several times without too much fatigue to the patient, or to his bladder, and it is the most effectual method of getting rid of the *débris* of a stone, where the bladder cannot act for itself.

There are other modes of accomplishing the object, which may be employed where the patient is unable to assume the upright position, or where it has been thought better to operate under the influence of an anæsthetic. Clover's apparatus (Fig. 89) consists of a large-eyed metallic catheter, such as has been described, to the nozzle of which a powerful sucking-bottle of caoutchouc, with a cylindrical reservoir of glass at its neck, is adapted. This has been modified in Paris by substituting an exhausting-pump for the caoutchouc bag (Fig. 90). There is some danger, when suction is employed, of drawing the mucous membrane of the bladder into the eye of the catheter. The ordinary enema or self-injecting apparatus of caoutchouc, with a glass reservoir let into the tubing at a short distance from its nozzle, is also of practical utility. Additional tubing can be added, if desired, to any length. The fragments can be seen collecting in the transparent reservoir, while the supernatant fluid is thrown back into the bladder.

Fig. 91.

Before finally withdrawing the evacuating catheter, the patient should be again in the horizontal position, and, the instrument being advanced a little farther into the cavity of the bladder, the pointed stylet should be reintroduced. This precaution is necessary, in order to get rid of a fragment possibly impacted in the eye of the catheter, which might cause laceration in withdrawal, as well as to close this large opening, the edges of which would be liable to occasion a similar accident.

The double catheters employed for washing out the bladder by a continuous current are not suitable for the present purpose. The channel of exit cannot be made large enough to serve efficiently in the evacuation of *débris* without increasing the diameter of the instrument beyond a convenient size. The best of them, that of Mercier, of Paris (Fig. 91), has this fault. There are conditions, however, in which such an instrument might render service.

The large opening or eye at the beak of the evacuating catheter is made, in some instruments, at either, or on both sides, at its concavity or convexity.

In the use of all evacuating catheters it is well to exercise caution as to over-distention of the bladder by the injected fluid, especially in a patient who is insensible. Fluids under pressure transmit force equally in every direction, and in much greater degree than seems probable to one who has not given especial attention to this point. Moreover, it is one of the objections to lithotrity that it leaves the bladder with a tendency to atony, and this is a condition readily produced, or aggravated, if already existing.

Whenever it is feasible, the urine passed after the crushing operation has been performed, or the washings of the bladder—if artificial evacuation has been effected—should be passed through a strainer, and this should be provided before crushing. A piece of muslin, substituted for the perforated bottom of an ordinary tin colander, and kept in place by a movable ring or band slipped on its projecting bottom rim, makes a very good strainer. Such a contrivance may be placed upon an ordinary chamber-vessel, and so used; or, if the patient passes his urine while in bed, the contents of his urinal should be poured upon the strainer, so that all detritus escaping from the bladder shall be surely collected.

Impaction of a Fragment in the Urethra.—A fragment of the crushed calculus may lodge in the urethra, and require surgical aid to effect its removal. This accident, formerly not infrequent, and greatly feared, occurs rarely in modern practice. Its frequency in the early history of lithotrity—Leroy d'Etiolles says it is to be expected once in every four cases—was due to the impatient desire to see the immediate effect of the operation, which led to early and unrestrained efforts at voiding urine to get rid of the result of the crushing. The surgeon, also, considered it his duty to bring away as much as possible of the crushed stone between the jaws of his lithotrite, after each operation—a frequent cause of abrasion and laceration of the lining membrane of the urethra, producing, naturally, an irritable condition of the muscular tissue surrounding it, and a tendency to spasmodic contraction. Such a condition would greatly favor the arrest and impaction of a sharp angular fragment, or even of a round or smooth one, which, in a healthy urethra, would find its way out readily. At the present day, every precaution is taken to avoid injury to the urethra, and the patient is not allowed to pass water in the upright position for at least twenty-four hours after an operation of lithotrity. Moreover, the surgeon makes it a point to pulverize the fragments of the stone as thoroughly as possible, and the improved construction of his instruments enables him to do this without fatigue or injury to the bladder. Yet, the accident will occasionally happen, and it is well to keep the possibility of its occurrence in view under the following circumstances: when operating upon young and irritable subjects; whenever uncontrollable spasm of the bladder comes on, as it sometimes does, after a crushing; and, especially, when stricture, or any lesion of the urethra, has existed.

