Injuries of the ureter / by Henry Morris.

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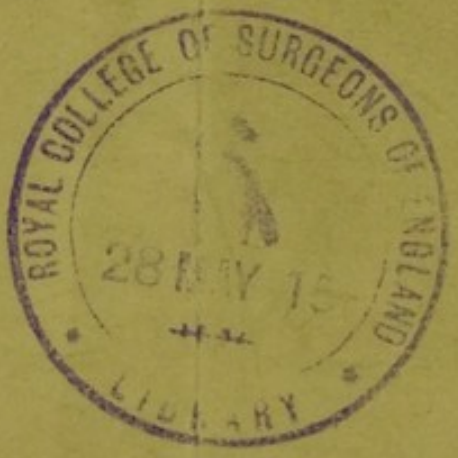
By HENRY MORRIS, M.A., F.R.C.S.



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INJURIES OF THE URETER.

By Henry Morris, M.A., F.R.C.S., *Surgeon to the Middlesex Hospital, London.*

Injuries to the ureter are exceptionally rare, if we exclude those which occasionally happen in the course of certain surgical operations on the abdominal or pelvic viscera. Its small size, its deep position, the fact that in one-half of its extent it is protected by the bony wall of the pelvis, its loose connections whereby it is able to move freely upon the structures behind it, together with its own elasticity, serve to explain this exemption from injury.

In 1885, when writing on "Rupture of the Ureter," I stated[1] there was no occasion to consider it apart from rupture of the kidney, because in the very few cases on record the rupture of the ureter was quite close to the renal pelvis, and that it was neither practicable nor requisite from the point of view of treatment to distinguish between subcutaneous rupture of the renal pelvis and subcutaneous rupture of the ureter.

With reference to "Penetrating Wounds of the Ureter," I therein pointed out that, with the exception of the gunshot wound of the ureter which happened to the Archbishop of Paris in 1848,[2] and the doubtful case recorded by Hennen in 1818,[3] there did not exist any published report of a penetrating wound of the ureter alone, unless we accept Holmes' very doubtful case as such.[4]

No case of penetrating wound is reported to have occurred in the American War of the Rebellion; and when we recall the care and thoroughness with which the medical and surgical history of that war was prepared, this fact alone shows the extreme rarity of such injury.

The conclusion arrived at was that the diagnosis, symptoms, sequelæ, and treatment of injured ureter in no way differed from those of ruptured or wounded kidney.

These remarks were based upon a careful perusal of the reports of thirteen cases described as subcutaneous injuries, and upon the three cases above mentioned of penetrating wounds. The cases were all that I was at that time able to discover, after a fairly laborious search through the literature of wounds and other injuries of the abdominal viscera.

Two of the cases of subcutaneous injuries had been under my own personal observation; as dresser to Mr. Hilton, I was responsible for the notes of his case, which was one of rupture of the kidney, not, as Poland described it, and others have quoted it as

[1] "Surgical Diseases of the Kidney." [2] *Gaz. d. hôp.*, Paris, 1848.
[3] "Military Surgery," 3rd edition, p. 430, Case 72.
[4] *Med.-Chir. Trans.*, London, vols. lx. and lxv.

being, one of rupture of the ureter; and, as house surgeon at Guy's Hospital at the time, I daily watched Mr. Poland's case, which was really one of ruptured ureter.

Although reports of renal cases of a surgical nature have during the last ten years multiplied a thousandfold, and although experimental researches and tried or suggested operations upon the ureter have led to the surgical affections of the ureter being considered as a subject apart from the surgical affections of the kidney, there is very little as yet which can strictly be called ureteral surgery; and very few cases have been published which are really cases of unmixed ureteral disease or injury.

Since 1885, only seven cases, so far as I am aware, have been published, purporting to be subcutaneous injuries of the ureter (namely, by Godlee, 1887; Chaput, 1889; Le Dentu, 1889; Coull Mackenzie, 1891; Allingham, 1891; Fenger, 1894; Page, 1894). These are not, however, all cases of injury to the ureter proper, and they do not supply any grounds for altering the conclusions based upon earlier cases.

In view, however, of the growing importance attached to the surgery of the ureter, it is well to describe the injuries of the ureter, and the operations performed and suggested for their relief, apart from those relating to the kidney.

The injuries involving the ureter depend very much as to their symptoms and gravity upon whether they are subcutaneous or open, extra- or intraperitoneal. They may be conveniently considered under three classes—

1. Subparietal injuries; or those in which no open wound communicates with the injured ureter.

2. Penetrating wounds; or those in which an open wound communicates with the injured ureter.

3. Surgical wounds, accidentally or intentionally inflicted, including those which are caused by the use of obstetric instruments, or following gangrene due to difficult or prolonged labour.

Those which result from gangrene and from surgical accidents come necessarily for consideration under ureteral fistula; whilst those made intentionally by the surgeon come under "Operations upon the Ureter."

In all three classes the peritoneum may or may not be involved. In Class 1, as a rule, it is not; in Class 2 it is most likely to be; whilst in the accidental wounds of Class 3, excepting those produced by obstetric instruments, it almost always is.

In this article I shall confine my remarks to Class 1, that is, to subparietal injuries of the ureter.

Twenty-three cases are now scattered through surgical literature, which have been repeatedly mentioned by writers as subcutaneous injuries of the ureter; but a close examination of the details given of them shows that twelve at least are injuries of the parenchyma or pelvis of the kidney not of the ureter proper,

and there is considerable room for doubt as to the exact nature of the injury in several of the others. The explanation of the fact that cases of ruptured renal pelvis are so often described as ruptured ureter is no doubt in part due to the want of uniformity in the use of terms. The ureter in anatomical works is described as commencing at the renal pelvis; but the term renal pelvis is often used as if it were synonymous with hilum of the kidney, instead of embracing that dilated part of the renal duct which extends from the union of the calyces to the upper end of the ureter proper.

The following is a list of the twenty-three cases to be found in surgical literature, described as "rupture of the ureter." Thirteen of them were more or less fully quoted in my book on the kidney in 1885. Seven others have been published since then. The remaining three had been overlooked, and were those by Joel, Cabot, and Bardenheuer. The whole twenty-three cases are now arranged in four different groups.

(A) Verified cases of rupture of the ureter—(1) Poland (with extraperitoneal extravasation and tumour), (2) Coull Mackenzie (with intraperitoneal extravasation, but no tumour).

