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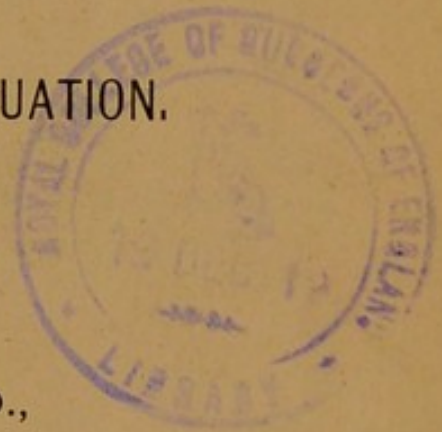
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RAPID LITHOTRITY WITH EVACUATION.

BY

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THIS operation, to which its inventor has given the name Litholapaxy, has been sufficiently long before the profession to be tested and to be declared a successful procedure. It seems to be upon the eve of general adoption by surgeons in this country and in England, as attested by the comparatively numerous cases reported of late in the journals accompanied by brief remarks, these coming from varied sources.

The success of the new departure in vesical surgery is due to the general acceptance by the profession of the fact that the bladder tolerates prolonged manipulation kindly if left empty afterwards, a principle worked out and first clearly demonstrated to the world by Prof. Bigelow, to whom certainly belongs the credit.

Upon this principle of vesical tolerance, however, the method rests, and not upon any particular instrument or set of instruments,—as witnessed by numerous slight changes already made and possible yet to be made by Prof. Bigelow in his own apparatus, as well as by the fact that a number of other operators have performed the identical operation perfectly well with other instruments.

In consideration therefore of these two facts, (1) that the operation seems to be about to fall into the domain of general surgery, and (2) that different surgeons have succeeded well with the operation using indifferent instruments, I look upon it as a duty of any one who has had any considerable experience in this method to contribute that experience to the common fund of information now rapidly accumulating, in order that the profession as a whole may profit thereby. Different points in the detail of manipulation and otherwise come up in various cases. These should all be exposed for general comment; for it is out of the sum of these that general laws governing the operation must eventually shape themselves.

It is in this spirit that this paper is now written—to contain all the practical points of experience gained by Dr. Van Buren and myself from contact with the patients upon whose histories it is founded. In these cases we have been constantly associated. It has fallen to my lot to per-

form most of the operative work, but to the wise counsels of my senior I must ascribe much of the success which attended many of the operations.

In discussing the subject I shall use information derived from all valid sources, and impartially discuss my own errors with those of others. My object is to get at the truth and to search for it fearlessly. It is only in this way I believe that a true estimate of the points under consideration can be reached. In referring personally to different surgeons I do so that the authority for the points I make may not be open to question.

Before undertaking litholapaxy I had performed the crushing operation in whole or in part in connection with Dr. Van Buren in eighteen cases, and the experience gained in the very numerous sittings, without ether, which these cases called for, has been of incalculable value in executing the new operation. I have on several occasions seen a surgeon perform litholapaxy who had never used the lithotrite in the bladder of a patient not under the influence of ether.

But one conclusion was possible after watching these operations, namely, that the general surgeon is not competent to perform rapid lithotrity well until he has first learned how to manipulate the bladder carefully by a training at slow lithotrity. No ordinary surgical tact and ability seems capable of taking the place of a little special training, and my conclusion is absolute and mature that the general surgeon does not do justice to his patient if he subjects him to rapid lithotrity before he (the surgeon) has trained his own hand. One or two cases of slow old-fashioned lithotrity are enough. After such a training in a sensitive bladder without ether any surgeon is as capable of performing rapid lithotrity with ether as he is of executing any other surgical manœuvre. He may not make as brilliant a figure at the operation as another surgeon who has crushed more cases, but he does the work safely, and with suitable instruments does not subject his patient to any unnatural risks.

The operation promises to become general among surgeons, and in this protest that ordinary surgical training does not fit a man to operate in the bladder under ether, I think most lithotritists will join me. There is no possible objection to allowing the operation to fall into the domain of general surgery. It is a safer and better operation for dealing with most cases of stone in the adult than lithotomy is, and the latter has always belonged to the list of general surgical operations.

Rapid lithotrity must eventually take the place of lithotomy because it is a better and a safer operation; but to take the place of lithotomy it must be made a general operation capable of being safely performed by the general surgeon, and this it will doubtless some day become.

At present I think it is at least questionable whether any surgeon has a right to use a lithotrite for the first time upon the bladder of a patient rendered insensible by an anæsthetic. There is no royal road to rapid lithotrity which is a safe one. The straight path lies by slow lithotrity in a

suitable case with small stone in a patient having full possession of his vesical sensibility.

These remarks are made in good faith and seriously, because the operation in this country is already tending to become general. This is proved by the sale of lithotrites. I have not extended my inquiries beyond New York in this matter, but have been satisfied of the fact above stated from the returns made by the three largest instrument dealers in this city.

One of these tells me that he sold a dozen lithotrites in 1879, the rate being two to three a year in previous years.

Another reports eighteen sold in 1879, remarking that there was an extra call for lithotrites after the appearance of Prof. Bigelow's paper on litholapaxy (*American Journal of the Medical Sciences*, Jan. 1878). The third sends a list of sales, the rates being taking for periods of two years instead of one. This list shows 81 lithotrites sold in 1878 and 1879, against 46, the largest number in any previous two years.

These figures I think prove the point claimed, and justify the caution formulated above. The general surgeon has a full right to use this operative procedure, but he should approach it respectfully. Various instruments with which he is presented may help him, but they cannot do the operation for him. Any one can catch the bladder with any instrument, if he tries to do it, but no man should operate upon an insensible patient unless he is able to tell at once that he has caught the bladder and expert enough to drop it before he has bruised it.

An instrument to be serviceable in this operation must be one which does not readily catch the bladder, is not sharp enough to injure it if it does catch it, and cannot clog.

Injury to the Bladder and Urethra.—Yet injury to the bladder is not a matter of great importance, apparently, in this operation. The bladder is very patient when left empty after the injury has been inflicted. The deep urethra, on the other hand, resents violence much more positively. It is wise to inflict no injury in either locality, but if choice must be made the deep urethra calls for the greater forbearance.

My own experience in this line is confined to four cases, in two the bladder was injured without the least serious result. In the third the urethra was injured and death followed. In the fourth the urethra and vesical neck were injured and the result was nearly fatal. The cases are briefly these:—

CASE A.—An old man of 70, who had relied upon the catheter for sixteen years, having a bladder totally atonied, and urine full of pus, one day broke off two and a half inches of a worn-out woven French catheter in his bladder. This I attempted to remove with an old fashioned fenestrated lithotrite, a dangerous instrument having a cutting edge to the male blade. I had never before put any lithotrite into the bladder of a living person. I promptly caught something soft corresponding in size to the small woven catheter, flat and water-soaked as I judged it to be. I

screwed down lightly on the object caught. The patient said he felt nothing whatsoever (I had forgotten that his atonied bladder was almost insensitive), and as I moved the jaws of the lithotrite, the object caught moved freely, since the thin flabby walls of the bladder were more like a bag of soft wet leather than anything else. Still the patient continued to assure me that he felt nothing, and I had not at that time any education in my touch to teach me what I had caught. I, therefore, screwed the male blade down hoping to crush the woven catheter at the point caught, and then, relaxing the male blade, to have a flexible hinge upon which the two ends of the catheter could bend backward during their passage through the neck of the bladder.

So loose were the tissues in this case and so insensitive the bladder, that the patient made no complaint until I had withdrawn the lithotrite to such a distance as to put the tissues into a condition of tension at the point caught. Then came the first mild complaint, and now by free rotary movements of the lithotrite I learned that I had caught the bladder. I unscrewed the lithotrite and made all efforts to liberate the bruised fold of mucous membrane, but it had been cut and crushed to such an extent by the sharp male blade that I failed to disengage it and succeeded only in tearing away the piece which had been caught and bringing it out through the urethra. The piece contained some muscular fibres, but was, mainly, a strip of mucous membrane one inch long by one-third of an inch wide.

No blood followed this violence; no chill, no increase in the cystitis, and on the next day but one, with a small scoop lithotrite I had no difficulty, without ether, in catching and extracting the foreign body.

No harm came to the patient. He died five years later of apoplexy.