The varying dimensions of the urethral canal explain why impaction

of a fragment occurs, almost of necessity, at certain points where it is narrowest, viz.: at its membranous portion just behind the hole in the triangular ligament, where also the presence of the cut-off muscular fibres especially invites the accident; at the middle of the spongy portion, where the urethra, after its enlargement opposite to the bulb, has again gradually diminished in calibre; and, finally, just within the external meatus.

At each of these points the removal of an impacted fragment calls for a different surgical manœuvre. If lodged in the bladder-side of the opening in the triangular ligament, or in the grasp of the "*cut-off*" muscles, it is to be gently pushed back again into the bladder. This

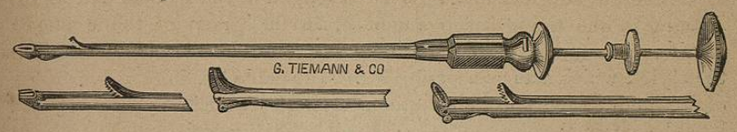
Fig. 92.

Fig. 93.

Fig. 94.

has been effected most frequently, perhaps, by the introduction of an ordinary full-sized catheter; but the following is more perfectly adapted to the purpose, namely, a metallic catheter of the largest size, with an open end, containing a bulbous stylet that fills the open end during

introduction, and when in contact with the calculus can be withdrawn, so as to leave a cup-like cavity, with rounded edges, to inclose the fragment more or less completely. Should the fragment prove to be immovable without the use of force, which must always be avoided, the injection through the catheter of water, olive-oil, or flaxseed tea, as warm as can be borne, will aid the manœuvre. When a fragment has freed the opening in the triangular ligament, and has lodged at a point in front of it, an attempt to push it back into the bladder is not advisable.



A. Fig. 95. *B.*

The proper course now is to withdraw it through the meatus. For this purpose a variety of instruments have been devised, their number suggesting the idea that the proceeding is not devoid of difficulty; and, in view of the danger of laceration of the urethra, this is not without truth. The best of these instruments is the simple, long, urethral forceps (Figs. 92, 93, 94) in one of its forms.

The instrument represented (at Fig. 93) has one solid blade, while Fig. 94 is jointed so as to work by double lever. The former is more efficient. Ordinary urethral forceps (Fig. 92) should always have long, slender blades, with spoon-shaped jaws, slightly roughened on the concavity, and handles that cross each other, so as to prevent over-distention of the meatus when the jaws are opened. The flat, jointed, urethral

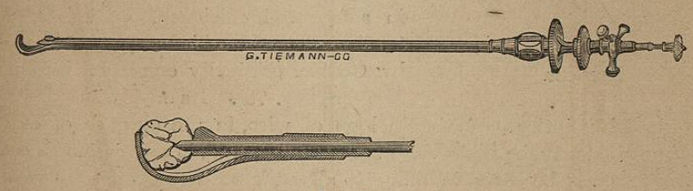


Fig. 96.

scoop of Leroy d'Etiolles (Fig. 95) still remains in favor. It is introduced, open (*A*), a little beyond the fragment, and then, by turning a screw at its handle, the little spoon-shaped beak is gradually brought to a right angle with the shaft (*B*). Although this ingenious instrument has a certain degree of efficiency, yet, as the walls of the urethra are not protected by it from contact with the rough surface of the fragment, abrasion will almost certainly occur as the latter is being withdrawn. This liability is best avoided by crushing the fragment in the

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 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.

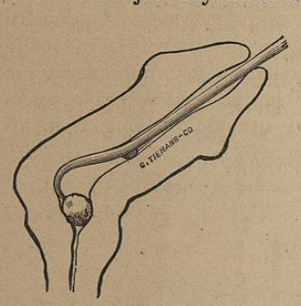


Fig. 97.

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 lithotrity, 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.

Lithotrity 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 Lithotrity, their Significance and Management.

The position of the patient during the operation of lithotrity 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.