(B) Probable rupture of ureter with extravasation—(1) Stanley (boy), (2) Godlee, (3) Chaput, (4) Page.

(C) Contracted ureter, with hydronephrosis, etc., possibly due to ureteral injury—(1) Haviland, (2) Pye-Smith, (3) Soller, (4) Cabot, (5) Fenger.

(D) Not injuries of the ureter proper, but rupture of renal pelvis or renal substance opening calyces, and giving rise to extravasation—(1) Stanley (female), (2) Hilton, (3) Hicks, (4) Barker, (5) Bardenheuer, (6) Dumenil, (7) Joel, (8) Allingham, (9) Harrison (two), (10) Croft, (11) Bennet May.

Besides the above, Dr. W. J. Collins[1] has published two cases of traumatic hydronephrosis, in which the injury may have been either to the ureter or to the renal pelvis. Dr. Collins thought that the most plausible explanation of one of these cases was occlusion of the ureter, from contraction following bruising at the time the child, æt. 5, was run over; or else compression by blood, or by callus thrown out around a fracture of the pelvis. In neither case was there any direct evidence as to the cause of the hydronephrosis.

Of the twenty-three cases, we find only eleven with any pretensions to be considered injuries of the ureter proper, and of these only two were actually proved to be ruptures of the ureter. One of the two (Coull Mackenzie's) was an undoubted case of intraperitoneal laceration, and was verified as such by post-mortem examination.

In five cases (Group C) a tumour was formed by alteration in the kidney itself. In four of these, contraction or obliteration of

[1] *Brit. Med. Journ.*, London, April 30, 1892.

the ureter followed the injury, and after a long time a renal tumour formed; in three of them the condition was ascertained by post-mortem examination to be, in one, pyonephrosis with atrophy and impermeability of the ureter (Haviland's); in another, pyonephrosis (which had at one time communicated with the colon), with the ureter contracted $1\frac{1}{2}$ in. from its commencement, so as scarcely to admit the smallest probe (Pye-Smith's); and in the third the kidney was converted into a large polycystic tumour, and the ureter in the middle of its course was almost obliterated (Soller). In the fourth case the ureter was strictured, and an intermittent hydronephrosis developed ten years after the injury. The stricture had existed for twenty-four years when Fenger performed ureterotomy from the loin. He divided the stricture, and closed the wound in the ureter by longitudinal sutures, after the Heinecke-Mikulicz method for the treatment of pyloric stricture. The patient recovered, and had no return of the hydronephrosis (Fenger). In the fifth case (Cabot) the nature of the obstruction and its precise situation was not ascertained. It is described by Cabot as one of "nephrotomy for hydronephrosis," and resulted in recovery. The swelling developed "several weeks" after a fall, and it seems to me highly probable that the obstruction was only partial and temporary, and was caused by blood clot, either in the renal pelvis or in the ureter, which subsequently became absorbed or passed on into the bladder.

In Haviland's case the injury was received four years before the tumour developed, in Pye-Smith's two years, in Soller's nine, and in Fenger's ten years before. It is very doubtful whether the condition of the ureter in Haviland's and Soller's cases was not due to causes other than injury.

In five cases, namely, those included in Group B and Poland's case, a tumour was formed by a collection of fluid behind the peritoneum.

In none of these instances was the precise seat of the extravasation ascertained. Stanley's case was that of a boy in many respects precisely like Croft's and Bennet May's and others, where the injury was supposed or ascertained to have implicated the renal pelvis and not the ureter.

There is also much room for doubt as to whether the ureter proper was injured in Godlee's case. It is more than probable that the injury was to the renal pelvis, but that it could not be discovered at the time of the nephrotomy, nor, owing to the difficulty in separating the kidney from the surrounding tissues, at the subsequent nephrectomy. We cannot, however, positively exclude either of these cases from the list of injuries to the ureter. The two other cases in this group (Chaput and Page) are in great probability veritable injuries of the ureter proper.

Chaput's case is exceptional, in that the cæcum was ruptured on its posterior aspect, and the extravasated urine not only accu-

mulated in the retroperitoneal tissue, but entered the cæcum through the rupture in its wall, and distended this and the neighbouring colon so as to create a very misleading abdominal tumour.

In three of these cases (Godlee, Chaput, and Page), an incision, followed by drainage of the retroperitoneal space, was practised, and in Godlee's case evacuation had been effected before the lumbar incision was made. In each of these three cases nephrectomy was subsequently and successfully resorted to, because of pyrexial attacks due to suppuration of the kidney, and of the persistence of a fistula.

In Page's case the incision was made in the linea semilunaris, and drainage was effected through this. In Chaput's case, as well as in Godlee's, the incision and drainage were through the loin.

The fifth case, in which a tumour formed behind the peritoneum (Poland's), is allied to the four cases just mentioned, though it differs from them in some most important particulars. As the accident resulted in death on the sixth day, the exact nature of the injury was ascertained by post-mortem examination.

Poland describes the ureter as torn quite across, just below the renal pelvis; and its broken end, together with the kidney, was surrounded by the half-sloughy, putrescent, and jelly-like tissues behind the peritoneum. The kidney itself was injured, its capsule being separated from it by extravasated blood; the renal capsule prevented this blood clot from mixing with the urine extravasated through the torn ureter. The right lumbar region was raised in a great swelling, this being moderately dark in colour from some effusion of blood.

It is unnecessary to analyse the twelve cases in Group D, which have been often quoted as subcutaneous injuries of the ureter, but which in reality are not so. It will suffice to give a list of these, with the dates and references to them. This is done at the end of this article.

We will now summarise the result of a careful analysis of the eleven cases above mentioned, with the view of arriving at the causes, pathology, symptoms, and treatment of ureteral subcutaneous injuries.

Causes.—Of the eleven cases above enumerated, forcible compression between two hard bodies, at the level of the umbilicus and loin, was the form of violence inflicted in three; kicks from horses in two (Chaput and Pye-Smith); the passage of the wheel of a carriage over the trunk in two (Godlee and Page); falling on to the back from a height in one (Haviland's); falling down stairs in one (Cabot); the bursting of a cannon shell in one (Soller); and a violent jerk in jumping from a horse in one (Fenger's case). It is noteworthy that in both the cases in which the peritoneum was ruptured (Poland's and Coull Mackenzie's) the form of violence was forcible compression of the trunk—between the platform and

a railway carriage in one, and between two heavy trucks in the other.

