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EVACUATION.

BY

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LITHOTRITY WITH EVACUATION.

WHEN Sydney Smith asked, "What human plan, device, or invention two hundred and seventy years old does not require reconsideration?" he would no doubt have regarded with favor an occasional reconsideration of the theory and practice of medicine and surgery, — especially in view of the current belief that their traditions had been kept alive and their rules prescribed in part by authority. The surgical literature of Lithotomy, both French and English, so long showed the influence of the early specialists, that we have hardly now escaped from its exaggerated circumstance and detail. And yet, with attention to a few precise rules, the operation of lithotomy is quite a simple one, — much less difficult, for example, than the dissection of tumors. It is not impossible that convictions in some degree traditionary may prevail in regard to certain points connected with the practice of the more recent art of Lithotrity.

Civiale was among the first to inculcate the excessive susceptibility of the bladder under instruments. Later surgeons, perhaps influenced in part by his teaching, have continued to invest the operation of lithotrity with precautions which, though by no means groundless, because under certain conditions both the bladder and urethra are actively resentful of even slight interference, are nevertheless greater than this operation generally requires. As a rule, there is little difficulty in it. The stone is readily caught and broken into fragments, of which a few are pulverized; a large-eyed catheter is then sometimes introduced; a little sand and a few bits of stone are washed out; after which the patient is kept quiet, to discharge the remainder and await another "sitting." Under

favorable circumstances, such an operation, lasting a few minutes, is not only simple, but, if skillfully performed, safe.

On the other hand, it is not always safe. This is the fact that seems to have arrested so strongly the attention of surgeons. It may happen that during the succeeding night the patient has a chill, — not the chill of so-called "urethral fever," which sometimes follows the mere passage of a bougie, and which is of little consequence, but one followed by other symptoms, such as tenderness in the region of the bladder, a quickened pulse, an increasing temperature, and the frequent and painful passage of urine. These symptoms may insidiously persist rather than abate. Others may supervene. The surgeon vainly waits for a favorable moment to repeat his operation; it becomes too evident that the patient is seriously ill, and it is quite within the range of possibilities that in the course of days or weeks he may quietly succumb. An autopsy discloses a variety of lesions, — some of them remote or obscure, others of more obvious origin, — and among them, not the least common, an inflamed bladder, upon the floor of which angular fragments and chips of stone are resting. It is then evident that during a certain interval before death the bladder was not in a condition for further instrumental interference; and although, in view of the fatal result of delay, lithotomy or active lithotrity, to both of which I have resorted, might have been deemed on the whole the less dangerous, still it is plain that either operation would have furnished in itself an additional cause of serious inflammation.

Such cases have been supposed to point to the necessity of extreme precaution, as well as of extreme remedies. It is evident that the purpose of such interference at an unfavorable moment is the removal of the offending fragments as a last resource. But if at the first operation the bladder could have been completely disembarrassed of every particle of stone, even with the risk of irritating its lining membrane, we can hardly doubt that the relief would then have been followed by comparatively ready repair. In short, it is difficult to avoid the conviction that in an average case damage to the mucous membrane is as likely to result from irritation by angular fragments, added to the injury inflicted by an opera-

tion, as from the use of instruments protracted beyond the usual time, for the entire removal of a stone, if this result can be accomplished.

It is probable that injury from the use of instruments has been confounded with that resulting from the presence of fragments in the bladder. That the average bladder and urethra have no extreme susceptibility is attested by the generally favorable results of lithotrity, and even of catheterism, which are practised with very varying skill everywhere; also by the singularly innocuous results of laceration of the contracted urethra, by an instrument like that of Voillemier, for example; so, too, by the recovery of these organs from the considerable injury inflicted during the extraction of a large and rough stone in lithotomy. The bladder is often also to an extraordinary degree tolerant of the presence even of a mulberry calculus. If we remember that in this case it clasps the stone at every micturition, often with a persistent gripe, the comparative immunity of its tender mucous membrane is quite remarkable. But when after an operation, sharp fragments are thus embraced, presenting acute angles, which do not soon become blunted, and to which the bladder is unaccustomed, it is still more remarkable that serious consequences are the exception and not the rule in lithotrity. Polished metallic surfaces carefully manipulated can hardly do such damage as the other agencies here mentioned.

Gentleness, dexterity, and experience are especially to be valued in lithotrity. If the bladder is pinched, the patient may die. A false passage or a lacerated inner meatus is a serious complication. It has been well said that no novice should undertake this operation. But the habit of confounding the symptoms resulting from the presence of fragments with those following the use of instruments originally led to precautions in the introduction and manipulation of the latter which are sometimes excessive. Civiale, with an almost unparalleled experience, introduced a small lithotrite with much less pressure than its own weight, and with uniform and great slowness. And yet, in a healthy urethra, it is only at the triangular ligament and beyond it that such extreme care is called for. The same author, who had no means of evacuating fragments in the bladder, restricted the length of his operation

to two or three or perhaps five minutes. The like solicitude seems to have led Sir Henry Thompson, in his admirable and standard work upon this subject, to assign two minutes as the proper average duration of a sitting, — a period which his exceptional skill has often in his own practice enabled him materially to reduce. I have been gratified to find, however, that since he has availed himself of the advantage of etherization he recognizes the benefit to be derived from somewhat more prolonged manipulation. My own conviction is that it is better to protract the operation indefinitely in point of time, if thus the whole stone can be removed without serious injury to the bladder. I believe that in any case as favorable to lithotrity as the average, in these days when stones are detected early, this can be effected, — and that if the bladder be completely emptied of detritus, we have as little to apprehend from the fatigue of the organ consequent upon such manipulation as from the alternative of residual fragments and further operations. The duration of the longest sitting among the cases reported at the end of this paper was three hours and three quarters. The same result can be now accomplished in a shorter time. In a majority of cases the bladder can be completely and at once evacuated. The stone, after crushing, can be removed through the urethra by a tube contrived for the purpose.

But has not this result been already attained by evacuating instruments variously devised and modified? The following quotations from the latest authorities sufficiently answer this question in the negative.

"We may here say, without fear of being accused of exaggeration, that evacuating injections practised after sittings of lithotrity have no apology for their use. *The whole surgical arsenal invented for their performance is absolutely useless. . . . . It should be well understood that the best of evacuating catheters is worthless.*" (Article Lithotritie, by Demarquay et Cousin, in the Nouveau Dictionnaire de Médecine et de Chirurgie Pratique. Paris, 1875. Pages 693, 694.)

"*The practice of injecting the bladder to wash out detritus is obsolete. . . . . This apparatus of Mr. Clover should not be employed, if it is possible to dispense with it*, as its use is quite as

irritating as lithotrity itself." (S. D. Gross, Diseases, etc., of the Urinary Organs. Philadelphia, 1876. Page 232.)

"Having used it [Clover's apparatus], very frequently, I would add that it is necessary to use all such apparatus with extreme gentleness, and *I prefer to do without it*, if possible." (Sir H. Thompson, Practical Lithotrity and Lithotomy. 1871. Page 215.)

"*All these evacuating catheters are little employed.* They require frequent and long manœuvres, which are not exempt from dangers; besides, *they give passage, as a rule, only to dust, or to little fragments of stone, which would have escaped of themselves without inconvenience to the urethra.*" (Article Lithotritie, by M. Voillemier, Dictionnaire Encyclopédique des Sciences Médicales. 1869. Page 733.)

In short, the "evacuating apparatus" and the evacuating method hitherto employed do not evacuate. This fact is beyond question.

Such apparatus is not of recent contrivance. From the earlier days of lithotrity, the operation of breaking the stone has been followed by the obvious expedient of introducing a large and special catheter, through which water was injected and allowed to escape, bringing away a little sand, with a small fragment or two. This attempt at evacuation was aided by suction. With this object, and before the year 1846, Sir Philip Crampton employed an exhausted glass globe. For the same purpose a syringe has been used, or a rubber enema or hydrocele bottle, with which fluid could be also injected and the bladder washed. By entering the catheter well within the bottle or syringe, fragments were dropped inside the neck, where, lying below the current, they remained when the bottle was again compressed. When this neck was made of glass, by Clover, the fragments became visible, as in Crampton's globe, and to this neat arrangement the accomplished lithotritist, Sir Henry Thompson, refers as Clover's bottle. But neither the previous practice nor the efficiency of evacuation by suction through a tube had been materially advanced. In the mean time the syringe was modified in France by a rack and pinion attached to the piston, so that water could be injected and withdrawn with great force, — a procedure not only useless, but detrimental to the bladder, if inflamed and thickened.

Before describing my own instruments, it may be well to say a word in regard to the introduction of large instruments into the bladder. The successful introduction of the large straight tube is so important that it deserves especial mention.

A syringe facilitates the copious use of oil both in the urethra and within the tube. Into the normal urethra a straight instrument can be introduced with more accuracy than a curved one. Either may be passed rapidly as far as the triangular ligament, unless the instrument is very large, in which case great care is required not to rupture the mucous membrane. Having reached this point, which implies that there should be no premature endeavor to turn the instrument, but that it should be passed *as far as it will go in the general direction of the anus before its direction is changed*, the extremity of the instrument depresses the floor of the urethra in front of the ligament. Traction upon the penis next effaces this depression, and adds firmness to the urethral walls; so that if the instrument be withdrawn a little, and again advanced after lowering the handle, it can be coaxed without difficulty through the ligament in question, — a natural obstruction which physicians often mistake for a stricture. The straight tube may be *advantageously rotated through the aperture like a corkscrew*. This obstruction passed, the rest of the canal is short, and corresponds to the axis of the body, to the line of which the instrument is now depressed. Even the enlarged prostate can often be traversed advantageously by a straight instrument. In fact, the metallic prostatic catheter, before it was superseded by the modern rubber one, consisted essentially of an inch or two of straighter tube added to the extremity of a common catheter, to reach through the unyielding prostate before the hand was depressed and the beak turned up. In passing either a sound, catheter, or lithotrite, the extremity of a straight instrument, and, curiously enough, the convexity of a curved one, is sometimes arrested just at the entrance of the bladder by the firm lower edge of the inner meatus. The fact that water now dribbles through the inner meatus thus dilated, or that a stone is felt with the tip of the curved instrument, which has really entered the bladder, may lead the operator into the mistake of supposing that the instrument is

fairly within; and I have known its further entrance, after sliding over this obstacle, to be erroneously explained by assuming the existence of a second or hourglass cavity in the bladder itself. To obviate this difficulty, and so soon as the triangular ligament is passed, a catheter, if curved, should be pressed through the indurated neck or prostate in the direction of the axis of the body, by the hand on the perinæum, — a most efficient manœuvre, when the prostate is large. If there be further difficulty, the tip should of course be sought and guided in the rectum. After introduction, a straight tube or the shaft of a curved one often returns to an angle of about 45° with the recumbent body, and, if the patient is not etherized, a feeling of tension may then be relieved by depressing, with the hand upon the pubes, the suspensory ligament of the penis, — an expedient also useful during the passage of the instrument.