CASE B.—While trying to construct an instrument which would not clog, and working with great rapidity in one case of slow old-fashioned lithotrity without ether, I pinched up a small piece of mucous membrane along with the stone and bruised it considerably, bringing away a minute shred of mucous membrane and occasioning some hemorrhage.

The intensity of the cystitis was aggravated in this case although there was no chill; but whether the cystitis was due to the injury done the bladder (which was very moderate), or to the broken mass of stone left in the viscus, is not evident. This patient was shortly afterward subjected to rapid lithotrity at my hands, and promptly and entirely relieved.

Since adopting the operation of rapid lithotrity I have never once pinched a fold of mucous membrane in the bladder. I have frequently with various instruments caught a trabeculated fold of the bladder by making an effort to do so, but I have caught it lightly by design and for a purpose, always recognized it when caught and dropped it without pinching.

My experience in injury to the deep urethra during lithotrity is the following:—

CASE C.—A Reliquet lithotrite made by Collin and warranted not to clog was used by me upon a case of slow lithotrity without ether. Collin, contrary to the instructions of Reliquet, had made the male blade too short, so that it could not penetrate the female blade and clear itself. This I did not observe, but used the instrument to test it in the hospital. It clogged frightfully. I was unable to disengage the débris in the bladder and had to use some force in extracting the clogged jaws at that point of

physiological constriction in the deep urethra situated normally at about two and a half to three inches from the meatus.

The slight divulsion of the urethra at this point terminated in a minute abscess; the stretching and scratching of the deep urethra, caused by drawing the clogged jaws of the lithotrite through it, prevented further efforts at lithotrity. The angular fragments left in the bladder inflamed that organ. Pyelitis and surgical kidney resulted, and supra-pubic lithotomy with drainage of the bladder through its floor failed to save the patient.

This is the only death I have had after slow lithotrity, and it was this case which caused me to appreciate the value of small instruments, and to attempt to devise a safe lithotrite which could not become clogged in the bladder by any possibility.

CASE D.—My second experience with an injured urethra was in the case of an old gentleman, who forms one of the series of cases upon which this article is founded. He will be referred to again, when speaking of the re-accumulation of phosphates from which some cases suffer. I operated upon this gentleman and relieved his bladder of stone by rapid lithotrity. He returned with fresh symptoms after some months, but a washing operation only detected a very small phosphatic re-accumulation. Relieved of this he returned again after a few months. This time I did not even subject him to the formality of etherization, but in my office placed him upon the lounge and washed out a small phosphatic round stone as large as a pea. This was a new stone and not an old fragment re-coated. Again he returned, and in perhaps two minutes I again washed out a similar stone in the office. He walked to see me and walked away and was relieved.

Each operation on this patient was done with a tube 16 English. This his urethra took comfortably. I learned finally, by examination under ether, that this patient had a sacculated stone. Upon this stone, apparently, little buds would form and during some sudden motion break off. Symptoms would then come on at once, and after a washing the patient would be and remain entirely relieved. No blood, no sickness, no vesical reaction followed any of the operations.

But the patient became discouraged by his continued relapses, and finally, when a fresh attack came on, he applied to another surgeon. This surgeon ascribed the relapses to imperfect washings. He operated under ether and used a large evacuating tube. The operation lasted one hour. As a result a small phosphatic stone the size of a pea was produced, exactly the same, in appearance and composition, as I had twice procured by a few minutes' painless wash without ether in my office. As a result of the operation with large tubes, bloody urine for many days followed, and a most violent cystitis with general prostration, which confined the patient to his bed for two months and seriously threatened his life.

He slowly rallied, and, without using ether, I washed out, through a small tube, at a later date, another small phosphatic stone, without occasioning any vesical disturbance, and, in a prolonged search under ether, detected the sacculated phosphatic stone, which undoubtedly was the cause of the repeated relapses.

Among cases recently published, I find two facts bearing upon the point I have just made, and one on the other side. These are found in

the cases collated by Dr. Weir,¹ Cases IX. (Hutchison), XI., and XII. (Wynkoop).

In Case IX. Dr. Hutchison is reported to have pinched off pieces of the mucous membrane of the bladder with my (Keyes's) lithotrite, which is said to have "worked badly." It is perhaps only just to say here that there is no Keyes's lithotrite in the market. I have distinctly forbidden the sale of any as being my instrument. I have had a number of working models made, and have used them in all of my operations, but I am still modifying the male blade, and my lithotrite is perfect, I believe, as yet only in theory. This theory of construction I have published in the *Medical Record*, May 18, 1878, page 388. The theory implies an instrument, as compared with the older lithotrites, (1) relatively small in proportion to its power. (2) A broad flange or shoulder on either side of the shaft of the male blade, extending up to the very end of the shaft (fig. 1 *a*, page 389), that the slender shaft may not become sprung, since the shaft itself cannot well be damaged in any other way. (3) Extra breadth antero-posteriorly of the heel of both the blades, to insure strength at weak points. (4) Such a relative size of the male blade as compared with the female as is customary in ordinary scoop instruments, which are known readily to escape entrapping the bladder. (5) Such a roughening of the male blade as shall enable it to hold a smooth hard stone and yet shall not be sharp enough to seize the bladder easily. (6) Such a flaring lateral breadth to the jaw of the female blade as shall enable it to steady the stone properly while it is being seized. (7) Fenestration of the female jaw and possible penetration of the male blade slightly through it, so that impaction becomes a mechanical impossibility. On this theory, and with instruments constructed upon it, I have done all my work, and I am satisfied with the instruments, excepting in so far as the prehensile power of the male blade is concerned. When I become satisfied with this I shall advocate the use of the instrument, until then I shall forbid its sale as my instrument. Any one may buy it if the instrument makers will deliver it to him, but he does it without my sanction. I have loaned my working models to several gentlemen, and these models have always rendered good service. Where Dr. Hutchison got his instrument I do not know; I believe it was from Tiemann. He tells me that with the one he had he pinched off three pieces of mucous membrane from the bladder of an etherized patient at one sitting. It is upon this ground that Dr. Weir states that the Keyes lithotrite "worked badly." Perhaps it did.

In any case, the fact remains that no reaction followed after this violence done to the bladder, and "the result was satisfactory" in Dr. Hutchison's case.

In Case XII. (Wynkoop) Bigelow's lithotrite was used. It became seriously impacted. Dr. Wynkoop informs me that he was unable to

¹ On Litholapaxy. *Am. Journ. Med. Sci.*, Jan. 1880.

free the impaction by making the proper movements in the bladder and by opening and shutting the blades. He, therefore, was obliged to exert as much force to extract the lithotrite as he would have done upon the forceps in a case of instrumental delivery of a child at term. The derangement in the screw, to which Dr. Weir refers, seems to have been occasioned by some efforts made to clear the blades. The jaws appear to have caught in some manner, so that some mechanical defect in the instrument was at fault, and not the principle of construction, at least so I understand it.

As a result of this laceration of the urethra, produced by the violent withdrawal of the lithotrite not screwed home, Dr. Wynkoop states that abscess ensued, and, on this account, at a later date, lithotomy through the perineum was performed to evacuate the remains of stone left after the operation of litholapaxy. Since his lithotomy the patient is reported to have done well.

Both of these cases confirm my proposition that injury to the fundus of the bladder, if the viscus can afterward be left empty, is of less importance than injury to the urethra. Hence the value of using small instruments, which cannot be made to impact by any possibility.

Case XI., Dr. Wynkoop's first case of litholapaxy, showed a number of abrasions and minute lacerations of the bladder at the autopsy. The patient's general condition was bad, and this local violence had been sufficient to light up a peritonitis. Death followed twenty-nine hours after the operation.

It is rather singular to note that these lacerations were what Professor Bigelow¹ supposed would follow the use of an instrument, made according to the principle upon which I proposed to construct a fenestrated lithotrite, while in fact these lesions were occasioned during the use of his own instrument.

This case only goes to demonstrate what is indeed self-evident, that violence done to the bladder in a weakly subject may be followed by a fatal result.

Is Litholapaxy a New Operation?—It was recognized long ago that the bladder would tolerate considerable injury without showing signs of distress, and the cystitis, after the short sittings of old-fashioned lithotrity, was known to be due not so much to the injury inflicted at the moment of operation as to the cumulative effect of the repeated acts of violence done to the bladder by the angular fragments of stone constantly present after the operation.