Tuffier has suggested that the ureter gives way by being crushed against the tip of the transverse process of the first lumbar vertebra. This may be the method by which the renal pelvis more often is torn, opposite the hilum of the kidney; but the ureter only commences a little above the level of the tip of the transverse process of the third lumbar vertebra, too low down, therefore, to be crushed against the first transverse process, though it may be so compressed against the tips of the third, fourth, or fifth processes. In Poland's fatal case, in which the ureter at its junction with the renal pelvis was torn right across, the transverse processes of the three upper lumbar vertebræ on both sides were broken off, and the twelfth rib on both sides was fractured.

Le Dentu thinks a veritable tear of the ureter may be caused by the sudden and violent downward displacement of the kidney, the weight of which drags forcibly upon the ureter at its junction with the renal pelvis, or at some point lower down than this, namely, at the level at which the ureter retains, during the shock, its normal attachments.

As the kidney is under cover of the lower ribs, and the lower half of the ureter is protected by the bones of the pelvis, it would seem that any great violence, applied either from in front or from behind, will tend to stretch the ureter most severely at one or other extremity of its abdominal course, whilst the intervening portion will escape with the rest of the soft structures in the ilio-costal space. The holdfast influence of the kidney above, and the resistance of the brim of the pelvis below, would thus tend to the giving way of the ureter at its junction with the renal pelvis, or just above the place where it passes over the sacro-iliac synchondrosis.

The fact that in five out of eleven cases the injury was brought about by violent compression of the trunk in the antero-posterior axis, and in a sixth case (Fenger) was caused by overstretching, gives support to this theory.

The intimate adhesion of the ureter to the peritoneum, the readiness with which it becomes detached with the peritoneum, when the latter is torn away from its connections, and the fixation of the peritoneum to the spinal column, make it probable that the peritoneum will yield just external to the line of fixation to the spine rather than that the ureter will give way. Possibly this is what really happens, and thus the ureter escapes.

The fact that the peritoneum over the ureter was injured in only one case out of eleven, and that in five cases out of eleven there was a large retroperitoneal accumulation of urine, without the peritoneum giving way, suggests that in the rare instances when the ureter is ruptured there is less than the normal adherence between the ureter and peritoneum.

Perhaps this helps to explain the greater frequency with which subcutaneous rupture of the ureter occurs in young life; thus, of ten cases in which the ages of the patients are given, only two were over 30, only one was between 20 and 30, four were between 4 and 10 years of age, and three were between 10 and 16.

The ages at which the accidents happened were 4, 5, 9, 10, 13, 14, 16, 22, 33, 36.

PATHOLOGY.—The actual nature of the injury inflicted on the ureter can only for the most part be imagined, because in only two cases has it been actually seen. In Poland's patient, who died 135 hours after the accident, the ureter was torn right across, below the pelvis of the kidney. The kidney itself was much damaged. In Mackenzie's case there were two small ruptures in the ureter, each of the size of a pea, communicating with the peritoneal cavity.

In both these cases the peritoneum was torn; but only in one (Coull Mackenzie's) did the rent in the serous membrane allow of the entrance of urine into the cavity, and in that case death ensued from peritonitis within twenty-four hours of the accident. In Poland's case, the rupture of the peritoneum was on the anterior wall of the abdomen, and quite distinct from the ureteral injury; the patient died from exhaustion due to vomiting, but there was no peritonitis.

In Mackenzie's case, in which the whole of the peritoneum was described as being highly inflamed, and the intestines matted together by lymph, it is to be regretted that we have no information as to the character of the urine. We know the peritoneum is tolerant of healthy urine; it was probably the admixture of blood with the urine in the peritoneal cavity that caused the fatal peritonitis.

In five cases (out of the nine in which we have no precise definite knowledge of the exact nature of the injury inflicted) it is necessary to assume that the ureter was more or less completely torn across, or else lacerated in a longitudinal direction, in order to explain the extravasation of urine into the retroperitoneal cellular tissue. In those instances where the ureter was found constricted or obliterated, some long time after an injury, one of several things may have happened. The ureter may, in the first instance, have been simply contused, or its wall may have been only partly torn through, and subsequently have undergone cicatricial contraction, or occlusion; or the cellular tissues around it may have been the seat of the injury, and the constriction of the ureter may have been the consequence of the subsequent inflammatory changes in those tissues, or of compression by blood clot on its exterior; or, again, the narrowing may have been the result of hæmorrhage from the kidney, and the impaction and subsequent organisation of a blood clot in the ureter,—the changes in which,

after a time, may or may not have allowed of the passage of urine.

But however this may be, the inference is obvious, that if the coats of the ureter are completely torn through, and the peritoneum is intact, a tumour will sooner or later be formed by the accumulation of urine in the retroperitoneal tissue; whereas, if the ureter, from direct or indirect injury, becomes imperfectly obliterated, a tumour will in course of time be formed, consisting of one or other of the varieties of obstructed kidney, namely, renal abscess, pyonephrosis, hydronephrosis, or, as in Soller's case, a polycystic kidney.

If the ureter were to be at once completely obstructed by blood clot, and permanently remain so, the result to be expected is atrophy of the kidney. Yet this does not necessarily follow, as shown by the post-mortem examination on a man æt. 36, whose right kidney was ruptured by the kick of a horse. In this case (recorded by Mr.Holmes)[1] the ureter, renal pelvis, and calyces were found plugged with blood clot eighteen months after the kidney had been ruptured; the clot in the interior of the kidney communicated with a mass in the perinephric cellular tissue, and the line of rupture could be faintly traced through the substance of the gland, which was quite healed. Both kidneys were small, granular, and cystic, and had probably been so for a year or two before the accident. There was no marked difference in the size and general appearance of the two kidneys.

In two of the eleven cases under consideration, a communication was formed between the urine cavity and the large bowel; in Pye-Smith's case the colon was, at the post-mortem examination, found adherent to the pyonephrotic cyst, but the communication had become closed. In Chaput's case, a rupture of the posterior wall of the cæcum allowed of a communication between the bowel and a large retroperitoneal collection of urine.

Symptoms.—The manifestations of subcutaneous rupture of the ureter are not characteristic. For a time there may be no sign whatever beyond the pain and tenderness caused by the injury. It is only by the subsequent development of symptoms that we are able to learn that any damage has been done to the urinary system, and not even then are we able to say at once whether it affects the renal parenchyma, the renal pelvis, or the ureter.