My own practice has always been to etherize for lithotrity.

Each operator prefers the position to which he is accustomed; and when the urethra is healthy, this is of very little importance. But if there be obstruction, a position at the patient's left side enables the operator to introduce a catheter or lithotrite to advantage with the right hand, leaving the left hand free to act in the perinæum. After the instrument is introduced, and both hands are required above the pubes, they are most available, if the surgeon changes his position and stands upon the patient's right. I also introduce the straight tube on the right side.

It is important by a preliminary injection to ascertain carefully the capacity of the bladder by emptying it and then refilling it slowly with warm water previously measured, until the water is expelled through the loosely held urethra by the side of the tube. In this way we prevent its over-distention. In the etherized subject a short pipe or nozzle suffices for this purpose. I have for many years employed a common Davidson's syringe. An unetherized patient may for a moment resist this injection through a short tube by contracting the sphincter of the bladder; but this readily yields. Except in a large bladder, a distention by eight or ten ounces suffices for breaking the stone. The smaller the injection of water, the more readily, indeed, do fragments fall into the blades of the instrument. But, unfortunately, so also does the mucous membrane. In

fact, with too little fluid in the bladder the use of a lithotrite in unpractised hands is attended with danger; and in a long sitting an injection which will render the walls moderately tense is the only really safe way of keeping the bladder from between the blades. A careful examination of the action of a lithotrite through an opening in the summit of the bladder, has confirmed me in this opinion, which was that of the older writers on this subject. From time to time the diameter of the collapsing bladder should be estimated by slowly opening the blades of the lithotrite, and water introduced when necessary; but care should be taken to guard against the serious injury to a contracted bladder which might result from injecting the contents of the syringe or aspirating bottle when it is already distended.

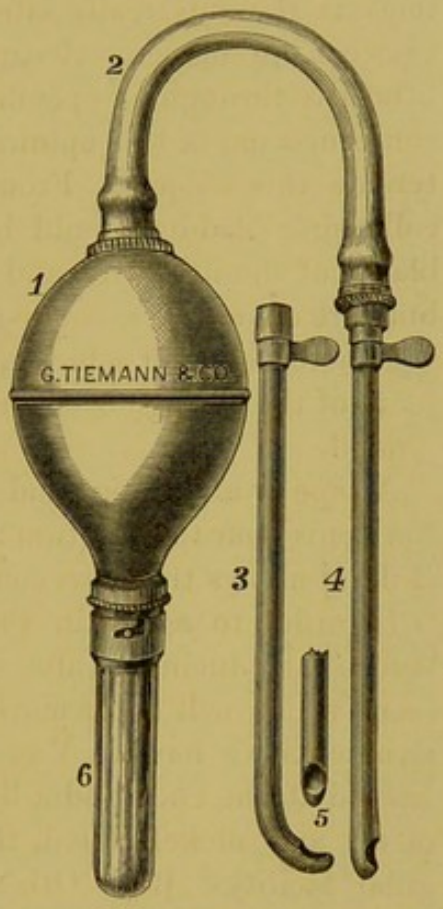
A tape or an elastic band wound lightly once or twice around the penis near the scrotum retards the escape of injected water, and yet allows the movements of the tube or lithotrite.

In order to ascertain the maximum calibre of the urethra before introducing a tube, it should be measured by an instrument which will enter more readily than the tube. Such instruments we have in Van Buren's sounds, which are slightly curved at the end, and a little conical. Being made of solid metal, and nickel-plated, they traverse the urethra with singular facility. Both Otis's sounds, and the conical probe-pointed elastic bougie also answer admirably for this purpose.

Evacuating Instrument. (Figure 1.) — The following points are worthy of consideration in connection with any evacuating apparatus. The ten-ounce elastic bulb or bottle supplied with the usual instrument is inadequate to the exhaustion for which it is designed. It will barely sustain, without collapse, a vertical column of water of the length of a catheter. A thick flask fatigues the hand of the operator. The bulb is also an awkward weight at the top of the catheter. These difficulties are obviated by interposing between the catheter and bulb a piece of rubber tube, varying in length, as the surgeon may prefer, from six inches to two feet, to relieve the bladder from the force of any movement of the apparatus, and, what is more important, to allow the operator to hold the bulb on a level with the water in the bladder, or consider-

ably below it. The exhaust then acts as a siphon, and readily draws off the water. The fragments gravitate to the bottom of the bulb, and are there collected in a glass chamber. (See Figures 1, 4, 5.) To prevent the possible return to the bladder of some single fragment while on its way to this receptacle, the rubber tube, if long, should be provided with a small glass trap containing a wire-gauze or perforated tube, to deliver the current and strain it on its return, but with a short rubber tube (Figs. 1, 4, 5), which is more convenient, this is not essential. One or two smaller bulbs might perhaps be provided for a contracted bladder.

FIG. 1.



(FIG 1.) Evacuating Apparatus. 1. Elastic bulb. 2. Curved rubber tube. 3. Curved evacuating tube of silver. 4. Straight evacuating tube, which is preferable to the curved one. 5. Front view of same. 6. Glass receptacle with bayonet joint for debris. (Tiemann & Co., N. Y.)

The successful evacuation of the bladder depends upon several conditions, both in the apparatus and in its use, which for distinctness may be enumerated separately.

(1.) *A large calibre of the evacuating tube.*

(2.) *Its shape.*

(3.) *The shape of its receiving extremity.*

(4.) *Manipulation of the bulb.*

(5.) *Evacuation of the fragments.*

(6.) *Immediate recognition and removal of any obstruction in the tube.*

(1.) *A large calibre of the evacuating tube.* Whether or not we adopt the view of Otis, that the average capacity of the normal urethra is at about 33 of Charrière, there can be no question that it will admit a much larger tube than that commonly attached to either Clover's or the French apparatus. The efficiency of the process of evacuation depends much upon using the largest tube the urethra will admit. This fact has

been stated by Sir Henry Thompson. But he recommends for the glass cylinder or trap which is to admit this tube a "perforation at the end, the size of a No. 14 catheter," = 25 Charrière.[1] This perforation is too small; and the tube which is designed to enter it is further reduced by its collar to the diameter of only 12, = 21 Charrière. In fact, this is the calibre of the evacuating catheters now attached to Clover's instrument, and is of itself fatal to their efficiency. An effective tube has a calibre of 28 to 31 or even 32 Charrière, and the meatus, which is the narrowest part, may, if necessary, be slit to admit it, if the urethra is otherwise capacious. Again, in the instrument, as sometimes constructed by Weiss, a joint is made by inserting an upper tube into a lower one, thus obstructing the calibre by a shoulder. The joints should become larger as the tube approaches the bottle, so that the tube may deliver without difficulty fragments of its own calibre. Whatever be the size of the evacuating tube, the rubber tube, with its metal attachments, should have a calibre of at least seven sixteenths of an inch, = 31 Charrière.

My evacuating tubes are of thin silver, of sizes 27, 28, 29, 30, and 31, filière Charrière, respectively.

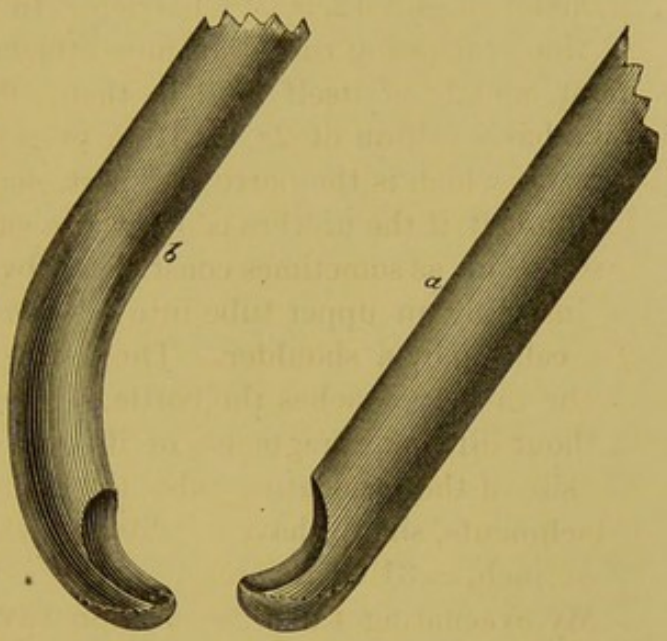
(2.) *Shape of the tube.* Works upon lithotrity enumerate and figure a variety of tubes through which fragments are to be aspirated. Many of these are useless. The best tube is a straight one. (Figure 2 a.) That which is curved quite near the extremity is designed to be used with the curve inverted and directed downward, the orifice then looking forward.

(3.) *Shape of the receiving extremity.* The receiving extremity should depress the bladder when required to do so, and thus invite the fragments, while its orifice remains unobstructed by the mucous membrane. Upon the floor of the bladder, when not indented, a fragment of stone, lying at the distance of half or even quarter of an inch from the tube extremity, may not be attracted by the usual exhaust of the expanding bottle, which requires that the fragment should lie almost in contact with the tube. A very slight obstacle also impedes its entrance; and this fact renders inefficient all tubes like catheters, with orifices along the side or upper wall. Chips will not

[1] Diseases of the Prostate, 4th edition, 1873, page 337.

surmount their edge. Again, the orifice of a tube cut square is at once occluded by drawing in the vesical wall, while the spoon-shaped beak of the French instrument, made like the female blade of a lithotrite, allows fragments to lie too far from the opening in the tube. The best orifice is at the side of the extremity, and is made by bending the tube at a sharp right angle, carefully rounding the elbow, and then cutting off the bent branch close to the straight tube. (Figure 2 a.) The tube is then practically straight, while the orifice, which is slightly oval, delivers its stream laterally. The edge should be thickened and rounded to slide smoothly through the urethra; any rim inside the orifice should be masked by a false floor; but the calibre should be nowhere contracted. If the side walls of this orifice be removed a little, it gives an unguiform extremity to the tube, which is advantageous; and in introducing such a straight tube this tip should be insinuated through the triangular ligament by rotation. If a couple of inches of the end of such a tube be bent, it may be inverted after introduction, and will bury itself in the floor of the bladder, which it depresses, while the orifice looks forward and is unobstructed. (Figure 2 b.) This form is tolerably efficient; although I prefer the straight tube, as less liable to lodge fragments, and more readily cleared by a rod, — as safer, because it involves less risk of injury to the bladder than is incurred by the rotation of a curved extremity, — and especially because it is easy to know exactly where the extremity

FIG. 2.