This fact was announced in so many words by Heurteloup long ago, and many other surgeons had recognized it. It was fully appreciated and taught by Thompson before Bigelow's first paper appeared,² and he (Thompson) had recommended as a remedy for acute cystitis, coming on

¹ Medical Record, June 8, 1878.

² Am. Journ. of Med. Sci., Jan. 1878.

during a course of lithotrity, that the sittings should be more closely approximated to rid the bladder of the foreign element speedily, and, even in an extreme case, that ether should be given, and the whole stone reduced to powder, if possible, at a single sitting. Yet Thompson did not then recognize the general applicability of rapid lithotrity with entire evacuation at a single sitting, and did not advise it for general use.

Neither did the other surgeons who from time to time evacuated a stone at a single sitting, with or without ether, with or without washing, appreciate the possibility of a general application of the method. Civiale's early operations were marked by the length of his sittings. As he progressed he shortened the sittings, and taught the propriety of so doing. Dr. Van Buren many years ago evacuated a large stone by washing out the dust through a catheter from an atonied bladder in a moderate number of sittings without ether, but the idea of litholapaxy did not occur to him. Neither did it occur to Clover, when he devised his washing bottle, or, if it did occur to him, the surgical world was none the wiser, and, when Nélaton constructed the French Aspirating pump, he failed to conceive the idea of litholapaxy.

It is therefore wide of the mark to imagine that Prof. Bigelow's operation is a modification of any old procedure. The operation is a totally new conception, a new design which disclosed itself to its discoverer, a design which may be executed equally well with different instruments from those with which it was first performed. The new operation forms as distinct a step in advance over the old method as Esmarch's bandage does over the tourniquet, or Dieulafoy's aspirator over the trocar and canula. Bigelow's washing bottle is not a modification of Clover's, and, if it had been, this fact would not have detracted from the credit of designing a new and effective surgical procedure.

The operation of litholapaxy is exclusively the property of Professor Bigelow by right of discovery; but if others object to the instruments which Professor Bigelow advocates, and do so on reasonable grounds, they are certainly justified, especially if the operation in their hands turns out as well or at all better than it does in the hands of the original inventor with his own instruments. Edison's quadruplex system in telegraphy certainly does not detract from the excellence of the Morse character. The same telegraphic character is used with the quadruplex instrument, and the latter rather intensifies the value of the Morse discovery than otherwise. So it is with litholapaxy. Its success does not depend upon the instrument, but upon the method, the method is the operation. The method is, prompt and entire fragmentation of the stone, immediate and if possible entire evacuation of the débris. No matter by what safe means through the urethra these ends are accomplished, litholapaxy, in Bigelow's sense, is performed.

The specialist in bladder disease, the man expert in manipulating the

bladder, can use any instrument and do well at litholapaxy. The surgeon not very familiar with the bladder will do better, as the instruments are more suitable, as they are less likely to harm first the urethra, second the bladder. I say likely to harm, for with any instrument the bladder may be harmed, as shown in the cases already cited above. If the surgeon has not learned how to distinguish the bladder when he catches it from any thing else, he should not undertake litholapaxy under ether.

But the general surgeons are interested in this operation already, and are buying instruments, as I have shown, and they propose to do the operation, therefore it is well that they should have a variety of good instruments which have done good service from which to choose; and neither these instruments nor the number of them detract from the excellence of the first discovery of this most excellent operation.

Description of the Cases.—Twenty-four cases cover all the operations of rapid lithotrity which I have performed, nearly all of them in connection with Dr. Van Buren. By rapid lithotrity I mean operations at a single or double sitting with the object in view of evacuating the bladder at once, if possible, either by immediate urination (in case of very small stone) or by pumping with various apparatus or by extraction in the female with finger, scoops and washing tubes, operations not all of litholapaxy but all of designedly rapid lithotrity.

Of these twenty-four patients one died. Out of the twenty-four, five cases must be excluded from consideration here. Two were small stones in middle-aged men, and the operation was the old one, a short sitting without ether, and simply acquires the name of rapid because all the fragments were promptly evacuated by urination and the patients were at once relieved. One case was that of a young girl with a hairpin in the bladder surrounded by a small amount of phosphatic concretion. She was relieved at a single sitting under ether, and the bladder was washed with Bigelow's tubes and bottle; but the hairpin was the feature of this case, and the evacuation of a moderate amount of phosphatic débris simply a formal matter, not important in a litholapaxic sense, since the detritus, if left alone, could not have failed to pass out equally well through the dilated urethra.

The remaining two cases which I exclude were very old women. Their stones were crushed and entirely removed under ether, at a single sitting, but the finger and the scoop were used through a dilated urethra, and the washing was here also a secondary matter. These cases cannot justly be counted when considering the claims of a new operation like litholapaxy.

There remain therefore nineteen patients, all men, all past middle age, upon whom the modern operation of litholapaxy strictly speaking was performed. They include every case of stone in the male which has come to Dr. Van Buren and myself in the past two years. No case which offered has been refused operation. No case has been cut. No condition

of disease in the patient has thus far been deemed sufficient to exclude him from a chance of benefit from the new operation. This was an error in the one fatal case, as will be shown. In it the pre-existing disease killed the patient, not the operation, and in justice to statistics he ought not to have been operated on. No child (except the girl with the hairpin) has come to us for operation for stone during these two years. No case has been cut in these years, and the cutting operation is already beginning to smack of antiquity.

These nineteen patients stand for twenty-one distinct and separate operations, two of the patients having required a new operation at the end of one year, after having been entirely relieved of phosphatic stone. Phosphatic re-accumulation in some cases is inevitable, especially where there is phosphatic calculous pyelitis, and in cases where sacculated stone is left in the bladder. One of the cases already referred to was subjected to repeated washings without ether, after his one litholapaxy, in each instance with the result of washing out a small phosphatic stone. These washings can neither be counted as new operations, nor as extra sittings of the first operation, since the new stones always formed on the existing encysted stone, and when they broke off and got into the bladder were simply washed away, in each instance relieving the patient, who is to-day up and about at his duties. All the operations were concluded at a single sitting, with two exceptions, (1) the second operation on M. of New Orleans, in which there were two sittings of about five minutes each without ether in my office, (2) S. of Brooklyn, the fatal case (No. 18).

These cases include the total personal experience of Dr. Van Buren and myself. I operated in every case. In many of the cases Dr. Van Buren did a portion of either the crushing or the washing; in the last case but one Dr. L. A. Stimson did the greater part of the operation. My working models of lithotrites were used in every case, with occasionally some other instrument. Whenever I happened to have a Bigelow lithotrite with me the urethra turned out to be small, and I was unwilling to use it. Rarely was a tube larger than 16 English (27 French) used in evacuation, and sometimes tube 13 English (22 French). Curved tubes were used rather than straight ones generally. They render the fragments less well but often pass more easily, I think. All three of the washing bottles (one of Bigelow, two of Thompson) were pretty evenly tested.

In most cases after the operation a few grains of detritus were passed or washed away in the final search always made before pronouncing the patient cured and certainly freed from stone, but on no occasion was a piece left large enough to require crushing at a second sitting, excepting in the two cases mentioned—M. of New Orleans second operation, and S. of Brooklyn, the fatal case.

The oldest of the nineteen patients at the time of operation was past 73,

the youngest past 46. The average age of the whole nineteen was a trifle more than 60 years.

The composition of the stones was generally phosphatic, as might have been expected from the time of life at which they occurred. No oxalate of lime stone was encountered.

The greatest length of time consumed in any one sitting, from the first insertion of the lithotrite to the withdrawal of the last washing tube—in which I did the whole of the work—was 85 minutes, and the yield in phosphatic stone was 630 grains. The longest case of the series was the last but one in which Dr. Stimson did the greater part of the work. This operation lasted 95 minutes, and yielded 495 grains, a yield decidedly above the average, and particularly striking in that the case was the first in which Dr. Stimson had operated by the rapid method. My lithotrites (the working models) were used. The bladder was not injured. The patient was out of doors in a week.

The shortest operation lasted 10 minutes, and the yield was 81 grains.

The greatest proportionate result in yield as compared with the time occupied by the operation was the removal of 540 grains of mixed uric acid and urates in 57 minutes—9 grains to the minute; and the least yield proportionately to the time was (S. second sitting) 30 grains of phosphatic stone in 60 minutes—an average of 2 minutes to the grain; and this not in an early case, but in the eighteenth of the series. The total number of minutes consumed in all the operations was 938, yielding 4241 grains of stone, an average of $4\frac{1}{2}$ grains to the minute.