There may be no immediate indication in the urine of any kind whatever. Hæmaturia may be entirely absent, the urine being passed naturally and freely, as in Stanley's, Godlee's, and Chaput's cases; or slight hæmaturia, of a more or less transient character, may be observed, as in Page's patient, who, after the second day, passed at intervals small quantities of blood with the urine; or as in Cabot's case, in which there was bloody urine for three or

[1] *Trans. Path. Soc. London*, 1860, vol. xi. p. 140.

four days; or as in Pye-Smith's patient, who had hæmaturia for several days after the injury.

If the ureter alone is ruptured, it is not likely that the hæmaturia will be very considerable or prolonged. But slight hæmaturia, or even the absence of hæmorrhage, is in no way characteristic of ureteral as distinguished from renal injury, because many cases prove that there may be but little or no blood whatever in the urine, even though the renal pelvis or the renal parenchyma be wounded.

If, besides injury to the ureter, one or both kidneys are seriously damaged, there may be incomplete or complete suppression of urine. Thus, in Poland's case, there was thrombosis of all the vessels of the opposite kidney, as well as severe damage to that on the side of the torn ureter—very little urine indeed was passed during the few days the patient lived.

A common immediate symptom is pain and tenderness at the part injured. The pain may be referred to the loin, front of the abdomen, umbilicus, or to the middle of Poupart's ligament. This pain may pass off in a day or two, and the patient may remain quite free, till fresh pain is caused by the development of a tumour. Transient collapse and vomiting may occur.

In some of the cases (Stanley's, Poland's, and Godlee's) there was ecchymosis over the loin, abdomen, and inguinal region, and in Stanley's there was extensive suppuration of the cellular tissue about the loin and sacrum. If the patient survives the injury, a swelling will form on the injured side of the abdomen, or in the corresponding flank, within a period varying from a few days to several years.

The abdominal swelling may be caused either by a collection of urine, or urine and blood, behind the peritoneum, or by one or other of the changes which supervene in the kidney itself. If due to a retroperitoneal collection, the swelling forms much earlier than when due to change in the kidney itself; appearing usually within a few days or weeks in the first event, but only within "many weeks," months, or even years in the latter.

Of the five instances in which the swelling was *behind the peritoneum*, it appeared within a day or two in Poland's case, at the end of the sixth week in Stanley's, and within two or three weeks in the others.

The swelling is usually well defined, palpable from the loin and front of the abdomen, and is round, oblong, or sausage-shaped. It may extend from the thorax into the false pelvis, and may reach the median line of the abdomen.

The length of time which elapses before the appearance of this tumour, depends upon (1) the character of the rupture; (2) the degree of resistance to the escape of urine offered by the tissue into which it passes; and (3) to the interference—caused by the shock, or by damage—with the secreting capacity of the kidney.

The rent in the ureter may be very small, or, on the other hand, the tube may be torn right across. If separation is complete, the ends may possibly be curled up, as Tuffier asserts was the case in some of his experiments on dogs. Such a condition would offer an obstacle to the escape of urine; it was not, however, found to have occurred in Poland's case, in which the tear was complete, and the ends separated.

A much more likely obstacle will be blood clotted over the orifice, or around the torn end of the tube. Blood clot may fill the calyces and pelvis of the kidney; or the parenchyma of the kidney may be compressed by blood extravasated beneath the capsule; or the renal vessels may be thrombosed. Under any of these circumstances, urine would fail to escape or even to be secreted.

Again, the cellular tissue may be very dense and not easily opened up, or its meshes may be packed with extravasated blood, and thus much opposition offered to infiltration of urine. The shock of the accident, and the reflex suppression of urine following the injury, would explain only a certain amount of delay.

In injury to the ureter, as in injury to the renal pelvis, it is possible that the escape of urine may only follow the sloughing out of severely bruised tissue, and not take place as an immediate consequence of the original violence.

When the lesion occurs *on the peritoneal aspect* of the ureter, it is to be expected that the escape of urine will be early and profuse, as there is then less resistance to the outflow of urine; and no tumour will be likely to form in the flank.

As soon as the urine, or urine and blood, which have collected in the retroperitoneal space decompose, inflammation, suppuration, or sloughing occurs, and other symptoms then arise, namely, increased pain, redness of the skin in the loin, œdema of the abdominal wall, elevation of temperature to 101° or 102°, or even a degree or two higher, rigors, furred tongue, loss of appetite, and constipation or diarrhœa.

In both cases (Chaput and Pye-Smith) in which a communication between the bowel and the urine cyst was found to have existed, diarrhœa or simulated diarrhœa was a noticeable symptom.

The fluid drawn off from the tumour, before suppuration has commenced, has the characters more or less pronounced of urine, in colour, odour, and composition; but it is generally slightly alkaline in reaction, of a low specific gravity, *e.g.* 1008 to 1010, and contains very little, perhaps only a mere trace of urea. It will probably also contain a small quantity of albumin, a little blood, and most likely a considerable amount of chloride of sodium. When the parts become septic, the fluid withdrawn will also contain more or less pus.

In Chaput's case the fluid withdrawn on the twelfth and fourteenth days after the injury was sanguinolent, and showed fatty

globules and altered leucocytes and red blood corpuscles, and was thought to be the fluid of a hæmatoma on its way to suppuration.

In the five cases in which the swelling was *in the kidney itself*, the tumour was noticed at very different lengths of time after the injury. In one case it is stated to have been "several weeks," in others it was two years, four years, and nine years respectively. In Fenger's case, ten years elapsed between injury and hydronephrosis, and thirty-four years between the injury and the ureterotomy by which the intermittent hydronephrosis was remedied.

The nature of the renal tumour was very different in these five cases. One was an abscess-like dilatation of each of the calyces (Haviland's); one a pyonephrosis, the contained fluid being opaque and reddish and loaded with pus and blood cells (Pye-Smith's); in another (Soller's) it was a large polycystic kidney; in Cabot and Fenger's cases the condition was described as hydronephrosis.

Occurring at such long intervals after the accident, and with the intervening period between the injury and the formation of the renal tumour, perhaps absolutely without symptoms of any kind, these cases clinically come to have importance less in relation to injuries of the ureter than to renal enlargements generally.

Diagnosis.—If there is at first little or no hæmaturia and no swelling in the loin, and then after three or four weeks, more or less, a swelling forms behind the peritoneum, rupture of the ureter may be suspected. If, many months or even years after an injury in the region of the ureter, a tumour of the kidney is formed, though there has been an absence of symptoms, or only slight hæmaturia at the time of the injury, there will be ground for suspecting traumatic contraction or occlusion of the ureter.