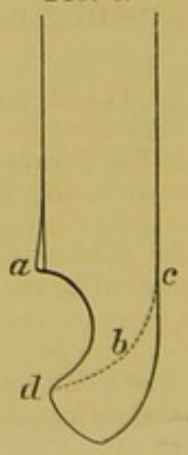


(FIG. 2.) Evacuating tubes, with unguiform extremity. *a*. Straight tube. *b*. Curved tube. The dotted lines show the false floor of the extremity. The tubes are here of a diameter 31 Charrière. The straight tube is preferable.

lies. An effective instrument may be made of a straight tube cut square at the end, if a disk convex outwardly, to repel the bladder, be attached to it, at the distance of a diameter from the orifice. This was the original of the straight tube already described. When such an instrument is introduced, the interval can be filled by a rod. Indeed, the orifice of a tube should be contrived with a view to its introduction. The French tube already spoken of, shaped like the female blade of a lithotrite, would be efficient, if it were made large enough, — as it is not, — and if the shoe were bent to make a precipitously inclined plane for the fragments. It would then offer a prolongation of the unguiform tip; but, thus sharply bent, it would be less easy to introduce. Whatever be added to the extremity of the tube, in order to facilitate its introduction or to repel the bladder, should not prevent the orifice from lying, if required, in the floor of the bladder at the apex of a steep inverted tunnel.[1]

(4.) *Manipulation of the bulb.* When the capacities of the bladder and urethra have been ascertained, the evacuating tube is introduced and the bladder completely emptied. A few ounces of water are next injected, that the fragments may still be floated after aspiration, and the apparatus, previously filled with water, is attached to the silver tube. To fill the bulb and at the same time expel the air, it should be held upright and several times compressed while the curved elastic is immersed in water, the latter being then kept uppermost until attached to the evacuating tube. Air in the bladder disadvantageously distends it without floating the fragments. The large bulb, together with its tubes, contains about ten ounces. If compressed with one hand until the sides meet, only about five ounces are displaced. If half compressed and then worked

Fig. 3.



[1] Too large an orifice impairs the suction and admits fragments that become wedged higher up. If the straight tube (Fig. 3) be closed by an extremity symmetrically round or ovoid, to facilitate its introduction, the hole *a d* in its side should have a length but little greater than the diameter *a c* of the tube. The curve of the inside floor *b* is a quarter circle described upon *a* as a centre. The tube is then proved by a close-fitting ball rolled through it from above. At *a* the edge is a little thickened on the outside, and at *d* rounded, to protect the urethra.

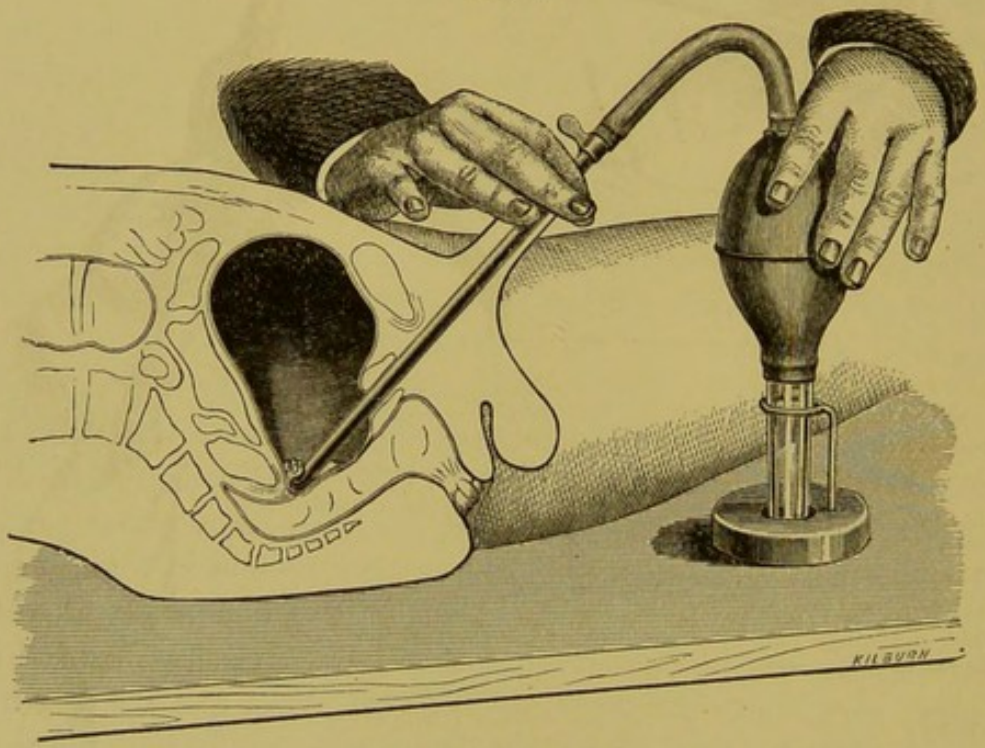
with a shorter movement, about two ounces are moved back and forth; so that, provided the tube itself be handled carefully and skilfully, the bladder is not greatly disturbed. At the beginning of the process the short movement is effective. The object of more water is to prolong suction when fragments are passing freely, — also occasionally to stir up the debris, — and especially to relieve obstruction in the tube, when it occurs. The best position for the surgeon is at the right hand of the patient, resting his left wrist on the pubes to steady the tube, while the bulb is supported in a stand on the table between the thighs. (Fig. 4.) Or, (Fig. 5,) the surgeon, sitting between the supported feet of the patient, compresses the bulb with the right hand, using the left alternately to hold the glass trap and to adjust the silver tube. In the latter position the hand is apt, when fatigued, to bear heavily on the evacuating tube, so that it is better then to use the bulb as a handle to direct the silver tube, the interposed elastic saving the bladder needless fatigue.

(5.) *Evacuation of the fragments.* Evacuation of the fragments is quite an entertaining art, requiring as much skill to accomplish the result in the shortest time as crushing them. Dexterity in the process will hardly be acquired without practice outside the bladder.[1] If the bulb be compressed and immediately allowed to expand, while the tube is held just above the debris, the fragments should fall in a shower into the trap. The operation may be divided into a first and a last half. During the first half, while the fragments are numerous, the secret is to separate and float them by the injection, so that they may enter the tube as they fall, in single file, without obstructing it. This is accomplished by keeping the orifice of

[1] The bladder may be imitated by the lower two-thirds of an ox-bladder (carbolized for cleanliness) suspended inside a vessel having a mouth of four or five inches diameter, to which it is tied. The vessel should be previously nearly filled with water. To show the different and more efficient action of circular currents in the closed bladder, let the ox-bladder be tied to the evacuating tube, and held before a bright light. With a tin funnel secured to the summit of a human bladder (*in situ*) to aid in replacing the fragments, the process of evacuation can be rapidly repeated. Calculi may be imitated by coal of varying hardness, or by a bit of old grindstone; a lighter and tough material for crushing, and liable to impact, is the cheap compressed meerschaum.

the tube away from the floor, aspirating them quickly while on the wing, just above the comminuted mass. In the latter part of the process, and after the smaller debris has been removed, the tube may be made to indent the floor so as to gather instead of separating the fragments; and as a final measure the tube should be raised towards a perpendicular in order to carry the orifice nearer the prostate. Some of the chips are apt to collect behind the tube orifice. The tube thus raised

FIG. 4.

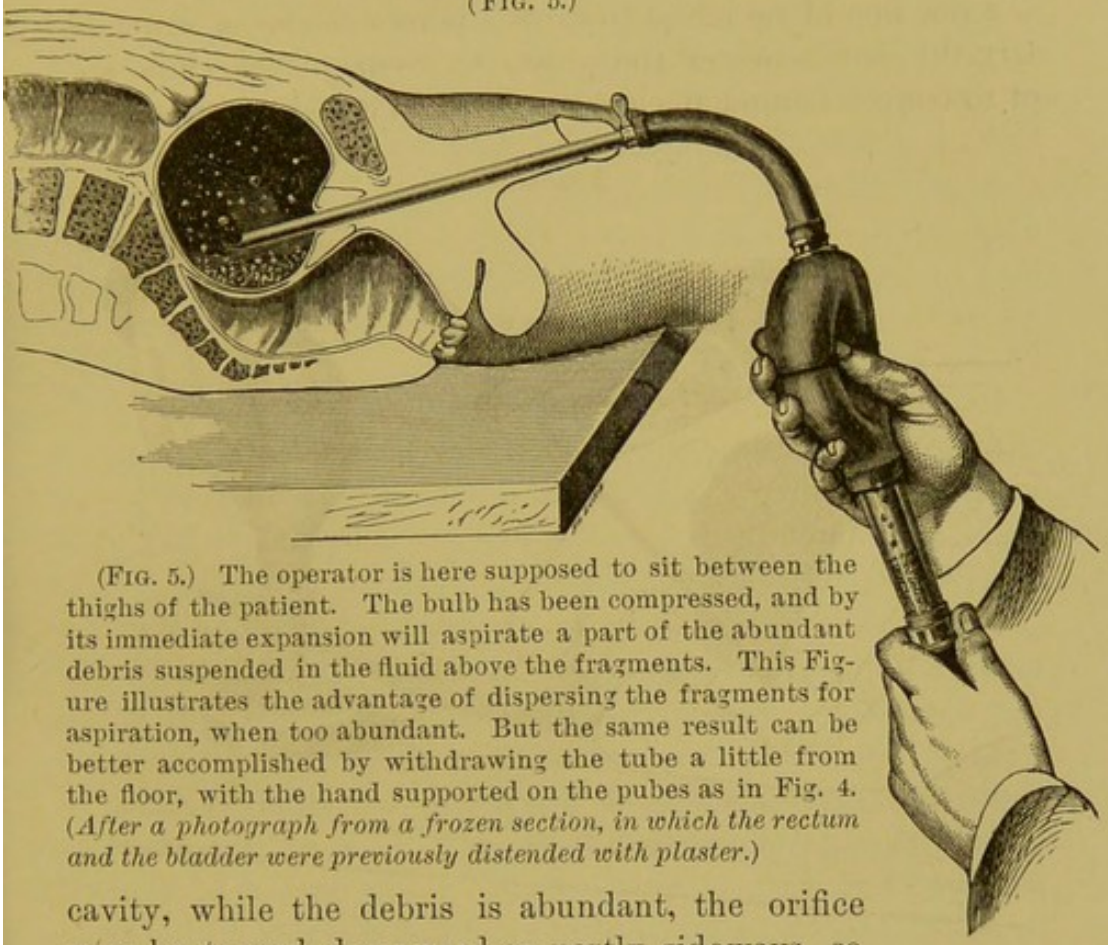


(FIG. 5.) The trap is here placed in a stand upon the table. The remaining fragments are few, and the capacious bladder is depressed to assemble them. The operator stands on the patient's left, and supports his right hand firmly upon the pubes. This position is, on the whole, the most advantageous.