This is a reasonably good result, considering that the patients averaged over 60 years of age, were nearly all subjects of prostatic overgrowth, and had phosphatic stones, while in no instance was the urethra cut except occasionally at the meatus, and once (Case 21, stricture) in the first inch. Large tubes were rarely employed in evacuation. 31 French was occasionally used, but vastly the greater part of the work was done with tubes 13 and 16 English (22 and 27 French). The urethra was in no instance overstretched in order to hasten the operation. In all of the earlier cases much time was unnecessarily consumed in prolonged crushings and infrequent washings, a procedure which is certainly not appropriate in this operation. Moreover Dr. Van Buren and myself were mutual workers and mutual learners in this operation, and were constantly inciting each other to caution, and demonstrating different features of the operation as they were recognized, thus losing much time.

Yet that a difficult case may give a small yield for a long operation is shown by the second sitting in case 18, in which an hour of diligent work only yielded half a drachm of débris.

In the ordinary run of cases therefore, judging from this experience, cases mostly of large prostate and of light soft stone, which often crushes like mortar and does not crackle into numerous angular fragments like the acid

stones, an average yield of about five grains of dried stone to the minute of work seems to be what may be reasonably expected, and about three hundred grains to the hour a fair proportion. In a patient with healthy prostate and capacious urethra, having a large friable acid stone, from 15 to 20 grains to the minute would not be too much to expect with ordinarily expert work. A good case of this sort has not yet applied for relief to Dr. Van Buren or myself since we adopted the Bigelow operation. In the best case of the table (No. 14) where the stone was acid and an average yield of 9 grains to the minute was obtained, the patient was suffering from inflammatory epididymitis at the time of operation. The crushing was very satisfactory, but tube 16 (English), made by Weiss, was used, and it constantly became impacted by the lodgment of an angular fragment which could only be displaced by withdrawing the tube. The peculiar shape of the fragments seemed to be the cause in this case of the impaction of the tube. Impaction, I find, happens less often in Bigelow's tubes than in the English tubes, but it has occurred in the former in my hands and in those of Coulson.¹

This question of the quantity of débris to be expected from fair work extending over a given limit of time is, I think, an important one. It has not yet been fairly raised by any operator except Thompson. My own average as shown above is $4\frac{1}{2}$ grains of dried stone to the minute, and I think this quite small. I confidently expect to produce double that amount in future, but do not regret that caution in operating which has led to this modest result in the past. How excellent a result may be produced by a hand long skilled in the performance of the old operation is shown by the average attained by the master lithotritist, which I have computed from his first list of cases, the only ones thus far published in detail. These 13 cases² show an average of $16\frac{1}{2}$ grains of yield to the minute, where the stone was composed of uric acid or oxalate of lime, and of $12\frac{1}{2}$ grains to the minute where the stone was phosphatic.

In his second article, where he reports a total of 31 cases (without details),³ Thompson states that he has "hitherto removed on the average from 150 to 200 grains in 10 minutes of hard calculus (uric acid or oxalate of lime)." This increase of average proves the advance made in his later over his earlier cases in precision and rapidity of execution, as well as (doubtless) improvement in the washing bottle and increased familiarity with the method. When however he adds that "when the stone is friable, as in the case of phosphatic formations, a larger quantity may be removed in a given time," I must hesitate to accept the conclusion, since it appears to me opposed to the nature of things. Most phosphatic stones certainly require more crushing than most acid stones, on account of the

¹ Lancet, Jan. 31, 1880, p. 162.

² Sir H. Thompson. Lancet, Aug. 2, 1879, p. 161.

³ Lancet, Jan. 17, 1880, p. 79.

facility with which many of the latter crackle up into angular fragments, segmentation going on laterally as well as in the line of the crushing force. Certain phosphatic stones do fall to pieces at a touch, but many are toughly cemented together in their layers, and break more like pieces of mortar. Moreover, as I have pointed out in Thompson's first series¹ (the only ones of which the details are published) the acid stones averaged a greater yield by the minute than the phosphatic stones: as $16\frac{1}{2}$ to $12\frac{1}{2}$.

Aside from the question of crushing, the capacity of the Bigelow bottle and similar washing apparatus for speedy delivery of small stones and fragments from the bladder is shown by the remarkable case of Thomas Smith, who on November 25, 1879, using a 16 English tube, in 20 minutes washed three ounces (℥ij) of small stones (dry weight) from a patient aged 69, without using any lithotrite. Nine days later a lithotrite was used, and in 24 minutes another ounce evacuated. The patient did perfectly well, leaving the hospital four days after his last operation "in comfort and cured."

What can better illustrate the beauty of this method than this delivery of 4 ounces of stone in 44 minutes, in safety and comfort to the patient?

No other surgeon so far as I know has operated sufficiently often to make it possible to get accurate information of any value as to the proper amount of débris to be expected for each minute of the operation. Bigelow's first published series² gives an average of a little less than three grains for each minute, but these cases were tentative, exploratory, so to speak, developing the method; while in several of them the stone was incrustated upon a foreign body. Moreover, in these operations Professor Bigelow doubtless followed out his own maxim strictly, practising what he preached, that rapid lithotrity should be performed slowly. Undoubtedly his last cases have shown a much higher average.

Tabulation of Cases.—I have placed the 21 cases upon which this article is based in tabular form.

¹ Lancet, Jan. 10, 1880, p. 44.

² Am. Journ. Med. Sci., Jan. 1878.

Case.	Name.	Age.	Physical condition.	Number of sittings.	Time consumed (minutes).	Composition of stone.	Weight when dry (grains).	Result.
1	P. of France.	63½	Feeble, nervous, large prostate, atonied bladder, healthy kidney.	1	60	Uric acid and urates.	119	Cure; no relapse of stone.
2	L. of Lanskburgh.	60½	Total atony, large rigid prostate, one sacculated, one free stone, sound kidneys.	1	25	Phosphatic.	162	Relief; re-accumulation of phosphates requiring washing on several occasions.
3	J. of Mexico, N. Y.	56½	Weight 230 lbs., albumen and casts in the urine, old and serious valvular heart disease, large prostate.	1	50	Uric acid.	161	Cure; no relapse of stone.
4	H. of New York.	58½	Feeble in general health.	1	42	"	239	Cure; no relapse of stone.
5	B. of Brooklyn.	46½	Generally feeble, atony.	1	10	Phosphatic.	81	Cure; no relapse of stone.
6	M. of New Orleans.	63½	Large prostate, fair health.	1	41	"	72	Cure; new formation of phosphates, and new operation after one year.
7	P. of Pittsfield.	57½	Large prostate, atony, feeble.	1	40	"	136	Cure; no relapse of stone.
8	J. of New York.	51½	Large prostate, healthy.	1	60	Urates.	360	Cure; no relapse of stone.
9	C. of Red Hook.	51½	Large prostate, feeble.	1	35	Phosphatic.	260	Cure; no relapse of stone.
10	McG. of New-ark.	54½	Large prostate.	1	30	Urates.	127	Cure; no relapse of stone.
11	H. of Hartford.	56½	Atony of bladder, feeble.	1	40	Phosphatic.	115	Cure; new formation of phosphates, and new operation in about one year.
12	M. of New Orleans.	64½	Large prostate, fair health.	2	{ 5 5	{ toge- ther	80	Cure; no relapse of stone.
13	H. of Poughkeepsie.	73½	Large prostate, fair health.	1	85	"	630	Cure; no relapse of stone.
14	B. of Poughkeepsie.	66½	Large prostate, fair health.	1	57	Uric acid and urates.	540	Cure; no relapse of stone.
15	W. of Abingdon.	68½	Large very rigid prostate.	1	42	Uric acid.	80	Cure; no relapse of stone.
16	H. of Hartford.	57	Atony of bladder feeble.	1	20	Phosphatic.	50	One extra washing required.
17	C. of New York.	58½	Large prostate, fair health.	1	45	"	152	Cure; no relapse of stone.
18	S. of Brooklyn.	67½	Albumen and casts, evidence of advanced pyelitis, patient had been bedridden nine months, and was passing catheter 24 times daily.	2	{ 60 60	" {	190 30	Death on fourth day after second operation from aggravation of pyelitis and suppression of urine; bladder uninjured at autopsy.
19	L. of Louisville.	68½	Large prostate.	1	19	"	98	Cure; no relapse of stone.
20	R. of Dubuque.	52	Moderate prostatic enlargement, fair health.	1	95	Uric acid.	495	Cure; no relapse of stone.
21	of Tarrytown.	65	Stricture, large prostate, atony.	1	12	Phosphatic.	64	Cure; no relapse of stone.
21	Average age	60	Total number of minutes employed	{ 938		Total No. of grs. { 4241 Average 4½ grs. to the minute.		Result— 20 cured. 1 death.