It is, however, impossible to distinguish injured ureter with extravasation, from injured renal pelvis with extravasation; injured ureter with complete obstruction by clot or recurved ends is equally indistinguishable from injured kidney with clot plugging the renal pelvis or the ureter. Nor is this impossibility of exact diagnosis of any practical importance, because the treatment must be the same.

Some assistance may perhaps be obtained, where an opening in the ureter is believed to exist, by distending the bladder with water. Kammerer found that the water escaped by the defective ureter until the bladder was quite distended, and then, doubtless through closure of the valvular entrance in the bladder, the water ceased to flow. Le Fort and Page applied this test in their cases, but without effect.

M. Tuffier thinks that a constant escape of urine after a wound of the ureter is the leading distinction between these injuries and wounds of the kidney. Wound of the kidney will cicatrise easily and rapidly, and give rise to no extravasation of urine, whilst

wounds of the ureter have no tendency to natural cure. If by "wounds of the kidney" Tuffier means also wounds of the renal pelvis, and wounds opening the calyces through the renal parenchyma, facts are against him. Even if this were a leading distinction, it would give no aid to diagnosis in subcutaneous injuries.

PROGNOSIS.—In cases not complicated with other serious injuries, the immediate effect of these accidents is not to endanger life, if the peritoneum is uninjured. If prompt and decided surgical treatment were adopted, the consequences to the kidney itself would be less unfavourable; and subsequent nephrectomy would probably be less frequently required than has been the case hitherto.

When the peritoneum is involved the outlook is most serious; in both the fatal cases the peritoneum was injured, and in one of them the cause of death was peritonitis. In the other case the wound in the peritoneum was not in the neighbourhood of the kidney and ureter, and no evidence of peritonitis was found at the post-mortem examination.

TREATMENT.—The ideal treatment for subcutaneous rupture, whether in a longitudinal or transverse direction, is immediate suture or anastomosis of the ureter, according to the character of the wound. But it is useless to state that this is the treatment at once to adopt, when the indications of the exact injury do not occur until weeks after the rupture has taken place; when there is nothing even then to indicate the site of the rupture, and when the retroperitoneal tissues have become changed by the pressure and inflammation caused by the extravasated fluid.

Puncture of the retroperitoneal cyst has been adopted, but with uncertain result. Stanley's doubtful case was tapped six times, and yet the tumour occurred again, and persisted as long as the boy was under observation. We must remember, however, that a repetition of punctures has been followed by the complete and permanent disappearance of the swelling, in cases of retroperitoneal extravasation due to rupture of the kidney or renal pelvis, and also in cases of traumatic hydronephrosis. Whilst in some of these cases in which the tumour ceased to refill, the ureter may have become patent, it is probable that in most of them the kidney ceased to secrete, and atrophied—a result which cannot be regarded as satisfactory.

Lumbar incision.—A free incision in the ilio-costal space will secure the complete evacuation of the extravasated fluid; and drainage will obviate the reaccumulation of urine subsequently escaping through the ruptured tube. If the ureter is not completely torn across, the experience afforded by the removal of calculi from its upper end would lead one to expect the ultimate cicatrisation of the wound, and the re-establishment of the ureteral channel to the kidney.

Through this incision it will be possible to explore the renal pelvis, and if the state of the kidney indicates that the urine has escaped at some point in the ureter, and not from the kidney, the loin incision may be prolonged in a direction towards Poupart's ligament, passing about a finger's-breadth in front of the anterior superior spine of the ilium. It will no doubt be very difficult to trace the ureter in tissues which have been changed in structure, and when its normal position is disturbed in consequence of the previous extravasation. The search, however, may be somewhat facilitated by remembering that the ureter is carried forward with the detached peritoneum; and that it is intimately attached to that membrane about half an inch, or little more, external to where the peritoneum is tied down to the side of the spinal column. If a rent in the ureter should happen to be found, it should be repaired by suture.

In none of the cases, however, which have hitherto been operated upon has the site of the injury been ascertained. Page says that the thought of closing the wound by suture occurred to him when he laid the cyst open, but the portion of the ureter visible was intact, and as it coursed away from the region of the kidney he did not think it desirable to follow it.

It is to be expected, however, that by a more extensive parietal incision, a freer search for the rupture, and with the aid of the ureteral catheter, the actual wound may be found and directly treated in future cases.

The proposal to apply an aseptic ligature to the torn upper end, with the object of inducing atrophy of the kidney, is to my mind very unsurgical. If the rent can be closed by sutures, so as to restore the continuity of the ureteral channel, this should be done. If the rupture cannot be found, the loin incision followed by drainage will put the damaged parts into the most favourable condition for repair. We have abundant evidence that wounds of the renal substance and renal pelvis, and also of the ureter itself, made by the surgeon for removing calculi, will ultimately heal without the aid of sutures. It should be the surgeon's object, therefore, to put accidental wounds of the ureter which he cannot localise, and therefore cannot suture, under the same conditions favourable for cicatrisation as he places wounds of his own making in operations on the kidney.

If the ureter is completely torn asunder, and its ends can be approximated, they should be united by one of the recognised methods of ureteral anastomosis. If its ends cannot be joined together, then a permanent fistula opening on the loin is the result to be expected. Such a fistula, by saving the integrity of the kidney, would be the means of preserving the patient's life, if his other kidney happened to be destroyed, or he had but one. In a case of my own, in which there was rupture of the renal pelvis, a permanent lumbar fistula followed, and has continued (with one

interval of three years' duration) over a period of ten years. On the other hand, if the second kidney is sound, and the fistula badly tolerated by the patient, nephrectomy is the final resource.

Of course, after lumbar incision, it would be requisite to use all customary precautions against sepsis; and if this is done successfully, and the lumbar incision has been made soon after the first development of the swelling, there is but little, if any, reason why the kidney should become the seat of suppurative changes more than after nephrolithotomy, or partial excision of the kidney for tubercle or abscess. It was, however, found that the kidney suppurated in all three of the cases in which the retroperitoneal collection was drained; but in one of them (Godlee's) there was pus in the fluid withdrawn when the cyst was first punctured, and before it was laid open by lumbar incision. In another (Chaput's) there were special conditions favouring sepsis, because there was a communication between the large bowel and the retroperitoneal collection of urine; and in the third case the drainage was imperfect, being made through the linea semilunaris, instead of through the ilio-costal space behind.