lies behind these chips. An advantage of the inverted curved tube is that it keeps the prostatic region clear; but the orifice of the straight tube may be occasionally turned forward with the same result. A very slight movement of the tube sometimes makes much difference in the rapidity of the evacuation, so that when it is on the floor of the bladder, or quite near it, and steadied by the hand upon the pubes or the thigh, if any one expansion of the bulb proves more successful than another, the precise position then occupied by the tube should

be carefully maintained. On the other hand, when the tube is choked at each expansion, if it be withdrawn or tilted up a quarter or even an eighth of an inch, it may happen that a shower of debris at once appears in the trap. Higher in the

(Fig. 5.)



(Fig. 5.) The operator is here supposed to sit between the thighs of the patient. The bulb has been compressed, and by its immediate expansion will aspirate a part of the abundant debris suspended in the fluid above the fragments. This Figure illustrates the advantage of dispersing the fragments for aspiration, when too abundant. But the same result can be better accomplished by withdrawing the tube a little from the floor, with the hand supported on the pubes as in Fig. 4. (*After a photograph from a frozen section, in which the rectum and the bladder were previously distended with plaster.*)

cavity, while the debris is abundant, the orifice may be turned downward or partly sideways, so as to project horizontal currents around the bladder, the fragments being aspirated as they whirl. During the earlier part of the operation there should be no interval between the compression and the expansion of the bulb, the object being to catch the fragments while suspended. If there be any pause, it should be after the expansion, to give them time to settle into the glass trap. Later, when the fragments are too few instead of too many, a second or more may be allowed before aspirating, to gather them into the depression in the floor of the bladder,—especially as even a teaspoonful of water lightly injected on the floor shoots the debris to every part of the cavity. This artificial depression, which is made by very slight

force, plays an important part both in gathering the fragments for crushing, and, at the end of the process, for evacuation. In placing the tube at the different stages of the process, there is opportunity for a little tact, as in discovering fragments with a lithotrite.

(6.) *Immediate recognition and removal of obstruction in the tube.* It has been said that when the trap is held upright, as in its stand, fragments should appear in rapid succession; so that, if a short interval elapses without the fall of debris, it may be presumed that there is obstruction. This happens not only when the bulb will not expand, when the dimple disappears reluctantly and when compression is difficult, but also when the current passes so freely that an impediment would hardly be suspected.

Obstruction occurs in several ways.

(1.) In the elastic tube, which may be accidentally bent at an angle or compressed. This should be looked at first. A bit is sometimes lodged by the injected current at the end of the elastic, and can be displaced by pinching it.

(2.) In the bladder, the most common obstruction is at the orifice of the evacuating tube. A little practice will enable the operator to distinguish the encouraging rattle of debris passing this tube to appear at once in the trap (if upright) from the valvular click of fragments too large to enter it. This click is quite constant at the end of the process, after the smaller chips have been sifted off. If the orifice be choked, an effort should be made to expel the fragments in the ordinary way: first raising the tube into clear water above the debris, and then compressing the bulb with a short and forcible jerk. A half dozen such efforts rarely fail; but the rod may be introduced, if necessary.

(3.) It sometimes happens that nothing appears in the trap, although the current passes quite freely, and the click of the abundant debris is still felt. A scale or angular chip is then wedged inside the evacuating tube, which admits water, but excludes fragments. This is worth remembering. The rod removes it.

(4.) If a fragment rattles back and forth in the evacuating tube without reaching the trap, there is obstruction high up. (See 1.)

(5.) The only other source of obstruction, and not an uncommon one, is by the wall of the bladder, when drawn against the tube with a dull thud, or a rapid succession of jerks, not unlike the bite of a fish. The tube orifice may be moved to another part of the bladder, where aspiration is more free. Perhaps the orifice has been accidentally turned sideways; it then readily engages the floor. Or the walls of the bladder are a little slack, and more water may be advantageously introduced to distend them.[1]

After a dozen or more aspirations it may be found that all the fragments which can pass the tube have done so, and that many of them have its full diameter. By the usual method of crushing, the lithotrite would now again be introduced, and again be followed by the tube.

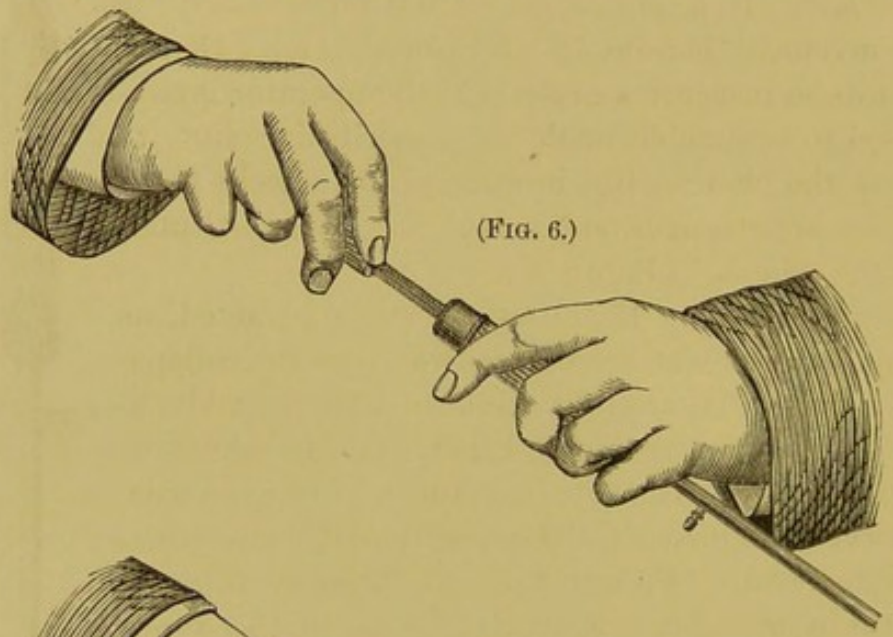
LITHOTRITE. (Fig. 8.) — It would be plainly desirable, if it were easy, to crush the whole stone before attempting to evacuate it; but this has hitherto been rarely possible. The lithotrite becomes so choked with impacted debris that the convex surface of the mass less readily receives other fragments. A clean lithotrite always works to best advantage; and the operator frequently withdraws the loaded instrument to evacuate it, sometimes with injury to the neck of the bladder. It would be obviously better, if the instrument could be emptied at will in the bladder, especially if we distinctly recognize that what can be withdrawn in a lithotrite would come through a tube, and that the province of the lithotrite should be to pulverize, or indeed merely to comminute, and not to evacuate.

Although all lithotrites are made a little loose for the purpose of working out the debris, and although I have had one constructed with an especial device for this motion, I do not find it easy to clear the female blade by a lateral movement of the male blade, chiefly because the impaction is so firm that the dense mass, instead of yielding, twists the female blade from side to side. Nor does an instrument like that of Reliquet fulfill the indications. It discharges itself, indeed, as does the

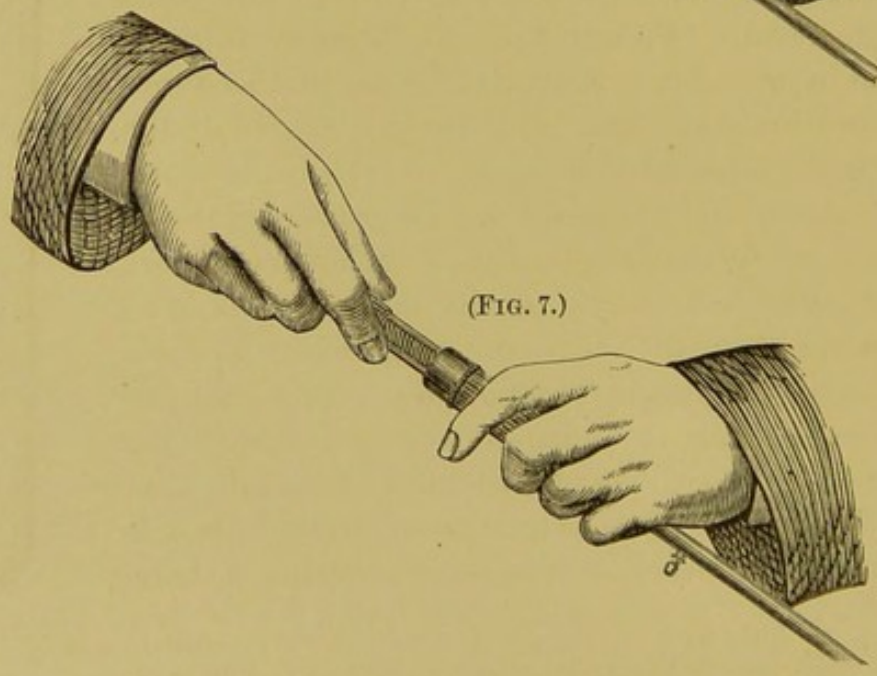
[1] The process of evacuation has been improved by repeated experiment since this paper was first published; that here described shortens materially the time occupied in drawing off the debris.

old fenestrated "*brise-pierre*"; but, as in the *brise-pierre*, its high sides are an obstacle to the approach of fragments. The male blade also of Reliquet's instrument is that of the lithoclast, and we need only close the blades between the thumb and finger to be satisfied of their scissor-like action upon the bladder.

The instrument about to be described keeps its blades clear, and secures certain other desirable ends pertaining to the injection of water, the lock, handle, etc.



(FIG. 6.)



