A CASE
OF
INTRA-PERITONEAL RUPTURE OF THE
BLADDER;
SUTURE; RECOVERY.
WITH REMARKS ON THE INFLATION TEST.

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WITH A TABLE OF TWENTY CASES OF RUPTURE
OF THE BLADDER TREATED BY SUTURE
SINCE 1888.

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IN 1888 I had the honour of reading before the Fellows of this Society a case of intra-peritoneal rupture of the bladder treated by suture, and supplemented my paper by a table of eleven cases, which were all the instances of that injury I could at the time find published, in which the same treatment had been adopted. I now venture to bring before the Society a second case, and I do so more

particularly to call attention to a test adopted as a means of diagnosis, namely, inflation with air—a test which I think it will be conceded is one of great value, and one that should be employed in all doubtful cases. My friend Mr. W. Ernest Miles, formerly house surgeon to the Metropolitan Hospital, has been at some trouble to collect the cases of intra-peritoneal rupture, treated by suture, recorded in medical literature since the publication of my table in the Society's 'Transactions' for 1888. These cases, which number seventeen, make, with the eleven published in my former paper, in all twenty-eight treated in this way. For the notes of the case I am indebted to Mr. Miles and to Mr. Meakin, also late house surgeon to the hospital.

V. B—, æt. 42, tailor, was admitted into the Metropolitan Hospital on March 8th at 1 p.m., with a history of having sustained an injury to the lower part of his abdomen.

History.—On March 7th, at 6 p.m., the patient, whilst endeavouring to separate two men who were fighting, was knocked down. One of the men fell upon him, striking with his buttocks the lower part of the patient's abdomen as he lay upon his back on the pavement.

Immediately after the injury the patient felt acute pain in the hypogastrium, and thinks that he became unconscious. He was taken home and put to bed, and slept for an hour and a half. On waking, he still felt great pain, and wished to micturate, but failed on attempting to do so. He then sent for Mr. Jackman, who passed a soft rubber catheter, and drew off a pint of urine tinged with blood. Though more comfortable for a time, he could not sleep for pain, and passed as he termed it a "terrible night." In the morning, a large quantity of urine, intimately mixed with bright red blood, together with some blood-clots, was again drawn off. Later in the day he presented himself at the hospital. When questioned as to when he last passed water before the injury, he gave various answers. At first he said at

dinner time (1 p.m.) ; then he said two hours before the accident ; then one hour before. This uncertainty in regard to the time of last passing water, coupled with the fact that he was able to sleep after the injury in spite of great pain, rendered the assumption probable that he was drunk at the time, and had not emptied his bladder for some considerable period before the accident. Since his convalescence he has admitted that this was the case.

Past History.—He has always been a heavy drinker, getting drunk frequently. As a rule he rises two or three times during the night to pass water. In other respects he has enjoyed good health.

On admission.—When brought into the surgery the patient looked pale, and his face wore an anxious expression. He complained of great pain in the lower part of the abdomen. The pulse was small, quick, and easily compressible. Acute tenderness on pressure was elicited over the hypogastrium. There was no distension at this region, and no dulness to percussion. There was no bulging of the flanks, but some degree of dulness which was equal on both sides. There was no side-to-side fluctuation. The abdominal wall above the umbilicus moved with respiration, but below the latter point it was rigid and motionless, and the abdominal muscles here were hard and resistant. As soon as Mr. Walsham arrived, a silver catheter (No. 10) was passed. On reaching what was taken to be the region of the prostate, a peculiar soft grating was felt, and as the point passed beyond this, blood-stained urine began to flow. The stream increased in volume during inspiration, and diminished during expiration. On withdrawing the catheter slightly the flow stopped, and began again on pressing it further in. About a pint of blood-stained urine was thus withdrawn, after which the patient felt much easier. On depressing the handle the point of the catheter could not be distinctly felt through the anterior abdominal wall. Fourteen ounces of warm 2 per cent. solution of boracic acid were then introduced through the

catheter, of which ten ounces returned. The test was repeated, and seventeen ounces were thrown in, of which ten ounces again returned, but by introducing the catheter to its full extent eight additional ounces were drawn off, which gave one ounce more than had been thrown in on the second occasion.