Nephrectomy.—Nephrectomy will be required, if pus in the extravasated fluid, continued high temperature, or recurring pyrexial attacks, with pain, loss of appetite, and emaciation, make it clear that the kidney or the retroperitoneal tissue is the seat of extensive suppuration. Nephrectomy may be demanded also in the absence of suppuration, if a permanent fistula has resulted and is a source of intolerable discomfort to the patient.

It has sometimes been stated that primary nephrectomy would be the best treatment in all cases of subcutaneous injury, whether of the kidney, renal pelvis, or ureter, attended with retroperitoneal extravasation of urine; but I am not of this opinion. Undoubtedly the danger of primary nephrectomy for severe injury is not inconsiderable; but the chances of recovery after secondary nephrectomy for septic nephritis are less than after primary nephrectomy for injury. The chance of recovery, with perfect function of the kidney on the injured side, ought, however, when the kidney is not also irreparably injured, to be given to the patient. This will be done by a prompt incision through the loin, as soon as a retroperitoneal swelling is formed, followed by free drainage into antiseptic dressings. Should this not succeed, secondary nephrectomy will very probably save the life of the patient; it did so in all three cases referred to above, and has done so in several similar cases, where the substance of the kidney or the renal pelvis has been torn.

In traumatic hydronephrosis a trial of ureterotomy for division of the stricture should be made, as was so successfully carried out in Fenger's case.

Abstracts of the Eleven Cases regarded as Subcutaneous Ureteral Injuries.

Group A.—Case 1.—Poland's case[1] was that of a woman, æt. 33, in the fifth month of pregnancy, who was squeezed and slowly twisted half a revolution between the platform and the footboard of a railway carriage. On admission there was a small superficial wound of the abdominal wall, about 1½ in. to the left, and a little above the umbilicus, with a subcutaneous laceration of the peritoneum and rectus muscle sheath, through which, on the fourth day, 16 inches of intestine bulged. On the fifth day she aborted, and on the sixth died of *asthenia*.

A few drops of urine were passed on the afternoon of the fourth day, but as this was with the motion, and was thrown away by the nurse, it was not ascertained whether blood was mixed with it or not.

A post-mortem examination revealed fracture of the spinous processes of all the lumbar vertebræ, both twelfth ribs, and both transverse processes of the upper three lumbar vertebræ. The right lumbar region was raised into a great dark swelling by blood effusion. The right ureter was torn quite across, just below the pelvis of the kidney, so that it terminated in a ragged end in the midst of the half-sloughy, putrescent, jelly-like tissues which surrounded the organ. The capsule of the right kidney was separated from the parenchyma by a considerable quantity of blood clot, extravasated over the anterior aspect of the organ, and prevented the mixing of this blood with the urine extravasated from the ruptured ureter. The blood under the capsule was derived from a rent on the posterior and lower part of the organ, which penetrated to and opened a vein at the base of one of the pyramids. The left kidney was in a very remarkable condition; it had a buff-pink or yellow-clay colour, very opaque and dead looking. On section, the whole of the vessels were blocked up with ante-mortem clot, which extended in both artery and vein to the principal vessel. In the trunk vein the clot was non-adherent; in the artery it was firmly adherent, but there was no wound of the arterial coats.

With such extensive damage to the kidney tissue it is impossible to draw any accurate conclusions from this case as to the symptoms due to rupture of the ureter.

The suppression of urine was evidently due to compression of one gland by subcapsular hæmorrhage, and thrombosis of all the vessels of the other. The case, besides other points of interest, affords an illustration of subcapsular extravasation of blood in the kidney, a form of injury to which attention has not yet been specially drawn, but of which I have seen three or four marked instances.

Case 2.—Coull Mackenzie's case is the only example of extravasation of urine into the peritoneal cavity, due to a subcutaneous injury of the ureter.[2]

It is that of a coolie who was jammed between two heavy trucks.

[1] *Guy's Hosp. Rep.*, London, 1868, 3rd series, vol. xiv. p. 86.
[2] "Med.-legal Experiences in Calcutta," Edinburgh, p. 98.

There was no external mark of injury. There were two small ruptures, each the size of a pea, in the right ureter. The abdominal cavity contained two pints of urine mixed with blood. The patient died from peritonitis, following the extravasation through the ruptures of the ureter. This case affords no special symptoms beyond such as are caused by fatal perforative peritonitis.

Group B.—Four cases (Stanley's, Godlee's, Chaput's, and Page's), in each of which there was a retroperitoneal collection of urine, were possibly instances of rupture of the ureter.

Case 3.—Stanley,[1] in a paper on rupture of the ureter, records the case of a boy, æt. 9, who was squeezed between the wheel of a cart and the curb-stone. The immediate consequences were contusion of the soft parts around the pelvis, and great pain in the lower part of the abdomen, much ecchymosis and extensive suppuration in the subcutaneous cellular tissue around the pelvis, from which several ounces of matter were discharged by puncture near the left sacro-iliac synchondrosis. By the end of the sixth week these soft parts had recovered, but a large circumscribed oblong swelling was found in the right side of the abdomen. The urine was passed naturally throughout.

From this swelling, fluid having some of the characters of urine was withdrawn by puncture with a small trocar and cannula. The swelling recurred again and again.

It was punctured altogether six times in a period of five months and a half. It refilled again, and extended from the linea alba to the right lumbar region, but further evacuation was considered inexpedient, and the boy was discharged from the hospital nine months after the accident. Subsequently he was often seen in good health, but with the abdominal swelling distinct.

Thus in this case of Stanley's, which, ever since Poland referred to it in 1868, has been quoted over and over again as one of ruptured ureter, we have no proof whatever of the exact part injured, nor of the ultimate result of the injury. It is more likely to have been a ruptured renal pelvis than a ruptured ureter.

Stanley states that by his exploratory puncture he learnt that the fluid was situated immediately beneath the abdominal muscles, and had formed for itself a cavity, by detaching the peritoneum from the abdominal and lumbar muscles. As to the source of the effused urine, he quotes the opinion of Mr. Taylor, who analysed the fluid, "that, owing to the absence of mucus in it, the probable source was high up in the urinary apparatus, as at the commencement of the ureter." This means only that Mr. Taylor did not think the urine he examined had remained in the bladder.