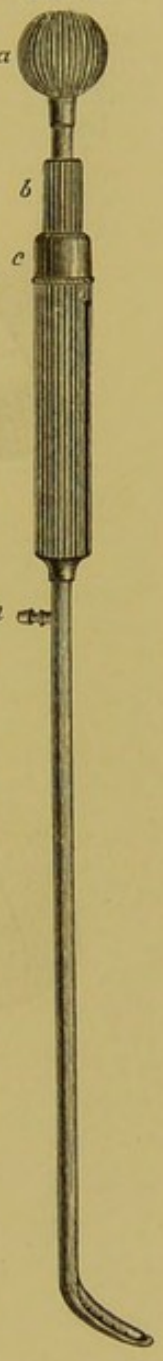
(FIG. 7.)

(FIGS. 6 and 7.) Position of the hands in holding and locking this lithotrite. Fig. 6. Lithotrite unlocked. Fig. 7. Lithotrite locked by a quarter rotation of the right wrist.

Lock. The general acceptance of the cylindrical handle of

Thompson's instrument testifies to its convenience as a hold for the left hand. But it is always a little awkward to disengage the thumb of this hand, or indeed of either hand, in order to close the lock of a lithotrite at the critical moment of grasping the stone. This objection I have obviated in closing the lock by rotation of the right wrist, without displacement of the fingers of either hand. (Figures 6 and 7.)

FIG. 8.



Wheel. In a protracted sitting the wheel is an inconvenient handle, its chief merit being that it affords so insecure a grasp that the operator is supposed to be unable, with its prescribed radius, to break the blades. But in a larger instrument these blades are stronger, and a ball may be substituted for the wheel. (Figure 8 a.)

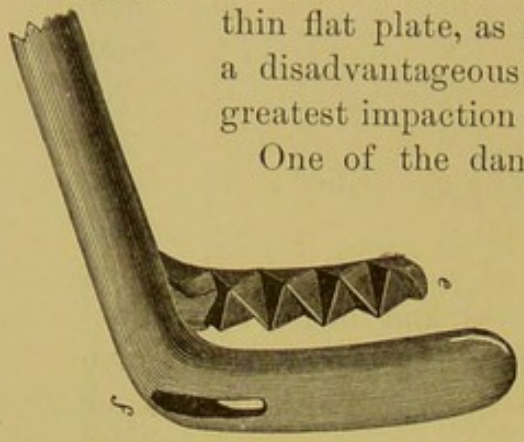
Injecting tube. If the sitting be protracted, as proposed, the water dribbles away, and the collapsing bladder, especially if trabeculated, is liable to serious damage from the lithotrite. To meet this difficulty, my lithotrite contains a tube or groove between the blades for the injection of water without removal. (Figure 8 d.) I formerly injected water by means of a short flat tube introduced into the urethra from time to time by the side of the lithotrite: a valuable resource in a long operation.

Blades. The blades of this lithotrite consist of a shoe or female blade, the sides of which are so low that a fragment readily falls or slides upon it; while the male blade, or stamp, offers a series of alternate triangular notches by whose inclined planes the detritus escapes laterally, after being crushed against the floor and rim of the shoe. At the heel of the shoe, where most of the stone is usually comminuted, and where the impact is there-

(FIG. 8.) Lithotrite by Collin & Cie., from a working model. *a.* Ball which turns the screw. *b.* Revolving cylinder-handle attached to the screw-guard, which also revolves. This guard consists of two square or T-shaped rods, which slide through notches in the cap of the lock. By their revolution the cylinder-handle turns the cap and operates upon the lock. *c.* Cap of the lock, which by its revolution wedges up the screws. *d.* Injecting pipe communicating with the blades. (*This pipe is now omitted as too small for effectual use.*)

fore greatest, the floor is high and discharges itself laterally, while its customary slot (Figure 9 f) is made to work effectively. It may be unnecessary to say that the female blade of the common lithotrite, when drawn from a thin flat plate, as in the French instrument, has a disadvantageous cavity at the heel, where the greatest impaction occurs by gravitation.

(Fig. 9.)



(Fig. 9.) *e*. Male blade, presenting on alternate sides triangular notches. The small portion of debris not discharged laterally by these notches is driven through the slot in the female blade. *f*. Slot in the female blade.

One of the dangers of lithotrity, which has been already emphasized, is the liability of the bladder to be nipped in the instrument. In view of the character of many of the instruments sold, we might expect to hear more of this accident, although indeed it is a quiet one. It cannot be too carefully provided against, not only by skill in the operator, but also in the construction of the instrument itself, and especially during a protracted operation, while water is escaping and the bladder collapsing. With this object, the shoe is here wider and longer than is usual, to repel the vesical walls. (Fig. 9 f.)

It can hardly be doubted that in practice dexterous operators secure most stones and fragments as they gravitate into the female blade while it depresses the floor of the bladder, perhaps a little to one side or the other, where the stone is felt. A simple and efficient manœuvre, especially for a small fragment, is that of opening the blades of the lithotrite widely in the vertical position, then slowly turning them to one side and closing them along the floor of the bladder. If, in attempting this, the instrument be opened after it is turned, the male blade displaces the fragment without securing it; and it is of course understood, that, in opening the lithotrite, the blade in contact with the bladder, commonly the female blade, is stationary. The inverted lithotrite works efficiently in a depression, if the bladder be kept out of harm's way by a special device; but with the common lithotrite it is essential to turn the blades up before crushing, and move them, in order to be sure

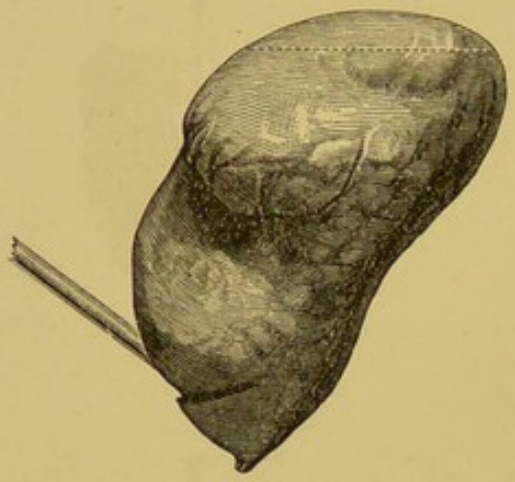
they are free. Indeed, whatever be the position of the lithotrite, it is important always to give it a little rotation before screwing down, to see if it is free from the mucous membrane. This habit also keeps the operator informed whether he has room, or needs more water in the bladder. In the exceptional case of a stone behind the prostate, it may be necessary to invert the lithotrite and seek it. Fragments, however, are readily washed from this region within reach of the evacuating tube by occasionally turning the orifice and directing the stream from the tube upon them.

While many years ago I had not infrequently prolonged lithotrity to ten or fifteen minutes, and longer, it is only within two years that I have aimed at the evacuation of a considerable stone during a single sitting; and although experience will perhaps be necessary to determine precisely what cases are unfavorable to such an operation, there can now be no question that it is practicable to remove at once a far greater quantity of debris than has hitherto been considered possible. The conditions most favorable to lithotrity are obviously most favorable to this modification of it, — a stone neither very large nor hard, and especially a large urethra, promising its best results. But if the preceding views are correct, the future of lithotrity lies in the direction of a fast-working lithotrite, which, while it effectually protects the bladder, is more powerful than the usual instrument, and better proportioned to the work it is to do, — a rapid comminution of the stone, — its immediate and complete evacuation by means of a large tube with an efficient orifice, while the fragments are at will scattered or gathered, for aspiration, — and the ready recognition and removal of any obstruction which delays the process. *It will be no longer essential to pulverize the stone, but only to comminute it;* and if, in so doing, the lithotrite can be kept free from impaction, the process will be more rapid and efficient.

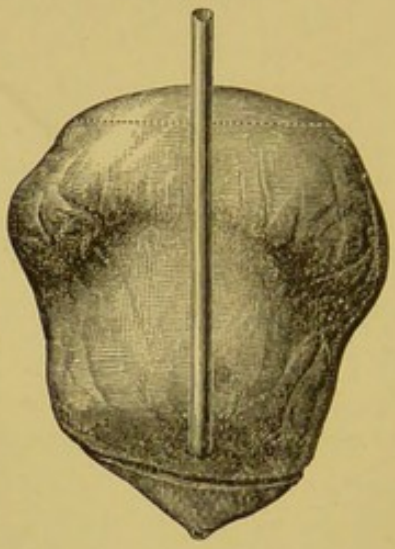
During the last year I removed by lithotomy two soft stones, weighing 1272 and 1230 grains, from two male adults, aged forty and twenty-four respectively, who recovered after various risks. I now cannot but think that with a tolerably sound bladder, a urethra of good size, a large lithotrite, and a large tube, the operation could have been performed with less risk by the method of lithotrity now described.

(Figs. 10 to 14.) Plaster casts of bladders variously distended, and holding instruments to show the effect of a slight pressure in indenting the floor of the bladder in order to facilitate the approach of fragments. The dotted line near the summit of each represents the level of an air cavity, which makes it possible to place the cast in the exact position it occupied in a horizontal subject.

(Fig. 10.)

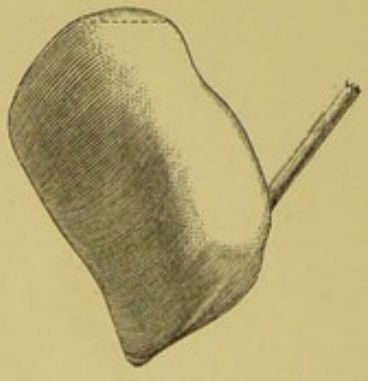


(Fig. 10*a*.)

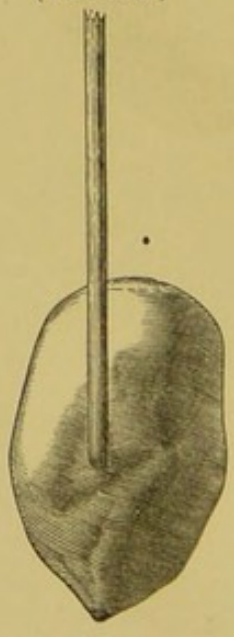


(Figs. 10 and 10*a*.) Side and front views of a distended bladder of singular symmetry. The original suggests in profile the torso of a Silenus, the pectoral pouches overhanging the pubes, the abdomen beneath the symphysis, while the hollow loins were cushioned on the sigmoid flexure which indented them. The extremity of a curved tube is seen below, at the apex of an inverted tunnel, and just above it is a trace of the vesical valve. These figures are one fifth larger than the rest.