By this means the most important points of all the cases are so placed as to be easily compared at a glance. The details of about half these cases have already been given to the profession by Dr. Van Buren in two short articles which appeared in the *Medical Record*,¹ and I have spoken

¹ September 28, 1878, p. 241, and March 22, 1879, p. 265.

of most of the others, and shown the specimens before the New York Pathological Society.

Many of the features of these cases have been already referred to in the earlier pages of this article, especially the fact that small lithotrites and tubes were used on account of a dread I have always entertained of injuring the urethra. The foundation for this dread has also been plainly given.

I may add that nearly all the cases passed a few grains of débris after the operation, occasionally quite an appreciable angular piece of stone. No case was allowed to go home without a subsequent washing (without ether), and if this wash brought anything away the patient was made to stay over until another wash had proved barren, both in yield of fragments and of the click, indicating the existence of any remaining piece of stone in the bladder. When possible, also, the patient returned to town after several months, and only then, after a final wash, yielding no return, was he pronounced cured. The cases of re-accumulation of phosphates and the fatal case require some special description later.

No fixed time can be set at which a patient will be out after his operation, but in uncomplicated cases the patient is quite certain to be up and out at the end of a week. If a patient comes from out of town, two weeks' stay in the city is generally all that is actually required, although he generally should come back after several months to be washed and receive the assurance that his bladder is empty.

Complications after the Operation.—In the cases I report the complications after operation have been unimportant. In one case (the first) there was a severe chill and subsequent fever lasting several days, and in about one-fourth of the other cases there has been mild chill followed by moderate fever. Temporary retention of urine, requiring the use of a catheter, occurred three or four times, but subsided promptly. No decided atony of the bladder has resulted from any of the operations, such as was sometimes known to follow the old operation. In every case there has been a moderate elevation of temperature lasting from twenty-four hours to several days. The urine is generally more or less bloody for several days after the operation. In good cases this feature is entirely absent. In one case mild epididymitis was set up by the operation. The grade of the existing cystitis was temporarily aggravated in several cases, but this quickly subsided.

Conditions Contraindicating Operation.—I know of no conditions necessarily contraindicating the operation, except hopeless maladies of any kind, distortions of the urethra preventing the use of proper instruments, and possibly large size of a very hard stone. I think that in case of very tight organic (especially traumatic) stricture of the deep urethra, external urethrotomy might be performed, and litholapaxy through the perineum.

Among the patients upon whose cases this report is based are found ex-

amples of very large and rigid prostate, complete atony, and various grades of chronic cystitis. One case had subacute epididymitis of a week's standing at the moment of operation, but the lithotrity terminated successfully, and the testicle did not suffer from it. Some of the patients had weak lungs, chronic bronchitis and asthma, feeble heart, valvular disease of the heart, great general debility, dyspepsia, etc. Several cases had a moderate amount of pyelitis, and several had urine of light specific gravity containing some albumen and a few casts of the kidney tubules; yet none of these complications have materially interfered with the result, except in Case 18, the fatal one. Indeed this man was known to be desperately and mortally ill before the operation was undertaken, and the risk was accepted knowingly.

Doubtless in cancer of the bladder, pyelitis of any intensity, and where albumen and casts are abundant in the urine, it will be proper to refuse an operation.

Preparation of the Patient for Operation.—This I consider very important. If a patient has atony and his urethra is accustomed to the constant use of a catheter, he is ready for operation at once, so far as local preparatory treatment is concerned, but it is better, if he can spare the time, to put him to bed for a few days, and to wash his bladder with a solution of borax and water, a heaping tablespoonful to the pint, at a temperature above 100° F. This is all the more necessary in case the patient has atony and residual urine but has never used a catheter.

In cases without atony and residual urine previous preparation of the urethra by the occasional passage of a full-sized conical steel sound at appropriate intervals is serviceable but not obligatory. I have operated in both these classes of cases where no instrument had ever passed the urethra save the one searcher which detected the stone, and have done so with the happiest result—no chill, very moderate reaction, patient out of doors in a week. Yet I do not think this precipitancy advisable.

Stricture of the urethra of very large calibre is in my judgment no bar to the operation, and may be disregarded, the size of the tube being regulated by the calibre of the stricture, or the latter when desirable may be dilated previously, or cut; but I think it best not to combine this operation with the litholapaxy where it may be avoided. All strictures within the first inch from the meatus, however, may as well be disregarded and cut to a fair size at the time of operation along with the meatus. The meatus when small, and the congenital band of narrowing so often found just within it, should always be cut at the time of operation, since this little incision adds no risk to the operation, and lends a few sizes to the tube which may be safely introduced.

In the healthy urethra the second point of physiological narrowing at about the third inch should regulate the size of the evacuating tube to be used. I do not think that this point should be cut.

Rest in bed two or three days before the operation I think is always desirable, and when the bladder is much irritated or inflamed, whether it be atonied and undergoing a course of washing or not, the free use of Bathesda or Poland water, or of some bland diuretic for a few days before the operation is of unquestionable advantage.

If the urine be reasonably bright and clear, but over-acid and concentrated, a little citrate of potash for a few days before the operation corrects it. Milk diet is useful. I am in the habit of ordering ten grains of quinia to be given two hours before the operation, and ten minims of Magendie's solution of morphia subcutaneously just before giving the ether.

The Operation.—The details of operative procedure, as at present practised by Dr. Van Buren and myself, are the following:—

If the bed is a high one, and the mattress solid, I prefer to leave the patient flat on his back, on the right-hand side of his bed, with something under him to keep the sheet dry. If the bed is not suitable a table should be used. Two assistants only are necessary—one for the ether, one for the washing bottle; and one assistant can sometimes do all the work. I have operated promptly and successfully (without ether) in my office without any assistant, and several times with ether, having only one assistant. If the patient takes ether badly, two more assistants may be desirable to hold the legs apart.

I first test the calibre of the urethra with a steel sound to find what size of washing tube should be used, incising the meatus if it be small.

If the urine has been reasonably clear and acid, the lithotrite is introduced at once, regardless of the quantity of fluid in the bladder, unless the stone be exceptionally large, when a little water may be thrown in as a first step. If the urine has been ammoniacal and putrid, it is first entirely drawn off, and the bladder repeatedly washed with a saturated solution of borax and hot water, about a full drachm to the ounce,¹ in the washing bottle until the wash comes away sweet. I formerly used a one per cent. solution of carbolic acid, but I prefer the concentrated solution of borax, which is a better disinfectant and anti-zymotic at that strength, and quite soothing to the bladder instead of irritating, as is an efficient strength of carbolic acid.

In the fatal case I used carbolic acid, but was unable to get the wash sweet. Indeed, after the end of the hour of operating, the last wash had a slightly putrid smell, due doubtless to the admixture of a few drops of urine from the diseased kidneys.

I find it most satisfactory to crush rapidly from six to ten times, according to the size of the seizures, then to wash until the débris ceases to fall into the receiver, and immediately re-introduce the lithotrite, while the assistant empties the receiver, and refills the bottle. Generally before the

¹ At 110° F. a saturated solution of borax is 1 in 6 = 3^{ss} in 3j.

bottle is again ready enough stone has been fragmented to require another washing.

For catching the stone the ordinary manœuvres practised in old lithotripsy still hold good. With my instrument I am in the habit of seizing and crushing a fragment at any part of the sides or base of the bladder, wherever I can pick it up, even with the beak reversed, so confident do I feel that the instrument is not apt to catch the bladder. I catch the button, throwing on the screw movement with any finger of either hand, whichever one happens to be nearest, and with the first gentle turn of the screw in crushing I likewise rotate the whole instrument, or draw it forward. In this way I should become aware at the very commencement if a portion of the bladder wall had been picked up along with the fragment; but I do not rely upon this test, for I think it easy, in most instances, to distinguish at once when a prominent, outstanding trabecule on the side or base of the bladder has been caught, by the peculiar, soft, elastic feel of the bite of the jaws as they are carefully brought together. In such case the instrument is rotated, and care exercised when exploring in the same quarter again.