The other case in Stanley's paper is specifically stated by Stanley as being one of ruptured pelvis of the right kidney, the nature of the injury having been ascertained by post-mortem examination.

Case 4.—R. J. Godlee,[2] in an interesting communication in May

[1] *Med.-Chir. Trans.*, London, 1844, vol. xxvii.
[2] *Trans. Clin. Soc. London*, vol. xx. p. 219.

1887, on "Three Cases of Abdominal Cysts following Injury," recorded the case of a little girl, æt. 4, who had been run over by a cab. Pain, tenderness, and burning in the left inguinal and lumbar regions resulted. Nothing further was revealed until a fortnight had elapsed, when an indefinite swelling in these parts was detected. Within three weeks from the date of injury, this had developed into a large, well-defined, fluctuating tumour, which extended from the iliac spine to the level of the eighth rib, and reached to within half an inch of the median line in front. No change had been observed in the urine. By the aspirator a large quantity of turbid alkaline urine was withdrawn, containing 3 per cent. of urea, much albumin and mucus, a small quantity of pus, and some phosphate crystals. The cyst refilled within two days, to the same size as before. At the end of one month from the date of the injury, an incision was made in the ilio-costal space, and a drain inserted. Then followed a copious and persistent leakage of urine from the wound and a series of pyrexial attacks, so that, at the end of three months and a week after the original injury, lumbar nephrectomy was performed.

Mr. Godlee had great difficulty in finding the kidney, which was situated at the upper and anterior part of the sac, pushed forward with the peritoneum; and great difficulty in removing it, as it was embedded in dense fibrous tissue. The child recovered, but with a fistula.

It was assumed before the nephrectomy was undertaken that the ureter was completely ruptured, "because no blood had appeared at any time in the urine, and if the laceration had been in the kidney it would probably by this time have closed." The history of cases of injury to the kidney shows, however, that these reasons are not sufficient for this conclusion.

The absence of blood in the urine, and the persistence of the escape of urine from the wound prior to the nephrectomy, are symptoms which have often been met with in cases of ruptured renal pelvis.

No description is given of the kidney removed, and one is led to infer that it was taken away piecemeal, and that it was impossible to tell whether the renal pelvis and the renal substance had been injured in the first place or not. There is difficulty in accepting the fistula in this case as evidence that the ureter was torn across; it seems improbable that a detached portion of the tube would cause more trouble than the open end of the ureter, or even a large part of the expanded renal pelvis, which in many cases has been left behind to form part of the stump of the pedicle.

Case 5.—M. Chaput[1] reported the case of a lad, æt. 16, who is described as having had his right ureter and the back of the cæcum ruptured by a kick from a horse's hock in the right flank. The case was one of great difficulty of diagnosis, and the operative treatment was complicated by opening the peritoneum and the front wall of the cæcum. The surgical wound in the front and the traumatic rupture of from 1 to 2 cms. in the back of the cæcum were sutured, and a large perinephric extravasation was incised and drained through the loin, but subsequently the kidney was removed, because of the persistence of the fistula and the general state of the patient. An examination of the kidney after removal

[1] *Bull. et mém. Soc. de chir. de Paris*, 13 Mars 1889.

showed it to be in a state of general ascending suppurative pyelonephritis. Its lower extremity was very friable, and bathed in a collection of pus. The renal pelvis was quite intact, and absolutely without sign of rupture, as was also the ureter for a distance of from 1 to 2 cms., but the actual seat and nature of the rupture below this point was not ascertained.

It is a question whether the friable, pus-bathed condition of the lower end of the kidney was due to injury which had ruptured the calyces and allowed escape of urine into the surrounding tissues, or whether it was due to changes subsequent to rupture of the ureter.

Case 6.—Herbert W. Page, *Ann. Surg.*, St. Louis (May 1894), reported the case of a boy, æt. 5, who was knocked down on 24th September 1892 by a light vehicle, the wheel of which was said to have passed over the abdomen.

There was no immediate evidence of injury, but within two days blood was noticed occasionally in the urine.

The temperature rose to 100° and 102° on two days, and then returned to normal. Twenty days after the injury the temperature rose again to 100° and 103°, and a swelling formed in the right iliac fossa, accompanied by abdominal tenderness and impaired respiratory movements.

On 27th October the abdomen was opened along the right linea semilunaris, and some clear serous fluid escaped from the peritoneal cavity.

Forty ounces of fluid, having some of the characters of urine, were removed from the swelling behind the peritoneum, the edges of the cyst wall were attached to the anterior parietal peritoneum, and the space drained.

The kidney and upper two inches of the ureter were exposed to view, and found to be uninjured and healthy. The ureter below this part was not visible, and it was concluded that the urine had escaped through a rupture in it lower down.

In November nephrectomy was performed, because of the continued escape of purulent urine from the retroperitoneal cavity, and the high fever. The kidney was then found to be three times its normal size, and in a state of ascending suppurative nephritis, the renal pelvis was distended with purulent urine, and this, as well as the upper part of the ureter, was entire. The bladder had previously been proved by injection to be intact. The child ultimately recovered completely. The actual lesion of the ureter, however, was never seen, and some doubt may possibly be felt about it.

Group C.—The five cases on record in which either abscess-like dilatation of the calyces of the kidney, polycystic disease, or hydronephrosis have been attributed to injury of the ureter, are the following:—

In three of them (Haviland's, Pye-Smith's, and Soller's) it was proved post-mortem that the ureter of the affected kidney was at some point contracted or obliterated, and the history in each case suggests that this might have been caused by an injury to the loin, received at periods of four, two, and nine years respectively before death.

In the fourth case (Cabot's), recovery without a fistula ensued after nephrotomy and drainage. The exact nature of the injury in this case was not ascertained, and it is therefore not possible to say that it was the ureter and not the renal pelvis that was damaged.

The fifth case, Fenger's, was one of subcutaneous injury, followed by stricture of the ureter, and resulting in intermittent hydronephrosis. It was cured by ureterotomy, with closure of the divided wall of the strictured portion by the Heinecke-Mikulicz method.

Case 7.—In Haviland's case,[1] a lad, æt. 18, sustained a fall on his back from a height of 20 ft., four years before his death. For several years he had been subject to a painful incontinence of urine, great pain in the loins and urinary passages, the urine being throughout charged with pus and sometimes with blood. After death the right kidney was found to have lost all its original structure, and to be converted into a series of sacs, containing pus-like fluid, each cavity being lined with a distinct membrane, which, when separated, preserved its shape. The cavities appeared to have no outlet, and the ureter was atrophied and impervious.