(Fig. 11.)

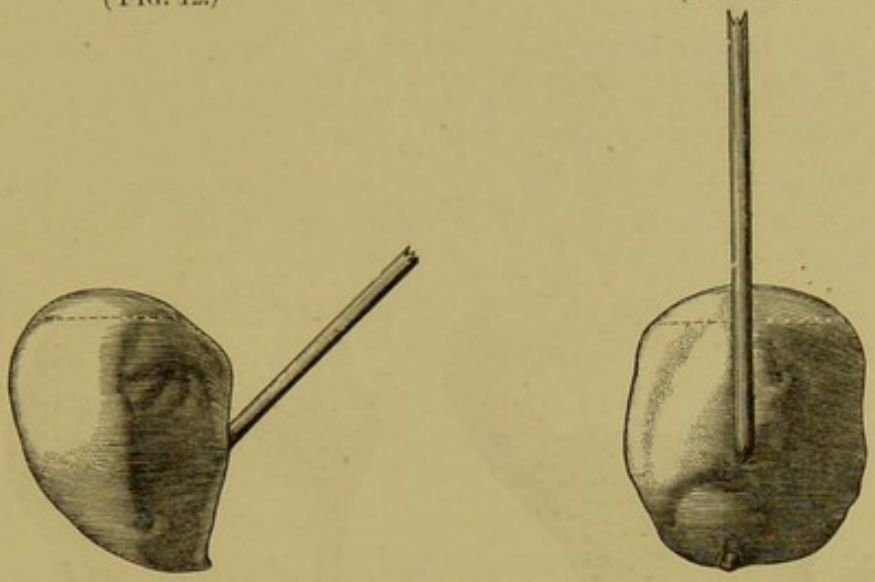


(Fig. 11*a*.)



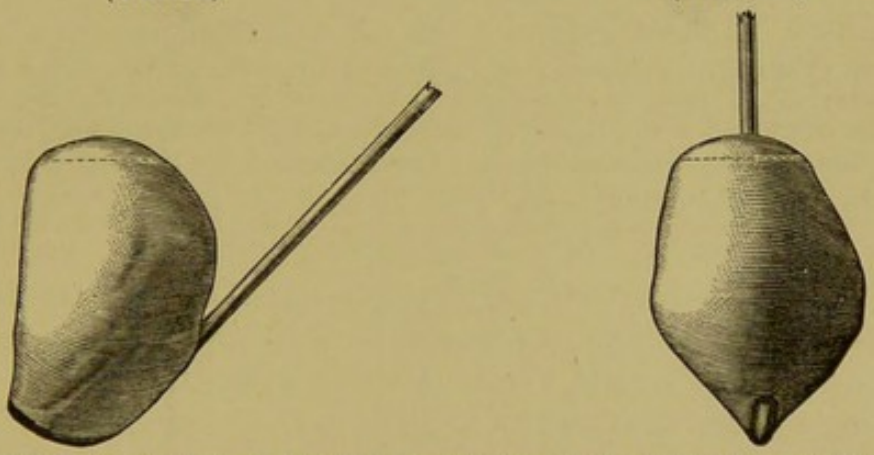
(Figs. 11 and 11*a*.) A less distended bladder, containing a straight tube which indents the posterior wall.

(Fig. 12.) (Fig 12*a*.)



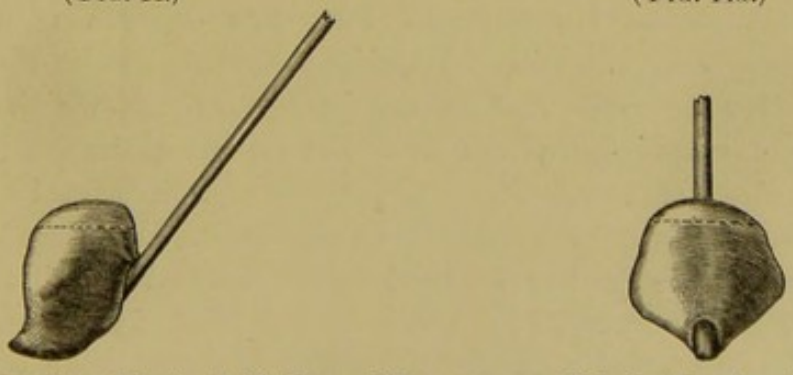
(Figs. 12 and 12*a*.) A bladder with a curved tube brought forward behind the prostate, slightly indenting the floor.

(Fig. 13.) (Fig. 13*a*.)



(Figs. 13 and 13*a*.) A bladder containing a large lithotrite, which has so depressed the floor that the posterior wall rises perpendicularly.

(Fig. 14.) (Fig. 14*a*.)



(Figs. 14 and 14*a*.) A bladder with a very small injection, imprisoning a lithotrite.

We get a useful view of the interior of the bladder by examining it in position through an opening in its summit. This part of the organ, with the free and thin posterior wall, is mainly concerned in distention. The floor of the bladder is comparatively firm and flat, and, if the subject be in good condition, adheres to a thick mass of cellular tissue in and near the ischio-rectal fossæ, upon which it rests. This mass is traversed by the rectum variously distended; and this canal, in a thin subject, may be advantageously filled with air during an operation, to facilitate its indentation by an instrument,—reversing, for the operation of lithotrity, one of the precepts of lithotomy.

The sigmoid flexure is largely concerned in compressing the bladder behind. The posterior wall of this viscus may be so crowded by the intestines as to become flat, or even concave. A horizontal section of the bladder is then transversely oval, flattened between the intestines behind and the pubes in front, each of these indenting it. A well-filled or tense abdomen tends so to shorten the antero-posterior diameter of the bladder, that, while a large stone may gravitate backward into that part of the bladder which is compressed by the intestines, carrying the thin wall with it, it is not so with a small fragment, which, unless the floor be artificially depressed, may lie on one side or the other of the vesical orifice more readily than at a considerable distance behind it. So, in sounding with a curved sound, it may sometimes be a little difficult to move the instrument back and forth in the urethra, when its extremity may be readily turned down upon the floor of the bladder on either side. It is seen also, (Figures 11, 13, 14,) as a result of this conformation, that a lithotrite or straight tube, standing at an angle of forty-five degrees with the recumbent body, abruptly buries its extremity in the floor of the bladder near the foot of the posterior wall, which then becomes more upright, and does not lie upon the centre of an extended concave surface, as sometimes represented. The deep pit at the extremity of the straight tube, and the similar depression made further forward by the curved and inverted tube, (Figures 10 and 12,) show how readily fragments can be made to gravitate to the lithotrite, or to the tube orifice,

provided the latter be not plugged by the mucous membrane. The curved tube, when inverted, rests on the adherent floor; but the straight tube, bearing upon the free and thin posterior wall (Figure 10,) should not be urged too forcibly against it. In either case, the nearer the instrument approaches a vertical position, the deeper will be the indentation. A pit of this sort, formed in the elastic floor by an almost insensible pressure of the instrument, explains the observation of Thompson, that, when a fragment is caught by the lithotrite, many more are likely to be caught, like fish, in the same place. A central indentation of the floor also explains how, in certain cases of large stone, a lithotrite or sound may be passed back and forth beneath it without touching it, unless the beak is tilted up. The stone may then seem to adhere to the upper wall of the bladder, and to be suspended from it.

Case I. December 14, 1875. Age, sixty-four. Date of symptoms, six years. Two or three stones, measuring from half an inch to more than three-quarters. Three sittings. First sitting: no fragments were removed through a tube. Second sitting: interval, seven days; duration, forty-five minutes, under ether; quantity removed, "a large mass of fragments"; size of tube, twenty-seven. Third sitting: interval, twelve days; quantity removed, "a few fragments." Result: the patient was discharged, well, one week after.

Case II. May 15, 1876. Age, sixty. Date of symptoms, twenty years. Two stones, of one and one-quarter inches and three-quarters of an inch diameter, respectively. One sitting: duration, one hour and a half, under ether; lithotrite introduced three times; quantity removed, one hundred and sixty-seven grains; size of tube, twenty-nine; there was afterwards a slight cystitis; no fragments were passed; in two weeks the patient was again sounded, and no fragments were found. Result: discharged, well.

Case III. August 6, 1876. Age, sixty-two. Date of symptoms, eighteen months. Several stones, none larger than three quarters of an inch. The patient was confined to the house, in great pain, drawing his water every half-hour or less. The prostate was unusually large. One sitting: duration, about one hour and three-quarters, under ether; size of tube, twenty-nine. He afterwards passed a few grains of sand only. Result: no unfavorable symptoms; almost entire relief from pain; later, no difficulty in retaining water, but

continues to pass a catheter; gained flesh and former health, and resumed avocation.

Case IV. December 14, 1876. Age, sixty-six. Date of symptoms, two years. Single stone. One sitting: duration, about an hour, under ether; quantity removed, one hundred and eleven grains; size of tube, twenty-eight. Result: the patient did well for two days; then there was a chill, with higher temperature; pain in the back, and pain referred to the left hip; a gradually failing pulse; moderate meteorism, with but little tenderness; death on the sixth day. An autopsy was not permitted.

Case V. January 8, 1877. Age, fifty-five. Date of symptoms, one year. Single stone. "A severe chill followed the primary examination." Seven days after, the meatus was incised and enlarged from 28 to 31 Charrière. One sitting: diameters of stone, ten to twenty millimetres; duration, one hour, under ether; size of tube, thirty-one. Result: no sand nor fragments were afterwards passed; nor were there any subsequent symptoms.

Case VI. April 21, 1877. Age, forty-three. Single stone, with nucleus of dead bone. Five years ago the pelvis of this patient was crushed. Sinuses, discharging dead bone, opened on both hips. Six months after the injury, symptoms of stone existed. One sitting: duration, one hour and a half, under ether; meatus incised; size of tube, thirty; quantity removed, sixty-six grains, and also three small pieces of bone, doubtless nuclei, one of which was incrusted; an indurated spot was detected by the tube, where the bladder seemed to adhere to the pelvis. Four days after, under ether, the lithotrite brought away, with difficulty, through the urethra, a square scale of bone, too elastic to be broken, measuring five-eighths of an inch by seven-sixteenths, but neither sand nor fragments. Result: there were no unpleasant symptoms at any time; and after another careful examination for bone, the patient was discharged, well.