Since, however, four ounces of the first quantity had remained, there were still three ounces to be accounted for. The evidence by this means was not thought to be sufficiently conclusive of there being a rupture of the bladder, as some of the fluid had escaped at the spot where the rubber tube was fixed to the catheter, and all of the urine might not have been withdrawn the first time. It was decided, therefore, to try the inflation test. For this purpose the india-rubber apparatus belonging to an ether-freezing microtome was utilised, the tube of which was attached to the free end of the catheter. The liver dulness having been carefully percussed out, a few cubic inches of air were forced through the catheter by two or three contractions of the rubber ball. The effect was instantaneous. The abdominal cavity became distended, the liver dulness immediately effaced, and the whole abdomen tympanitic to percussion. The patient fell into a condition closely resembling collapse, he complained of great pain, his respiration was laboured, and the action of the heart turbulent. The diagnosis of ruptured bladder was now placed beyond a doubt, and the patient was at once taken to the operating theatre.

Under chloroform an incision was made in the middle line from the umbilicus to the pubes. On opening the peritoneum a rush of air escaped together with a small quantity of blood-stained fluid. The intestines having been pressed back by means of a large flat sponge, the bladder was found collapsed, with a vertical rent in its posterior wall extending from the summit along the middle line to the base of the trigone bordering on, but not involving the reflection of peritoneum. A silver catheter, when introduced into the bladder, readily passed

into the abdominal cavity through the rent. The coils of small intestine that occupied the recto-vesical pouch were somewhat reddened, but no peritonitis or effused lymph was present. Fourteen Lembert sutures in all were introduced. Beginning as deep down the pelvis as possible eleven interrupted silk sutures were passed by the aid of Hagedorn's needle-holder. The introduction of the finger into the bladder whilst the lowermost sutures were being inserted greatly facilitated the procedure. The uppermost suture was passed well above the upper limit of the rent. These sutures having been tied, a much clearer view than had hitherto been possible of the deepest part of the wound was obtainable, and it was seen that about one third of an inch of the rent in this situation had not been closed. It was impossible to reach and secure this with the Hagedorn or any other holder, but the difficulty was finally overcome by using a Smith's rectangular cleft palate needle, which answered admirably. Three additional sutures were thus passed, and completely closed the rent. Four ounces of milk were then introduced into the bladder through a catheter at some degree of pressure, with the result that the bladder became distended without a single drop exuding through the line of sutures. The pelvic cavity below the sponge keeping back the intestine was then irrigated with 1 in 3000 solution of perchloride of mercury and afterwards with a 2 per cent. solution of boracic acid. The sponge was removed, the pelvis once more irrigated, the abdominal wound closed by first uniting the peritoneum and muscle by buried aseptic silk sutures, and the skin by interrupted sutures, and a collodion dressing finally applied.

The patient suffered very little shock, and about an hour and a half after the operation passed urine spontaneously under him. Subsequently a soft rubber catheter was introduced every four hours of the first twenty-four, after which period the patient was made to pass urine naturally at four-hourly intervals, he being awakened for the purpose if necessary.

From the time of operation the patient may be said to have made an uninterrupted recovery, and it is not necessary to detail the daily notes, which, however, were accurately kept by Mr. Meakin.

Remarks.—As far as I have been able to ascertain with the help of Mr. Miles, this is the first case of ruptured bladder in which the “inflation test” has been employed. In January, 1890, Dr. Morton contributed a paper to the ‘Journal of the American Medical Association’ in which he suggested the use of hydrogen gas for inflating the bladder in cases in which the existence of a rupture in the wall of the bladder was doubtful. He carried out several experiments upon the cadaver, and found that when hydrogen gas was introduced, at moderate pressure, into a bladder that was intact, a localised tympanitic swelling made its appearance in the hypogastrium; but, on the other hand, that if a rent was previously made in the wall of the bladder covered by peritoneum, the whole abdomen at once became tympanitic and the liver dulness was completely lost. Dr. Keen also published a paper in the ‘Annals of Surgery’ in 1890 in which he advocated the inflation of the bladder, in cases of rupture of that organ, with filtered air. Though to both of these surgeons is due the credit of having suggested this method of diagnosis, yet to neither of them had an opportunity occurred up to the time of publication of their papers for testing the practical value of their suggestions upon the living subject, and I have not been able to ascertain whether the test has been put into actual practice either by them or by any other surgeons since. In the case under consideration the injection of a few cubic inches of air, forced into the bladder by two or three contractions of the rubber hand-ball apparatus, caused the whole abdomen immediately to become markedly distended, and the liver dulness, which had been previously percussed out, to be entirely lost. The insufflation of this small amount of air produced such an instantaneous alteration in the abdominal contour that no