Some doubt must be felt as to this condition being the result of injury rather than of tuberculous disease, especially when we consider the history and the changes in other parts of the urinary organs. Thus the right kidney contained a similar cavity, and the corresponding ureter was considerably enlarged and embedded in fat, in which were a great number of indurated lymphatic glands; the bladder was contracted and its mucous membrane covered with pus, the urethra being in a similar condition.

The parents attributed the boy's illness to his fondness for bathing, affirming that up to his thirteenth year he was perfectly healthy.

The fall seems to have occurred about a year later than this, when the lad was 14, and he only received a shaking, from which he soon recovered.

Case 8.—In Pye-Smith's case,[2] a young farrier, æt. 24, had been frequently kicked in the abdomen, and on one occasion, about two years before death, hæmaturia of several days' duration occurred after a kick from a horse on the left side, "under the short ribs." He was only in bed three days, and after recovering, till his last illness, felt no inconvenience and had no return of blood in the urine.

The final illness was ushered in with diarrhœa and an abdominal tumour, attended with pain and vomiting. The tumour was tapped more than once, and several pints of opaque reddish fluid containing pus and blood cells were drawn off. Diarrhœa recurred, and ended in the patient's death. On post-mortem examination the kidney was found dilated into a series of sacculi, communicating with each other and with the renal pelvis, and contained a yellow puriform fluid, like that which had been removed during life. A communication had been established between the interior of the kidney and the adherent descending colon, which explained the diarrhœa and the presence of intestinal matter in one of the renal pouches. The ureter was dilated for 1½ in., when it

[1] *Trans. Path. Soc. London*, 1895, vol. x. p. 209.
[2] *Ibid.*, 1872, vol. xxiii. p. 159.

suddenly became contracted, so as not to admit the smallest probe. A few lines further on it again assumed its normal size. Dr. Pye-Smith seems to have taken pains to exclude calculus, tubercle, and other possible causes of the ureteral contraction.

Case 9.—M. J. Soller, Interne des Hôpitaux de Lyon,[1] reported the case of a joiner, æt. 45, who nine years before, during the campaign of 1870, received in the left hypochondrium, below the last rib, a blow from the bursting of a shell, which did not penetrate or even involve the skin. After the injury he felt continually a violent pain on the left side, at the level of the part struck, which was augmented by cold or changes of temperature. A year and a half afterwards his left testicle suppurated, but recovered. The pain in the left hypochondrium led to difficulty in respiration, amounting almost to suffocation, and was accompanied by violent beating of the heart. These symptoms increased up to 1879, when the signs of nephritis developed, and were followed by ascites, anasarca, anæmia, convulsions, and death in August 1880.

At the post-mortem the left kidney was enlarged one-third, and consisted of a congeries of cysts of varying sizes and contents, separated by partitions of fibrous tissue. All the renal tissue had disappeared. There was considerable hydronephrosis, and the renal pelvis was filled with seropurulent fluid. The ureter was the size of a quill pen, with thickened walls, and in the middle of its course it was so contracted as to scarcely admit the head of a pin. At the level of the contraction of the ureter the cellular tissue surrounding was indurated and chronically inflamed. The right kidney was very much congested.

This was not a case of rupture, but of contusion of ureter, I should say. Had there been rupture there would surely have been extravasation. If the conglomerate cystic condition was (and in all probability it was) developed after the accident, it supports the theory of the cysts being due to obstruction, not to an adenomatous change.

Case 10.—Dr. A. T. Cabot[2] reported the case of a boy, æt. 10 years, who for three or four days after falling down stairs passed bloody urine, and several weeks later developed a swelling which increased into a prominent fluctuating tumour, filling the right side of the abdomen.

It was twice aspirated, and large quantities of a clear, slightly yellow fluid, having the characters of altered urine, were withdrawn. The fluid was alkaline, had a specific gravity of 1007, and contained one-fourth of albumin, red and white blood corpuscles, and large round cells in varying numbers. Urea in small amount was discovered at the second tapping. As the fluid re-accumulated, a vertical incision was made in the ilio-costal space, and the cyst wall incised and stitched to the skin. "The finger passed into the cavity felt a soft nodular mass, probably the kidney, in the posterior part of the cyst. The ureter could not be felt." Between two and three pints of amber-coloured fluid escaped, having similar characters to that previously withdrawn, but in addition indican, chlorine, uric acid, and triple phosphate crystals, and round cells like renal epithelium, were noted.

[1] *Lyon méd.*, 1880, tome xxxv. p. 333.
[2] *Boston Med. and S. Journ.*, 22nd February 1883.

The boy recovered without fistula, five and a half weeks after the operation. This case was reported by Cabot as one of "nephrotomy for hydronephrosis," and the treatment described of the cyst wall, the character of the fluid, and the position on the posterior instead of on the anterior wall of the cyst, of what he took to be the kidney, support this view. There is nothing in the description which is proof of the injury having been ruptured ureter. The case was doubtless one of traumatic hydronephrosis, from blood plugging the ureter.

Case 11.—Fenger's case was published in the *Chicago Medical Recorder* for March 1893. It is described by Fenger himself as one of "traumatic stricture of the ureter close to its entrance into the pelvis of the kidney," causing intermittent hydronephrosis. The patient, who was 47 years of age, had sustained an injury thirty-four years previously. Hydronephrosis developed ten years afterwards. Lumbar nephrotomy disclosed no calculi. The ureteral orifice could not be discovered through the renal incision; the dilated pelvis was then explored, but still the orifice of the ureter could not be found. The ureter was then isolated, and its upper end found to be embedded in cicatricial tissue for half an inch. Lower down, though small in calibre, the duct was normal.

A longitudinal incision, 1 cm. long, was made in the ureter just below the cicatrix. The stricture itself was 1 cm. in length, and was incised upwards into the renal pelvis. The ureteral wound was then stitched longitudinally, according to the Heinecke-Mikulicz procedure in the treatment of pyloric stricture. No bougie was left in the ureter. A drainage tube was passed into the pelvis through the wound in the kidney. The patient made a good recovery without return of the hydronephrosis. This operation was performed on 26th November 1892.

Group D.—Cases usually quoted as rupture of the ureter, but which are really cases of rupture of the renal pelvis, or renal substance opening calyces.

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