In brief I believe the best results in the operation likely to be attained by the use of small, strong lithotrites which cannot clog, and will not readily catch the bladder, perfect purification of the bladder at the start, if the urine has been ammoniacal, short crushings, and frequent washings.

After Treatment.—I think it well in all cases where the urine has been decomposed before the operation to pass the catheter on the evening after the operation, and wash the bladder with a hot, saturated solution of borax at 103° F., and to repeat these washings twice daily, reducing the amount of borax after twenty-four hours. A heaping tablespoonful of borax weighs about seven drachms (3vij), and this, in a half pint of water, is near enough the required strength to begin with, later the same quantity may be used in a pint of water. Occasionally this solution irritates, but in most of the cases upon which I have thus far tried it the effect has been excellent. My experience as yet is small.

A rubber bottle containing a layer of hot water placed over the lower part of the abdomen gives much comfort after the operation. Bathesda water should be continued in all cases of ammoniacal urine or much irritation. Opium, nitre, aconite, quinia, laxatives, etc., as required. A milk diet is soothing, but most patients do not like it.

Special Manœuvre to catch the Stone.—I have only one manœuvre to describe which I believe to be new. In one case the bladder was pouched toward one ureter. In this pouch the stone rested; but I knew it not to be encysted, since I had felt it on one occasion on the other side of the bladder, and at the time of the operation could pass the end of the closed lithotrite all around it; yet I could not seize it. I tried with several

instruments, with the bladder full, and empty, but in vain. I turned the patient on his side with a full bladder, but the stone would not roll out. Finally I distended the bladder fully, rolled the patient upon his opposite side, introduced a searcher, hooked the beak around the stone, and dislodged it from its pouch. I then easily caught it on the other side of the bladder, keeping the patient upon his side; but I lost thirteen minutes in the operation in fruitless efforts to catch the stone in its old position. By keeping this patient upon his side with the bladder full, I finished his operation, although not very comfortably.

Last Fragments.—A most important feature in the new operation is its value as a detector of small stones and fragments. I have on several occasions found a small fragment with the washer when I failed absolutely to detect it with the sound. Occasionally the washer will fail to find a stone which the searcher can discover, as in the case to be narrated presently under the head of re-accumulation of phosphates. The washer will also fail to detect fragments which lie in a deep pouch toward one ureter, or behind a prostate, or in a sacculus, unless the stream of water be directed upon them as they lie—therefore the manœuvre of turning the patient upon his side in the final washing, while the bladder is distended, is a valuable one. With it I have caught fragments which escaped washing for a considerable time when the patient was upon his back.

In order to wash effectively for a last fragment it is absolutely necessary that no air should be in the bladder. A few bubbles will churn up to such an extent that there can be no certainty whether the click of a small fragment against the tube is real or imaginary. I have been unable, with Professor Bigelow's bottle, to couple with sufficient accuracy to avoid leakage of a minute quantity of air as a rule; and although this is a matter of no importance in many cases, sometimes it is all-important. I refer to Bigelow's old washer. I learn that he is devising another. If this new one has the water bulb above the level of the joint where the tube couples the air problem will be at rest, otherwise I think it will not be.¹

I have used Thompson's washing bottles exclusively in all my later operations, and find them perfectly efficient, very convenient, and entirely easy to use in such a manner that no air can enter the bladder. If a little does get in it comes out again through the tube and collects at the top of the bulb, where it does not make any churning noise.

¹ I have just seen (March 3d) Professor Bigelow's description of his new washer in the *Boston Medical and Surgical Journal*, Jan. 8, 1880, p. 30. It has an air-trap in the top of the bulb. It is evidently a great improvement upon the first washer. Its stopcock and air-trap render it capable of being used without wetting the bed or allowing air to enter the bladder; while an extra tube allows the operator to expel air from the bulb, should it by chance get in, and change the amount of water in the bladder at will, without uncoupling. Professor Bigelow writes me that it has proved satisfactory in all respects.

While the water is swashing backward and forward in the bladder, without air, if the surgeon or assistant places his ear over the bladder upon the abdomen he can hear the rush of the water perfectly, and detect the slightest click made by the contact of a minute portion of stone against the tube. When these clicks finally cease, or are so mild that they seem to be caused by very fine particles, the washing may be terminated with a certainty that no fragment of any importance remains.

The dull thud of the bladder wall drawn against the end of the tube when held in certain positions, the sharp click sometimes caused in the same manner, and the flutter of the bladder wall against the orifice in the tube are sounds with which the operator soon becomes familiar, and which he need never mistake for the sharp click of a stone.

A radical cure depends upon the thoroughness of the final test wash, which the operator should always make when the soreness has left the bladder before sending the patient off as cured. The wash should be repeated after a few months, when practicable, to confirm the certainty of cure.

Re-accumulation of Phosphates.—Cases II., VI. and XII., XI. and XVI., belong in this group.

CASE II. has already been alluded to in the earlier pages of this article, as the patient whose bladder was lightly pinched during old-fashioned lithotripsy, who was relieved by rapid lithotripsy, and then, after several washes without ether, had his urethra over-distended, and nearly died of cystitis. I have washed him since, and again found a small, smooth, round phosphatic stone about the size of a pea.

I now washed this patient carefully and thoroughly under ether. I used the Thompson bulb, and not the most minute bubble of air was allowed to enter the bladder. The thin atonied bladder readily received the whole of the contents of the bulb, and the swash of the fluid was very evident to the ear laid upon the thin walls of the abdomen. The tube was turned in all possible directions, and Dr. Stimson's ear brought to my aid; but no click announced the existence of any further stone.

I had formerly relied so thoroughly upon this test to decide that there was no stone in the bladder, that I was about to desist, when I concluded to search the fully distended bladder with the ordinary Thompson's searcher. This I did most exhaustively, and finally I succeeded in inserting the beak of the sound into a hole in the bladder-wall on the patient's left side at the base. Here I found a stone which I judged to be nearly an inch in diameter. I attempted to dislodge it, but failed. I withdrew the beak of the sound, and, by a little care, was able to re-insert it at will into the hole, and again demonstrate the encysted stone to Dr. Stimson.

When the patient came out of his ether I proposed the supra-pubic operation. This he declined. He has been very comfortable for some months past, and doubtless will so continue until another phosphatic bud forms, and breaks off so as to be free in the bladder. Then he will doubtless have another access of tenesmus and irritation until the little free stone is again washed out.

In a case like this, re-accumulation of phosphates is easy to understand.

Another cause for the re-accumulation of phosphates is the existence of chronic (especially phosphatic calculous) pyelitis. This is demonstrated by my fatal case, which is described under the sub-head Mortality.

Finally, perhaps, the most frequent cause for re-accumulation of phosphates is persistence of prostatic enlargement, chronic cystitis, atony, etc.,

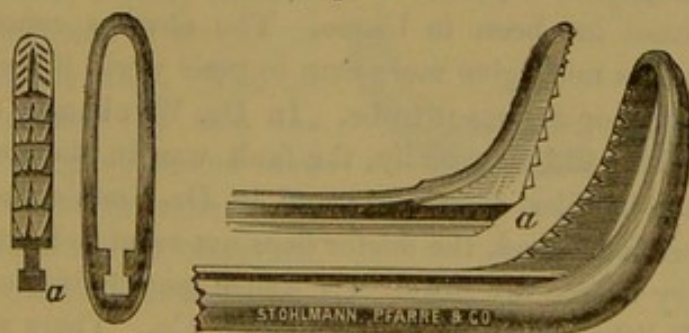
and lack of intelligent care on the part of the patient in washing out his bladder.

A certain number of cases suffer from this re-accumulation. M., of New Orleans (Case VI.), and H., of Hartford, are instances in the foregoing list. Both were certainly relieved by rapid lithotripsy, and both required a new operation for a new soft formation of small size after about a year. Both are now well so far as known. One has passed the summer in Europe, and both take the best of care to wash their bladders thoroughly. Thus far I have had no relapse in a case from which I had removed an acid stone.