question existed in the minds of any present as to the bladder being ruptured. The patient's condition incidental to the presence of free air in the abdominal cavity is worthy of note. Thus he became greatly distressed, complained of great pain, and experienced a sensation of impending suffocation. His pulse became small, rapid, soft, and easily compressible, and his respiration short and rapid. The immediate improvement in the patient's general condition attending the escape of gas on opening the abdomen shows that these subjective symptoms were entirely due to the presence of free gas in the abdominal cavity. The conclusions drawn from this single experience of the inflation test are briefly these, viz. :—that the amount of air to be introduced need only be very small, not more than three or four cubic inches ; that only very moderate pressure is required for the purpose ; that the presence of quite a small amount of free gas in the abdominal cavity is sufficient to establish the diagnosis beyond a doubt ; and lastly that the introduction of gas into the abdominal cavity even in small quantity is attended by a profound disturbance of the patient's general condition.

With regard to the last circumstance, it might be well on future occasions that the inflation test should be used when the patient is on the operating table, and not when he is in the ward as was the case here, so that in the event of untoward symptoms attending the presence of the gas in the abdominal cavity, immediate relief might be afforded by opening the abdomen. Before the inflation test was applied, I was doubtful whether a rupture of the bladder really existed, and my colleague, Mr. F. C. Wallis, who was present, considered that the signs were hardly sufficiently diagnostic to justify opening the abdomen. For the bladder being collapsed and the rent extending nearly to the prostate, the point of the catheter passed at once, without imparting any sensation of having first entered the bladder, through the rent into the rectovesical pouch, from which about a pint of blood-stained

urine flowed. It is true that a peculiar grating sensation was felt as the catheter passed through the rent, but the situation of this was so near the prostate that the grating sensation appeared, both to Mr. Wallis and myself, to be located in the prostatic urethra. Further, when the point of the catheter had passed through the rent into the recto-vesical pouch, a good deal of lateral movement of the beak of the catheter was obtained, which circumstance inclined us to believe it was in a distended bladder. Moreover, so soon as the urine began to flow away the lateral movement became limited, and this led us still more to believe that the bladder was contracting upon the catheter. This limitation of movement was no doubt due to the intestines falling into the recto-vesical pouch, and replacing the urine that had collected in that situation. The character of the flow of urine from the catheter was noteworthy, in that it varied with respiration, but this of course may happen in conditions other than rupture.

The water-injection test was by no means conclusive. On the first injection, although fourteen ounces were thrown in, only ten returned. Since some leakage had taken place at the point where the rubber tube was fixed to the catheter, it was felt that this loss might account for the disparity above mentioned. Accordingly the experiment was repeated, and seventeen ounces were thrown in, all leakage being stopped; eighteen ounces returned, showing an increase of one ounce. Perhaps more stress might have been laid upon the latter observation than was done at the time. Some surgeons rely upon the water injection test as a crucial one, but in their cases the difference between the amounts injected and returned was so great, as to leave no doubt in their minds that some of the retained fluid had found its way into the peritoneal cavity. In a case of suspected rupture of the bladder that came under my care some years ago, I applied this water test and made several injections, but since exactly the same amount returned as was thrown in,

it was concluded that no rupture existed, and this conjecture subsequently turned out to be correct.

Both tests, therefore, are undoubtedly of value, the water test especially so in those cases in which the abdomen is already tympanitic, and in which, therefore, the inflation test, it has been suggested, might not be conclusive. I would submit that both tests be applied, and I venture to think that with their combined aid the question of rupture in all doubtful cases may at once be set at rest.

The suturing of the rent was attended with much difficulty owing to the great depth of its lower limits.