Case VII. (Dr. T. B. Curtis's case.) March 6, 1877. Age, fifty-four. Date of symptoms, two years. Single stone. One sitting: diameter of stone, one inch and a quarter; duration, one hour and twenty-five minutes, under ether; lithotrite introduced three times; size of tube, thirty-one; quantity removed, when dry, two hundred and fifty-seven grains; the six largest fragments weighed together twenty-four grains; the strained urine yielded, during the next week, two and one-half grains. Result: rapid recovery, with no subsequent symptoms.

Case VIII. (Dr. C. B. Porter's case.) August 19, 1877. Age, sixty-one. A large, flabby man, with a feeble pulse. Date of symptoms, twenty-six years. Two stones, one of which is so large that it is barely possible to lock the lithotrite. Passes water every fifteen or twenty minutes. Three sittings. First sitting: duration, one hour and a half, under ether; size of tube, twenty-eight; quantity removed, two hundred and twenty-eight grains; passed afterwards one hundred and eight grains. Second sitting: interval, four days; duration, three hours, under ether; size of tube, thirty; quantity removed, seven hundred and forty-four grains; passed afterwards sixteen grains; no after symptoms of importance. Third sitting: interval, five days; duration, three and three-quarters hours, under ether; size of tube, thirty-one; quantity removed, seven hundred and six grains; no pain nor discomfort afterwards; total number of grains, after drying, one thousand eight hundred and two. Result: discharged, well, two weeks from the date of the first operation; after a few weeks the patient could retain his water from three to four hours.

Remarks. — The details of the earlier of these operations are expressed with less exactness than I might now desire, but were dictated by myself at the time, and are within the fact, as to the duration of each operation, and the size of the stones. The cases, all of soft stones, *i. e.* not oxalate of lime, are the only ones by which the method which is the subject of this paper has been tested. As statistics, they are not so numerous as to have importance. But they abundantly illustrate what this operation is able to accomplish in removing at once a large quantity of stone by the urethra. The fatal case without an autopsy, the absence of which is greatly to be regretted, must pass for what it is worth. The other cases demonstrate a tolerance by the bladder of protracted manipulation which has not hitherto been recognized.

Since the above was published, six cases have been successfully treated by the new method, — making fourteen cases in all, with one death, which is about the proportion of fatality in Sir Henry Thompson's list of four hundred and twenty-two cases with sittings of three minutes' duration. Among the later cases, two of the three which occurred in my own practice, offered exceptional interest. In the first case, a calculus

lodged deep in the urethra, was removed. A contracted urethra was then enlarged by divulsion with Voillemier's instrument, a tube 31 in size was introduced, and a considerable quantity of thick mucus was immediately evacuated. This was found to contain twenty-five grains of phosphatic fragments, the whole being so voluminous that it is unlikely the mass could have been otherwise as well withdrawn. In the second case, the extremity and wings of a red rubber catheter had been lost in the bladder. After the stone of which these formed the nucleus was broken, the fragments of catheter came through the tube at once.

The following are the cases.

Case IX. Patient aged fifty. Twenty-five grains of phosphatic deposit evacuated ; time, four minutes. 1861, the urethra was opened to remove impacted gravel. 1863, he was cut for stone, and has occasionally passed gravel since. 1876, he was operated on for stricture, and has passed a No. 12 sound until within two weeks ; one week ago he voided a stone "as large as the end of his little finger." Now, he has frequent micturition, and an impacted stone is felt in the urethra just behind the scrotum. This stone was broken, and ten grains were removed with long forceps. The rigid and cicatricial urethra was next divulsed. The bladder was evacuated through a twenty-nine tube, yielding about one and a half ounces of mucus and gravel, the latter weighing, when dry, twenty-five grains. The walls of the urethra were now scraped with the female blade of a small urethral lithotrite, to remove an abundant and closely adherent calculous deposit. During the succeeding five days the temperature and pulse remained nearly normal, frequent micturition being somewhat relieved by opiates. For a dull pain in the urethra after urinating, water was injected to wash the passage after each micturition, — an expedient I have long employed in the treatment of gonorrhœa, and also to terminate abruptly the action of strong gonorrhœal injections in the urethra, in imitation of the usual practice after strong applications to the eye. The patient did well. At the end of three weeks a single phosphatic concretion as large as a small pea, was discovered and removed through a twenty-six tube.

Case X. Patient's age, fifty. Eighty-two grains of stone, with a rubber catheter nucleus, were evacuated ; whole time, twenty-five minutes. Eighteen weeks ago, during the treatment of a traumatic laceration of

the urethra, a rubber winged catheter was kept in the bladder. A portion of this was broken off and remained there, causing, in a few days, frequent micturition and cloudy urine. Five weeks ago a stone was discovered. Now there is frequent micturition, and abrupt stoppage followed by pain in the glans penis. The bladder was filled and emptied,— the fluid measuring half a pint, which quantity was again injected. By the lithotrite the stone measured nearly an inch and a quarter, being doubtless caught lengthwise. A certain elasticity of the closed blades led to their withdrawal with a small fragment of brittle rubber. This withdrawal was twice repeated, with bits of rubber, including the two wings, and also twenty-seven grains of stone. The whole operation had now lasted nine minutes. A straight evacuating tube, No. 31, was next introduced, and the bladder pumped during four minutes, after which it yielded no more foreign material. Almost all the stone thus evacuated, (fifty-five grains,) together with three bits of rubber catheter, measuring respectively three-fourths, seven-eighths, and one-fourth of an inch in length and of a diameter No. 23 Charrière, came through the tube within the first minute. The lithotrite was now again introduced, but nothing more discovered ; after which the bladder was again washed out. The entire operation lasted twenty-five minutes, much of which was occupied in determining the fact that the bladder had been evacuated. The next night the patient had no pain, and micturated but twice, instead of six times as habitually before. Two days after, the temperature suddenly rose to 102° Fahr., but as quickly subsided, without other sign or symptom, the patient being entirely relieved.

Case XI. Patient's age, sixty-two. Date of symptoms, three years, Two stones, lithic ; largest diameter, thirty millimetres. One sitting : duration, one hour and twenty minutes : size of tubes, twenty-nine and thirty ; quantity removed, three hundred and nineteen grains ; urethra somewhat contracted in front of scrotum. In evacuating these stones, the time was found to have been occupied as follows : crushing, twenty-nine minutes ; evacuating, twenty-four minutes, the rest of the time being consumed in passing and withdrawing the instruments, renewing the water, etc. As usual most of the fragments passed the tube early in the operation, and readily ; much of the time occupied by the evacuation being consumed in making sure that no fragments were left behind. Micturition before the operation was once in one and one-half hours, — after the operation about once an hour, and obstructed by purulent mucus. The patient had a large, though yielding prostate. The water was drawn during eight days ;

at the end of which he was generally able to relieve himself, the purulent mucus having diminished in quantity. The testicles were somewhat swollen. Though still under treatment, the patient is fairly convalescent.

A discussion of the relative values of lithotrity and lithotomy, at a recent meeting of the Royal Medical and Chirurgical Society (March 16th, 1878, reported in the Lancet of the 12th inst.) has interest in this connection, because it exposes the current English views upon this subject, while it gives prominence, by contrast, to the advantages of the new method of lithotrity over the old one. It is evident that the large tubes offer a ready means for preventing the recurrence of stone by either nuclei or fragments, which are "by no means uncommon" after lithotrity, as Mr. Cadge remarked, and "one of its serious defects"; also, for removing the phosphatic deposits which, in the words of Sir Henry Thompson on that occasion, are "not unfrequently left after lithotrity,"—"being due to the injury done to the mucous membrane by sharp fragments of stone, and by continued instrumentation." Sir Henry looked upon them as "unavoidable, and as a price paid for the greater security to life which lithotrity affords." Again, Sir James Paget said "he must confess to a general feeling in favor of lithotomy over lithotrity," unless "the calculus can be got rid of in two or three sittings." Sir Henry Thompson on this subject said, "three, or at most, four sittings, at which point he should distinctly prefer to cut."

The obvious question then is, whether, in adult patients, when the stone requires more than three or four sittings of a few minutes each, by the old method, it is safer to cut, or to employ the new and rapid lithotrity with evacuation. The latter must, in cases now rejected by the lithotritist, be preferred to lithotomy, unless it can be shown that its mortality amounts to one in three,—this being the death-rate of lithotomy, in such cases, as stated during the discussion. Such a mortality for the new operation is improbable.

There can be no doubt of the importance of the complete evacuation of final fragments, renal nuclei, phosphatic masses and foreign bodies.

In the matter of crushing, stress was justly laid upon the difficulty of withdrawing the impacted lithotrite from the blad-

der, — both Sir Henry Thompson and Mr. Coulson speaking of fragments actually "preventing the withdrawal of the instrument," and "requiring, in one case, incision in the perinæum." This difficulty is obviated by the new notched lithotrite, which effectually clears itself. It also permits more expeditious work. The larger size, as made by Collin, is much more powerful than the usual lithotrite, while it can readily be introduced into a bladder that will admit a No. 27 tube.

As the female urethra is so easily dilated, this method will doubtless prove to be the easiest way to dispose of calculi in the female, the tubes being made shorter and larger than for the male urethra.

I may again say, in conclusion, that since its first announcement this method of evacuation has by repeated experiment been so modified and reduced to a system, that it has become much more rapid and efficient. The time then consumed by the operation, although it showed a surprising tolerance of the bladder, is no criterion of the time now required for accomplishing the same result. The improvements relate chiefly to the systematic dispersion or collection of fragments in the bladder, to the position of the tube, and to the recognition and immediate removal of obstruction. A considerable part of the time is still consumed in ascertaining whether the stone is wholly evacuated, — a large part of it being usually removed at the beginning of the operation.

[From the New York Medical Record, June 8th, 1878.]

Rapid Lithotrity with Evacuation.

To the Editor of the Medical Record.

An article by Dr. Keyes, in your last issue (May 18th), gives me occasion to call attention to one or two misapprehensions which pervade his allusions to "Modern Lithotrity," as he terms the new operation for stone.