Instruments.—Professor Bigelow's lithotrite is strong, effective, but open to the criticism that it is needlessly large¹ for stones as they are generally encountered, and that neither the catch for the screw on the outside by the wrist motion, nor the ball handle, seem to me adapted to the performance of as quick work as the button catch and wheel of the old instrument. This may be a notion on my part, due to being accustomed to handle the old instrument. Sir Henry Thompson's lithotrite, which I have seen, is solid, small, effective. He states that it does not clog. Had I possessed it, I might have saved much time in searching for a small, light instrument which would not clog. As I did not possess one, I set about to construct such an instrument, and reported progress in the *Medical Record*, May 18, 1878, page 388. I am still modifying my instrument. I am satisfied with it so far as my working with it is concerned, but I am not willing to indorse it for general use until I have tried a few more changes in the manner of roughening the sole of the male blade, so that it shall have the greatest prehensile power with the least sharpening of the points.

I make, therefore, this as a second report of progress.

Fig. 1.



The two cuts (Fig. 1) show the instrument, but they do not strictly represent it. They are supposed to be absolute representations of natural size, but no one could imagine from the rear view of the female blade at the heel, and the three-quarter view of the same blade at the same spot, that these

¹ Prof. Bigelow writes me that a small instrument of his design is manufactured.

cuts represent the same instrument. The female three-quarter view is much too broad. The rear view of the two blades is quite accurate. The features of the instrument are the smallness of the male compared with the female blade, the antero-posterior diameter of the jaws of the male and female blades at the heel; the breadth of the shoulder at *a*, and its continuance to the very end of the male blade, as shown by the hole at the bottom of the rear view of the female blade. This feature of the instrument insures great strength of action, and prevents the male blade from springing, an accident which once happened to me with one of Weiss's instruments in a case of old-fashioned lithotrity, where the stone was quite large, and very hard. The picture also, in the three-quarter view, gives too much of a curve to the female blade, and makes the whole instrument look clumsy, while the male blade is shorter and narrower than natural.

As made by Tiemann, I do not find the instrument at all clumsy. It is light and strong, only catches the bladder with difficulty, and then does not cut it if the operator recognizes what he has in the bite of the instrument. It has done reasonably quick work, and will crush a piece of brick an inch and a half in diameter without springing. The dimensions are: size of shaft, 18 French (10 English); of heel of jaws, 24 French (14 English); length of jaws, 1 inch. I have a larger model, which crushes pieces of brick two and a quarter inches in diameter. This I have used in the bladder. Its dimensions are a little greater than those given above. I personally prefer a fenestrated instrument. Coulson has expressed a similar preference.¹ Other operators, so far as I know, prefer an instrument with a solid back.

I had the misfortune, in 1878, in describing the jaws of my instrument in the *Medical Record*, to state that I thought the lithotrite of Professor Bigelow "must sometimes clog." I regret this hasty assumption. The only cases of impaction reported seem to prove that a faulty construction of the instrument has been to blame. The obvious conclusion is, that instrument-makers must give more care to their work, if the instrument is to be what its author desires it to be. In Dr. Wynkoop's case, in which Bigelow's lithotrite did clog badly, the fault was in the workmanship of the screw in the handles, I am told; and in Dr. Stein's case, at Charity Hospital, where it clogged, the doctor does not seem to have considered it necessary to try to free the jaws. He writes me relative to the case: "I used Bigelow's lithotrite made by Tiemann & Co. There was some clogging of the jaws of the instrument, because the stone (phosphate) was soft; nevertheless, there was no trouble or inconvenience caused thereby."

In this case, 220 grains were removed in twenty-five minutes, and all went well. As at present constructed, I do not well see how Professor Bigelow's lithotrite can clog. Dr. Weir, in his recent article,² states that

¹ Lancet, January 31, 1880, p. 163.

² Am. Journ. Med. Sci., Jan. 1880.

with Bigelow's lithotrite, "a tendency to impaction was noticed in two instances, but when the lithotrite was withdrawn, it was ascertained to be due to the slot in the shoe or female blade not corresponding with the termination of the groove between the two shanks of the instrument."

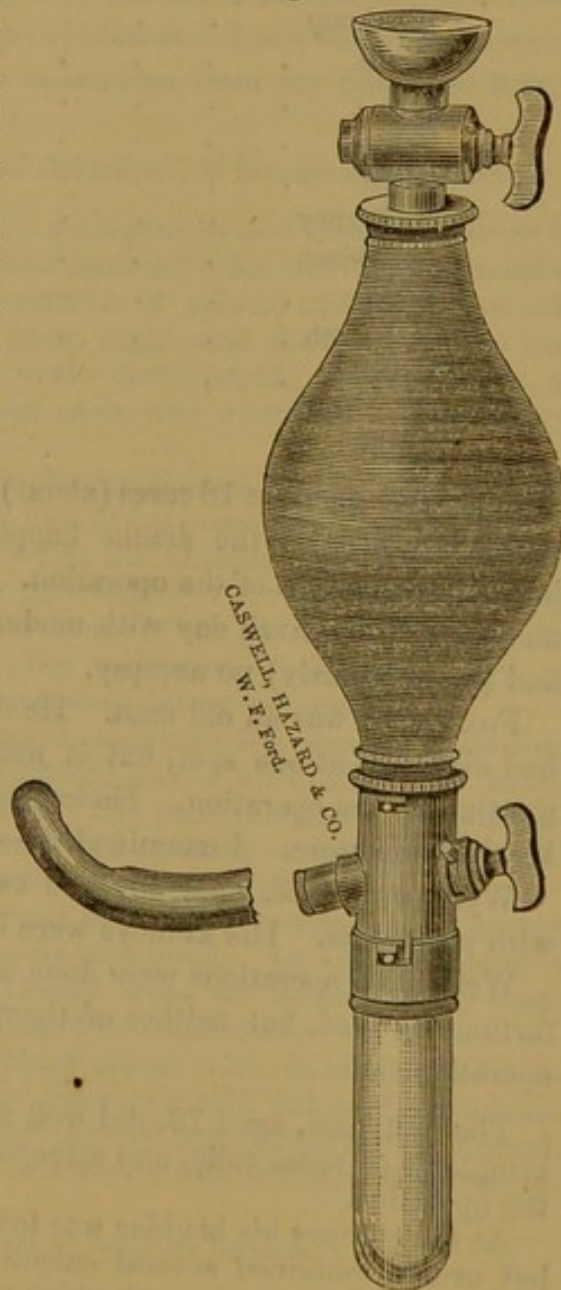
I have had the wheel made larger in the handle of my lithotrite than in the older instrument, and the button higher, so that it may be caught easily by any finger of either hand in any position, thus promptly throwing the screw power into action.

Among the three washing bottles in the market, I have no hesitation in preferring Thompson's last. I do not like the glass sphere however, because the fragments cannot be seen to fall into it when the wash becomes tinged with blood as readily as they can in the glass tube which was attached to the first Thompson washer. I have therefore had the tube as upon the old washer, attached to the new one in place of the sphere, and have cut off the funnel-shaped valve. (Fig. 2.) The fragments are stirred up in the tube by each compression of the bulb but the instrument works very effectively, and as soon as fragments are seen to cease to fall, the tube is withdrawn.

In using this instrument, I introduce the tube to the membranous urethra, then couple, turn on the stopcock, and make a very slight compression of the bulb. The air immediately mounts up into the bulb with a gurgling sound and now, confident that the tube is absolutely full of water, I enter the bladder and proceed with the washing.

The sudden distension of the bladder produced by pressing the bulb causes pain. The patient, although under the influence of ether, always winces a little as the water rushes in. I have never seen any ill result from this cause however, but am inclined to treat the bladder more gently in sensitive cases than in others.

Fig. 2.



Statistics and Mortality.—The total number of operations performed up to this date, Feb. 15, 1880, so far as I am aware is as follows:—

	No. of Operations.	Fatal.
Bigelow	21	1
Thompson	31	0
Van Buren and Keyes	21	1
Cadge	5	0
Coulson	4	0
Curtis	3	0
Weir	4	2
G. Buckston Brown	3	0
Thos. Smith	2	0
Wynkoop	2	1
Sands	2	0
Fox	1	1
Peters	1	0
Allen	1	0
McBurney	1	0
Hutchison	1	0
Stein	1	0
Wilmarth	1	0
Orth	2	0
Total	107	6

Average 1 death in 18 cases (about). This is an excellent showing, especially as nearly all the deaths happened in patients who were far from healthy at the time of the operation. Bigelow's patient was 66 years old and died on the sixth day with moderate meteorism, but little tenderness, and (unfortunately) no autopsy.

Fox's case was an old man. He died on the sixth day. His bladder had ulcerated at one spot, but it was believed not to be due to injury at the time of the operation. He had pelvic peritonitis, and surgical kidney. He died comatose. I examined the specimens when fresh.