No form of needle-holder was found suitable for introducing Lembert's sutures at this part, though Hagedorn's served the purpose admirably for suturing the upper three-fourths. When those sutures that had been introduced were tied, a clearer view of the lowermost limit of the rent was obtained, and it was then found that quite a fifth of its entire extent remained unclosed.

After various attempts this part was at length secured by means of a Smith's rectangular cleft-palate needle. Especial attention is called to this because it is from failing to efficiently close the deepest part of the rent that several fatal results have ensued.

As regards the after-treatment of the case, the only point that seems worth discussing is the expediency of tying a catheter in the bladder. Some surgeons advocate this practice on a plea that adequate rest is ensured to the bladder for the proper union of the rent. I would submit that the retention of a catheter can only be attended with danger in that it subjects the patient to the risk of septic infection and cystitis. In my former paper I maintained that it was quite unnecessary if the patient was made to pass water at regular and such intervals as would ensure no danger of over-distension. Further experience tends to confirm this view. In the present case a catheter was only passed five times after the operation, the patient subsequently micturating without its aid every four hours.

In conclusion I would offer a few brief remarks on the facts that I think are brought out by a review of the cases of intra-peritoneal rupture collected by Mr. Miles and myself. Mr. Miles has been able to find only twenty cases published since my paper in 1888. These added to the fourteen cases in my table make a total of thirty-four. In twenty-eight of these thirty-four the rent in the bladder was closed by suture. In the remaining six the bladder was drained either through the wound in the abdominal wall or through an incision in the perineum, the bladder wound itself being either stitched to the abdominal walls or left free, and the peritoneal wound drained or plugged with iodoform gauze. In one of these cases the rent in the bladder was said to be inaccessible to suture.

Of the twenty-eight cases in which sutures were employed eleven recovered and seventeen died.

The cause of death in the seventeen fatal cases, was in ten, peritonitis; in three, shock; in one, shock and peritonitis, the patient dying before the completion of the operation; and in two, shock and hæmorrhage combined, the cause of the hæmorrhage being in one case a tear in the superior vesical veins, and in the other an incision in the perineum made for the purpose of drainage. In one the cause of death is not stated, but from the context it appears probable that it was peritonitis.

It is noteworthy that in the eleven cases that recovered in only one was peritonitis present at the time of operation, whilst conversely of the seventeen that died in eight (and probably nine) acute peritonitis had already set in, showing very clearly the importance of an early diagnosis and operation. At the same time the considerable period that in some of these cases had elapsed before the operation without peritonitis occurring (as much as forty-two, fifty-four, and sixty hours) also shows how long healthy urine may remain in the peritoneum without doing any harm. This fact must not be presumed on, however, since in one case peritonitis had already set in as early as ten hours

after the injury. In the eight or probably nine cases in which peritonitis was present at the time of operation seven and probably eight appear to have died of peritonitis, and one died from shock on the operating table.

In the eight fatal cases in which there was no peritonitis at the time of operation, death was due in five to shock or hæmorrhage or the two combined, and in three to peritonitis subsequent to the operation. In two of the latter cases, the peritonitis was due to leakage of the bladder; in the third the cause of the peritonitis is not stated.

Leakage of the bladder from inefficient suture, or the giving way of a stitch, it will be seen from the combined tables occurred in no less than four of the twenty-eight cases, and in two as mentioned above was the direct cause of peritonitis and consequent fatal result. In the remaining two, peritonitis in one was already present; in the other, death occurred from shock seven hours after the operation, and before the leakage had had time to take effect. It is worth noting that in three of these cases the leakage is said to have occurred at the lower angle of the wound, the spot which in my case was with the greatest difficulty closed, and which could not have been closed without the aid of the rectangular palate-needle.

The importance of testing the competency of the bladder at the conclusion of the suturing by injecting with milk or other equally bland and easily detectable fluid cannot, therefore, be too strongly urged.