In this article, which is devoted mainly to a description of the jaws of a lithotrite, the writer states that my lithotrite "must sometimes clog," because "it is made on the principle of Reliquet's." He is mistaken. In the first place, Reliquet's instrument is fenestrated: mine is not. In the second place, as an ascertained fact, my lithotrite does not impact. The male blade is furnished with lateral notches forming inclined planes by which the detritus is extruded right and left, except where a small portion at the heel is driven through a slot by an effective spur. Reliquet's non-impacting lithotrite is identical with the obsolete fenestrated *brise-pierre*, with teeth in the opening below to insure pulverization. Dr. Keyes proposes to remove these added teeth, and return to the *brisepierre à mors fenêtré* (*porte à faux*) of Charrière. (Nouveau Dict. de Méd. et de Chir., Paris, 1875, Tom. XX. p. 667.) In fact, he goes back to the flattened jaws of the "slightly indented and fenestrated or open female blade" figured by Costello (Cycloped. of Pract. Surgery, London, 1861, Vol. III.

pp. 21, 50) with a male blade as small as in the common lithotrite, to avoid pinching the mucous membrane:* in short, a common lithotrite with the floor removed.

I am gratified to find that the writer of the article indorses my statement (which is an important corollary of the new system), that "*in future it will be no longer essential to pulverize the fragments, but only to comminute them.*" This may be accomplished by either a fenestrated or a solid instrument. Any fenestrated lithotrite, that sufficiently reduces the size of fragments driven through it, enables them to pass the evacuating tubes: the use of which characterizes the new method. But although instruments of this class will doubtless do well enough with small stones, as does indeed a common lithotrite, my objections to a fenestrated instrument, of which I considered and rejected several (including that proposed in your journal), are these: —

1. Sharp fragments, while firmly engaged in the opening, or driven through it, are likely to injure the floor of the bladder. During a long operation, such as I propose, it is hardly possible to prevent the frequent contact of the floor of the bladder with the extremity of the instrument, in which case the latter does not present to the mucous membrane a rounded and polished surface, but irritates it with protruding splinters of calculus, continually coming in contact with the same limited region of the floor.

2. The sides separately are not as strong as when united by a floor of metal; and if they are made low enough to be readily accessible to fragments (which is important), are consequently liable to break, especially should the strain come on one alone. The strength of a fenestrated blade lies in the height of its sides, and

* The mucous membrane would be less liable to injury, if care were taken always to blunt, or round a little, the edge of the sole of the male blade.

is but partially compensated by their breadth,—unless the latter is extreme. Moreover, the male blade must be disadvantageously narrow. When it is wide, the corresponding opening not only impairs the strength of the instrument, but delivers large fragments.

3. Now although fragments, if small enough, pass the tube readily, dust and small debris pass more readily, and first. Therefore, when a fragment has been fortunately seized, the operator loses an opportunity, if he fails to crush it, as happens when he drives it through a fenestrated blade, to be again seized. Although by the new method pulverization is no longer essential as before, our aim is still to accomplish a maximum disintegration at each closure of the jaws; and this is better done with a solid upper and lower jaw than when either of them is fenestrated. A non-impacting instrument is very desirable,—but not at the sacrifice of efficient and rapid crushing, or with danger to the mucous membrane.

I may add, that to prevent impaction, when the blades are closed, it is quite unnecessary that the male blade should project below the female blade,—an arrangement which Dr. Keyes has devised and emphasized for this purpose, and a description of which, indeed, occupies a considerable portion of his paper. It is sufficient that the blades of a fenestrated instrument occupy the same level at the outlet.

Again, the heel of the instrument figured in your journal has the form of the segment of a circle. Such curved blades admit fragments, and crush them, at great disadvantage.

Blades should be

1. As straight,
2. Set at as nearly a right angle with the shaft,
3. As little rounded at the heel,

as is compatible with their introduction.

In my non-fenestrated lithotrite the blades are nearly straight, and the triangular notches deliver on alternate sides. This lateral action not only clears the jaws, but makes their hold very tenacious. It also secures to the blades the incidental advantage of grinding while they crush.

Your contributor finds my instrument too large (or, as he says, "clumsy"). It is made large with a distinct object, namely, to break larger and harder stones than have been hitherto considered to be within the province of the lithotrite. It comminutes with safety to the bladder and without impaction, as no lithotrite hitherto devised has done. The new method of treatment is grounded in the fact that the normal urethra admits larger instruments, and is an easier road to the bladder, than the lithotritist has hitherto recognized. The operator soon becomes not only accustomed to the use of a large lithotrite, but reluctantly foregoes the power it gives him, even when the stone is small. Collin has, however, made a second size.

While the power possessed by this lithotrite and the fact that it does not impact are its more important features, and especially adapt it to the requirements of the method now proposed, almost as useful is the change in its lock. I believe that this will be ultimately adopted by those not already educated to the old system, because it is based upon the readiest movements of the hand and wrist.

But a modification of the jaws and lock of the lithotrite is but an inconsiderable feature of the proposed new method. Rapid work is indeed thereby facilitated; and an empty instrument can be safely withdrawn as often as the operator pleases, to relieve the bladder of what will come through the tubes, and so clear the way

for more rapid crushing. A far more important point to the lithotritist, however, is *the comparative harmlessness of long sittings*, which I think was unsuspected until the publication of my paper. In the first trials, what was wanted was not so much an improvement of the existing crushing apparatus as *an efficient means of evacuation*, capable of removing all the debris at one sitting. For this purpose the large tubes criticized in your journal are absolutely indispensable. Their use is precisely what makes the new operation practicable, and, together with their manipulation, is perhaps its chief innovation. The set of tubes described in my paper ranges from 27 to 31 Charrière; but they can be procured of any smaller size, and should of course, be adapted to the previously ascertained calibre of the urethra. It will be found, however, that the efficiency of the tubes diminishes very rapidly with their size, and that a canal narrowed by stricture or by a small meatus, will require to be enlarged so that the introduction of a large tube may be made possible. In such a case as that reported, where the urethra admitted only a No. 20 instrument (French), and in which the operator of course found my largest tubes too large, I should prefer to increase the size of the passage, rather than attempt to extract the fragments of a calculus through the small calibres formerly in use, even though the tube were otherwise modified as I have recommended. With a normal urethra I do not believe that the tubes supplied by Tiemann will be found any too large.

The change proposed in the new procedure, and the consequent advantages, will appear in a clearer light, if we consider the limitations of the usual dilatory method explicitly acknowledged, quite recently, by both Sir Henry Thompson and Sir James Paget. These distin-

guished authorities gave their opinion that lithotrity should be restricted to stones requiring only two or three or at most four sittings, of two or three minutes each. For larger stones, in their judgment, lithotomy does better, though resulting, in adults, in a mortality of one in three. It should be added, that, while lithotrity was thus pronounced unsuccessful in such cases, all attempts at the immediate evacuation of debris had resulted in practical failure.

The new method not only crushes calculi exceeding in size the limits hitherto affixed to crushing alone, but at the same sitting evacuates by the urethra the fragments and debris. This is done under ether, in a sitting of one or two hours' duration, or even longer. So far, its results have been better than could have been anticipated,—being sixteen or seventeen cases of complete evacuation with but one death, against one in thirteen by the usual method. Several of these patients would have been, by accepted rules, subjected to lithotomy, and consequently to a risk equal to one death in three cases. I cannot but think, that, with due care in its application, the method now proposed will be found to yield results at least as favorable as those before obtained.

LITHOLAPAXY.

The following are the chief points connected with the modification in lithotrity which I have described, and for which I propose the above name.

1. The calculus, although not necessarily pulverized, is crushed as rapidly and completely as is practicable. The dust and fragments are immediately evacuated, and a serious source of irritation is thus removed.

2. This can be generally effected in a single operation.

3. The operation — performed of course under ether — may be, if necessary, of one or two hours' duration, or even longer.

4. The method applies to larger stones than have been hitherto considered to lie within the province of the lithotritist. It also applies to small stones, nuclei, phosphatic deposits, and foreign substances.

5. Evacuation is best accomplished by a large tube, preferably straight with a distal orifice, the extremity of which is shaped to facilitate its introduction, and, during suction, to repel the bladder wall, — and by an elastic exhausting bulb, which acts partly as a siphon. Below the latter is a glass receptacle for debris.

6. The best size for the tube is the largest the urethra will admit.

7. Such a tube is usually introduced with facility, if passed vertically as far as it will go toward the anus before changing its direction, and afterward directed almost horizontally, and passed by rotation through the

triangular ligament. The first part of this rule applies also to the introduction of a lithotrite, and even a curved catheter. A free injection of oil is important.

8. A small meatus should be enlarged, or a stricture divulsed, to allow the passage of a large tube.

9. If the bladder be not small, a large and powerful lithotrite is always better than a small one.

10. That this may have room for action, the escaping water should be replaced occasionally, through a tube inserted a few inches into the urethra by the side of the lithotrite. But the bladder should not be overdistended.

11. To save time, and also to prevent undue dilatation of the vesical neck, a non-impacting lithotrite is desirable. The jaws of a non-fenestrated instrument will not impact, if the male blade is furnished with alternate triangular notches by which the debris is discharged laterally, and also with a long thin spur at the heel fitted to a corresponding slot in the female blade, — provided the floor of the female blade, especially at the heel, be made nearly on a level with its rim. To repel the bladder, the female blade should be longer and a little wider than is usual. It should have also low sides easily accessible to fragments, — relying for strength less upon these than upon a central ridge below the heel. In the male blade of such a lithotrite the apices of the triangles should be a little blunted. Lastly, a non-fenestrated female blade protects the floor of the bladder, during a long sitting. A fenestrated instrument directs sharp splinters against it. The latter also delays the process of disintegration, by delivering through its opening the same fragments many times.

12. In locking and unlocking a lithotrite repeatedly in a long operation, it takes less time and is easier to

turn the right wrist, as in my instrument, than to displace the thumb of either hand in search of a button or a lever, as in previous instruments.

Boston, May 25th, 1878.

June 16th.—The efficiency of this method has to-day been further illustrated by the removal through the urethra, under ether, without crushing, of thirty-five small calculi, during a single sitting of half an hour, in which the bladder was completely evacuated. The patient was sixty-five years of age, the prostate large. The stones were lithic, nearly spherical, and almost destitute of facets. The two largest had a diameter = 34 of Charrière. Of these stones thirteen were drawn through a tube of the calibre 31 Charrière. Twenty-two were arrested in the tube, — the smaller being detained by other larger stones simultaneously engaged in its extremity, which closely fitted them. Thus obstructed, the tube was withdrawn ten times, always with one or more calculi. The stones, when dry, weighed 240 grains. I used in this instance a tube having a long oval orifice with a thick edge, passing the latter through the meatus, and especially the prostatic portion of the canal, with facility, by rotating the tube.

Such an operation can hardly be called lithotrity. I have therefore proposed for the new method the name Litholap′axy, — λίθος, and λάπαξις (*evacuation*).