Wynkoop's case, aged 55, died twenty-nine hours after the operation with peritonitis. His kidneys were large, congested, soft.

Weir's four operations were done upon two patients, both of whom unfortunately died, but neither of them, I think, directly as a result of the operation.

The first case, aged 73, did well for a week, when he had a chill with symptoms of renal colic, and after further chills he died four weeks after the operation.

At the autopsy his bladder was found sound, and free from stone. The left ureter contained several calculi high up. The kidney was broken down with abscesses, one of which communicated with the peri-nephritic tissue. Here the impacted kidney stones, in the feeble state of the patient's health, undoubtedly originated the abscesses which caused death.

The second case, aged 65, constitutes the Cases III. and IV. of Dr. Weir's

article in this Journal already referred to. These were separate operations done upon the patient at an interval of fifteen weeks. From each of these the patient rallied reasonably well. Six months later, at a third and final operation, more stone was obtained. On the eighth day vomiting came on, and death on the ninth day following.

At the autopsy, enormous median hypertrophy was found, $1\frac{1}{2}$ inch in diameter. The bladder was not injured, and contained two fragments of stone, each one half an inch long. Both kidneys were filled with calculi. In the right were fifteen, varying in size from a hazelnut to a small egg, composed of phosphates and oxalate of lime. The cortical structure of the right kidney was almost totally destroyed. In one place a calculus had pierced the outer surface. The left kidney had more cortical substance upon it. The pelves of both kidneys contained much bloody pus.

It is hard to understand, not why this patient died, but how he lived long enough even to apply for the first operation. I saw the kidneys when they were presented along with the specimens from my fatal case before the New York Surgical Society.

My own fatal case (No. XVIII. of the table), is briefly as follows:—

CASE XVIII, age 67 $\frac{1}{2}$. Prostatic enlargement and bladder disease of many years standing. Patient had been confined to his bed for nine months, thinned to a shadow, using small quantities of opium, and passing a soft catheter when I saw him, once an hour, night and day. His pain was intense, and nearly constant. His urine decomposed, very offensive, of very light specific gravity, contained casts and albumen. The kidney region was tender on pressure.

Pyelitis and Bright's disease were diagnosticated, but at the patient's request an effort was made to relieve him of his stone and his pain.

The bladder was pouched (as proved at the autopsy), and very difficult to manage. An hour's diligent work only obtained one hundred and ninety grains. I then closed the sitting on account of the patient's feeble condition. He had no chill or reaction, but continued in as much pain as before, eating less and passing more pus than before the operation.

To get away the remaining fragment, although the general condition was desperate, I operated again in eighteen days; worked an hour again before getting away the last fragment. The pain increased, the pus increased, the urine diminished, fever and nausea came on with a chill, and finally on the fifth day after the operation the patient died.

At the *autopsy* the prostate was found large but uncongested. Urethra healthy. Bladder pouched, but entirely uninjured. Its surface was of a pale blue-white, containing no ecchymotic spots, no lacerations or abrasions, but uniformly smooth and shining, free from stone.

Both ureters were dilated, both kidney pelves were distended and contained about two ounces each of thick green pus with flakes of phosphatic calculous matter. The secreting substance of both kidneys was altered, atrophied, the organs small, the seat of chronic interstitial and parenchymatous changes.

It is wonderful that the patient lived so long as he did.

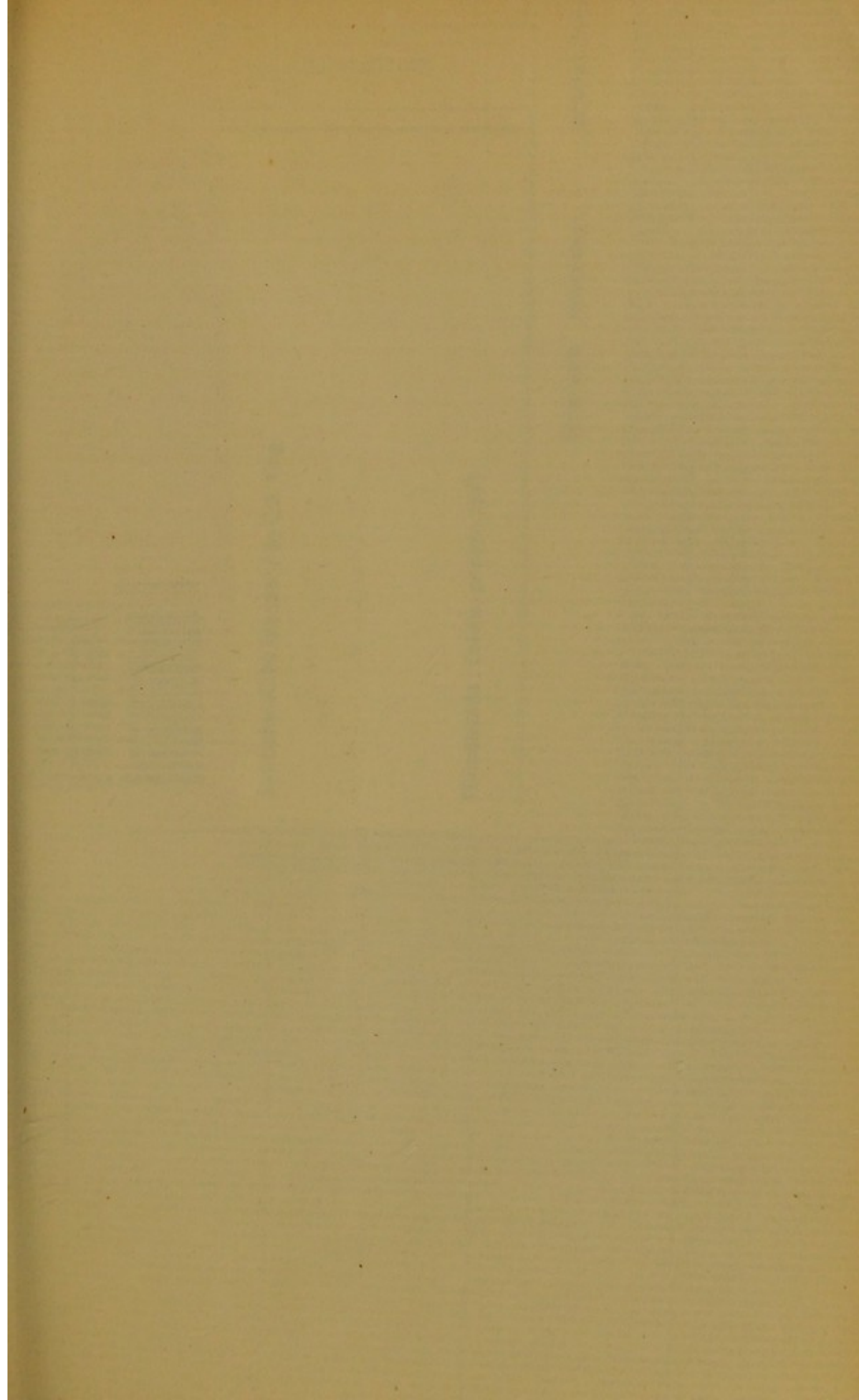
A mortality of 1 in 18 is good to start with, especially when the operators are so numerous; and the showing is still better for the new operation when the condition of the individuals who died is explained. Two of them

stood this operation, one on two occasions, one once, when they probably would have died under any other method promptly, if there is any value in post-mortem signs, and one of the others (Weir's first case) came to his death from causes apparently entirely separate from the operation.

What should be the Limit of Time occupied in a single Sitting.—Thompson allows thirty minutes as the limit to which he would be willing to push an operation, but in that time this veteran lithotritist could doubtless do as much work as another in an hour. I do not know that Bigelow adopts any limit. I have adopted none, but propose to operate as promptly as possible, and in a general way to accept one hour as the limit at which the sitting must close. If the patient's condition is good, however, and he bears the ether well, I think it would be better to prolong the sitting another half hour, rather than to leave angular fragments of any considerable size in the bladder.

If anything is left, it should be removed by a second sitting under ether, as soon as the patient has generally rallied from his first operation. It is not necessary to wait for cystitis to subside. On this point, the time for a sitting, wider experience from numerous operators will eventually establish a rule.

1 PARK AVENUE, NEW YORK CITY, February 15, 1880.



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