*Abstract of Twenty Cases of Intra-peritoneal**A. Rent closed*

No.	Reference.	Surgeon.	Age.	Cause.	Date after injury.	Condition of peritoneum.	Size and condition of rent in bladder.
1	Med. Rec. New York, 1887, xxxii, p. 781	Keyes	22	Run over by cart	22 hrs.	No signs of peritonitis; bloody fluid gushed out	Rent 1½ inches long
2	Lancet, June 28, 1888	Halstrom	21	Not stated	21 hrs.	No details	Rent 1½ inches long
3	Arch. Gen. de Med., 1888, t. xxii, p. 22	A. Blum	28	Run over by waggon	40 hrs.	On opening peritoneum large quantity of fluid escaped; signs of peritonitis	Rent size franc piece
4	Med. Rec. New York, 1888, xxxiii, p. 632	Brown	—	Fell on corner of doorstep	22 hrs.	Blood-stained fluid found in peritoneal cavity; signs of peritonitis	Rent 1½ inches long; edges ragged
5	Pittsburg Med. Rev., 1888, ii, p. 55	Hitchcock	30	Blow	—	Extensive peritonitis	Rent 6 inches long
6	North American Practitioner, Chicago, 1889, i, p. 408	Herrick	28	Kicked by horse	23 hrs.	On opening peritoneum blood-stained fluid escaped	—
7	Indian Med. Gaz., Jan., 1889, p. 22	H. F. Stanton	Adult	Kicked in abdomen	50 hrs.	—	Extensive tear; posterior wall
8	Brit. Med. Journ., Jan. 26, 1889	R. Morrison	25	Distended cystitic; bladder gave way to slight injury	—	Signs of extensive peritonitis	¼ inch rupture of pouch between ribs of bladder in upper posterior part
9	New York Med. Journ., Mar. 9, 1889	C. K. Briddon	Adult	—	3rd day	Signs of peritonitis	Rent posterior wall bladder

Rupture of the Bladder published since 1888.

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Kind of sutures.	Treatment of peritoneum.	Incision in perineum.	Catheter in bladder.	After-treatment.	Remarks.	Result.
9 Lembert's sutures	Peritoneal cavity flushed	No	No	Catheter passed at intervals	Vomiting continued after operation; collapse set in	Died 18 hours after operation
9 Lembert's sutures	No details	—	—	No details	—	Recovered.
6 Lembert's sutures	Flushed with boiled water	No	Yes	Catheter taken out after 48 hours	After operation vomiting ceased, and peritonitis disappeared	Recovered.
Lembert's sutures	Irrigated with boiled water	No	Yes	Opium given	No leakage took place after suturing, when bladder was filled with Thiersch's solution	Died 16 hours after operation.
Lembert's sutures	Irrigated with boracic acid solution	No	No	—	—	Died
Lembert's sutures	Irrigated with boracic solution; glass drain used	No	No	Catheter passed at intervals	Peritonitis supervened	Died 49 hours after operation
Lembert's sutures	—	—	—	—	—	Died 24 hours after operation.
Sutures	Abdomen irrigated	—	—	—	—	Died 4 days after operation of general peritonitis
Lembert's sutures	Abdomen flushed out	No	No	—	—	Died 14 hours after operation.

No.	Reference.	Surgeon.	Age.	Cause.	Date after injury.	Condition of peritoneum.	Size and condition of rent in bladder.
10	New Zealand Med. Journ., Dunedin, 1888-90, viii, p. 158	Knight	49	Fell against corner of bench	54 hrs.	Fluid escaped on opening peritoneum; no peritonitis	Ragged rent 1½ inches long
11	Lancet, 1892, vol. ii, p. 197	Hulke	33	Butted in abdomen	72 hrs	Several ounces bloody grumous fluid escaped on opening peritoneal cavity; extensive peritonitis	Rent 2½ inches long, posterior wall
12	Arch. für klin. Chir., Bd. xliii, Heft 1	Schlange	34	Run over by heavy waggon	24 hrs.	No peritonitis; blood-stained fluid found in cavity	Intra- and extra-peritoneal rent
13	Lancet, 1892, vol. i, Feb. 6	Page	—	Man fell across patient's abdomen	28 hrs.	Signs acute peritonitis	Stellate wound on back and upper part fundus
14	Lancet, 1893, vol. i, p. 413	Howard Marsh	34	Kicked in abdomen	80 hrs.	5 or 6 pints dark coloured urine mixed with blood escaped on opening cavity; signs of peritonitis	Ragged rent 2½ inches long behind and below fundus
15	Annals of Surgery, 1893, p. 653	Pilcher	23	Fell from second story of house	12 hrs.	Intra-peritoneal hæmorrhage; no peritonitis	Longitudinal rent about 1½ inches long
16	Lancet, 1894, vol. ii, p. 1032	Murphy	24	Run over by horse	2 hrs.	40 ounces fluid removed on opening abdomen; no peritonitis	Vertical rent extending from apex to trigone
17	The present case	Walsham	38	Man fell across patient's abdomen	25 hrs.	On opening peritoneum blood-stained fluid escaped, together with air that had been introduced in bladder; no signs of peritonitis	Vertical rent; edges slightly ragged; 2½ inches long; extending from apex to trigone

Kind of sutures.	Treatment of peritoneum.	Incision in perineum.	Catheter in bladder.	After-treatment.	Remarks.	Result.
Continuous suture	Peritoneal cavity thoroughly irrigated	No	Yes	Catheter removed on 4th day and passed at intervals	No peritonitis existed 54 hours after injury	Recovered.
Double row sutures	Peritoneal cavity flushed out	No	No	Urine drawn off at regular intervals	Vomiting returned after operation; peritonitis continued	Died 4 days after injury.
Lembert's sutures to intra-peritoneal rent	Peritoneum mopped out; not flushed; extra-peritoneal wound packed with iodoform gauze	No	No	Catheter passed at intervals	—	Recovered.
Lembert's sutures	Peritoneum flushed with solution boracic acid	No	No	—	—	Died before completion of operation.
20 fine silk Lembert's sutures	Abdominal cavity flushed	No	No	Catheter passed every 3 hours	Vomiting set in and patient sank gradually	Died 21 hours after operation of general peritonitis.
Lembert's sutures	Abdominal cavity sponged out and well irrigated	No	No	—	Hæmorrhage proceeded from torn superior vesical veins	Died 2 hours after operation from shock and anæmia.
15 catgut sutures to muscular coat only	Abdominal cavity washed out; glass drain tube used	No	Yes	Catheter removed at end of 8 days, and passed at intervals for one week	Diagnosis settled by injections of solution of boracic acid into bladder	Recovered.
14 fine silk Lembert's sutures	Abdominal cavity flushed with 1 in 3000 solution of Hyd. Perchlor., and finally with 2 per cent. solution boracic acid	No	No	Catheter passed every 4 hours for 24 hours, after which the patient passed urine of his own accord	Injection boracic acid solution gave negative results; diagnosis settled by inflating bladder with air, when liver dulness disappeared	Recovered.

B. Rent not closed

No.	Reference.	Surgeon.	Age.	Cause.	Date after injury.	Condition of peritoneum.	Size and condition of rent in bladder.
18	Lancet, Aug. 4, 1888, p. 208	W. H. Brown	20	Horse fell upon patient	11 hrs.	—	Rent posterior wall, far forward
19	Annals of Surgery, Dec., 1893	Kerr	33	Blow	8 hrs.	No peritonitis	Combined intra- and extra-peritoneal rupture
20	Deutsche Zeitschrift für Chirurgie, Bd. xxxi, Hefte 3 and 4	Rose	7	Blow	48 hrs.	No definite peritonitis; intestines slightly congested	Stellate rent on upper surface

(For report of the discussion on this paper, see 'Proceedings of the

by Sutures.

Kind of sutures.	Treatment of peritoneum.	Incision in perineum.	Catheter in bladder.	After-treatment.	Remarks.	Result.
Wound inaccessible to suture	Abdomen irrigated; drain inserted	No	Yes	—	Wound could not be reached for applying sutures	Died 11 hours after operation.
Side of bladder sutured to pubes	Pelvis tamponed with iodoform gauze; bladder and Retzius space drained	No	No	Drain in bladder removed after firm adhesions had formed	—	Recovered.
Not sutured	Peritoneal cavity flushed; bladder drained through abdominal wound and packed with iodoform gauze	No	Yes	Abdominal drain removed as soon as adhesions had shut off abdominal cavity	—	Recovered.

Royal Medical and Chirurgical Society,' Third Series, vol. vii, p. 178.)