

Delayed Rupture of the Renal Collecting System Secondary to a Traumatic Hemorrhage in the Setting of Suspected Chronic Ureteropelvic Junction Obstruction

Siddharth Rode¹, Ashaki Patel², Joseph Garrity³, Robert Garrett^{1*}

1. Department of Radiology, Saint Louis University Hospital, Saint Louis, USA

2. Department of Dermatology, Medical College of Wisconsin, USA

3. Department of Radiology, University of Utah, Salt Lake City, USA

* Correspondence: Robert Garrett, Saint Louis University, 3635 Vista Ave., 2nd Floor Desloge Towers, St. Louis, MO 63110, USA
(✉ rgarret7@health.slu.edu)

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ABSTRACT

Isolated rupture of the renal pelvis secondary to blunt trauma is rare, though there is increased incidence in the setting of a pre-existing renal abnormality that predisposes the kidney to injury. We report a case of post-traumatic hemorrhage into the renal collecting system leading to delayed rupture of the renal pelvis in the setting of suspected chronic ureteropelvic junction obstruction. This case illustrates the difficulty in diagnosis of acute hemorrhage into the renal collecting system. Special attention should be given to a kidney with a pre-existing abnormality in the setting of trauma to prevent complications. A literature review of hemorrhage into the collecting system along with appropriate imaging and management are discussed.

CASE REPORT

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A 43 year old male presented to the emergency department (ED) as a level 1 trauma following a road traffic accident. At presentation to the ED, the patient was unresponsive but had stable vital signs (blood pressure 140/40, pulse 82) and was breathing room air. Crepitus was noted over the right chest, with small pneumothorax noted on chest radiograph.

The patient was stabilized and transported to the radiology department for trauma protocol contrast enhanced computed tomography (CECT), which included arterial phase imaging through the chest and upper abdomen, portal venous phase imaging through the abdomen and pelvis, and 7 minute

delayed phase images through the abdomen and pelvis. Multiple traumatic injuries were reported, including a right pneumothorax, pneumomediastinum, tension pneumopericardium, pulmonary contusions and right pulmonary laceration, grade 5 liver injury with active bleeding, grade 1 splenic injury, and multiple rib and pelvic fractures (Figure 1). Review of the right kidney revealed moderate hydronephrosis and renal atrophy without associated hydroureter (Figure 2). Right renal atrophy was noted with long axis measurement of 8.9 cm and parenchymal thickness 0.6 cm (versus 10 cm and 1.7 cm, respectively, for the left kidney). A serpiginous collection of contrast was identified along the periphery of the dilated right renal pelvis, which increased in size on delayed imaging, indicating active hemorrhage (Figure 3). No renal parenchymal laceration was

identified. The combination of moderate hydronephrosis and renal atrophy without hydroureter were thought to represent chronic partial ureteropelvic junction (UPJ) obstruction.

While in the radiology department, the patient became unstable, with systolic blood pressure dropping to 65. The patient was given a 2L bolus of normal saline without blood pressure response, then was stabilized with 4 units of packed red blood cells. After returning to the trauma bay, a right chest tube and left femoral arterial line were placed. Cardiovascular surgery performed pericardial window in the operating room for pneumopericardium with tamponade physiology, and the patient was transferred to the trauma intensive care unit.

A repeat contrast enhanced CT of the chest, abdomen, and pelvis was obtained 21 hours later which revealed increased right hydronephrosis with layering hemorrhage in the collecting system (Figure 4). Rupture of the anterior wall of the renal pelvis with an adjacent hemorrhagic fluid collection was noted.

A right common femoral artery access angiogram was performed, demonstrating a small pseudoaneurysm of an interlobar branch of the right superior renal artery (Figure 5). This was presumed to be the source of bleeding and was embolized with a Terumo 2 mm by 2 cm detachable coil and Gelfoam. Superior mesenteric artery and common hepatic artery angiogram was also performed which revealed no active bleeding. In the intensive care unit, the patient continued to experience episodic hypotension which responded to IV fluid boluses. Due to the patient's unstable clinical condition, immediate retrograde ureteral stent placement was deferred by the consulting urologists. Attempts by urology to place a retrograde stent on day 7 were unsuccessful. A percutaneous nephrostomy tube was placed by interventional radiology on day 7, though the patient's kidney function did not recover.

The patient experienced worsening multisystem organ failure, therefore an exploratory laparotomy was performed on day 13 to assess for active bleeding or occult bowel injury. Laparotomy revealed venous bleeding from the liver and large volume hemolyzed blood in the abdomen. The bowel was viable without injury. Following surgery, multisystem organ failure progressed and the patient expired following withdrawal of care on day 16.

DISCUSSION

Etiology & Demographics:

Pre-existing abnormalities increase the susceptibility of kidneys to major injury even in the setting of minor trauma [1]. Rupture of the renal pelvis following blunt trauma is a rare occurrence [2]. Most renal pelvis ruptures in the setting of trauma occur due to avulsion at the ureteropelvic junction [3]. The first reported case of a tear secondary to avulsion was recorded by Moloney in 1970 [4]. Since this time, reports of pelvic rupture have been recorded in the literature from a variety of etiologies [3, 5-8]. To our knowledge, there are no

case discussions of hemorrhage into the renal pelvis from blunt trauma leading to delayed pelvis rupture.

Blunt trauma to hydronephrotic kidneys resulting in hemorrhage into the renal pelvis usually does not result in renal pelvis rupture [9]. In the presented case, hemorrhage into the collecting system led to delayed rupture of the renal pelvis, likely due to increased susceptibility from chronic ureteropelvic junction obstruction. Increased hydrostatic pressure in the renal collecting system related to hydronephrosis increases stress concentrations at the outer surface of the kidney. This amplifies the reaction forces of impact leading to a greater likelihood of rupture from minor trauma [1]. Additional factors that may increase the risk of rupture in the setting of chronic UPJ obstruction include renal displacement from the usual anatomical position increasing susceptibility to traumatic injury, as well as fibrosis and muscular atrophy which increase the likelihood of pelvis tearing via traumatic injuries [5]. This highlights the importance of maintaining a high index of suspicion for renal pelvis injury in trauma patients with pre-existing hydronephrosis.

Clinical & Imaging Findings:

The proper use of imaging, along with heightened suspicion in pre-existing renal abnormalities can lead to a timely diagnosis. Ultrasonography can provide a quick and cost efficient method to screen for patients with a possible rupture, but has limited specificity [10]. Nuclear medicine renal scintigraphy utilizing Tc99m-MAG3 may allow a diagnosis of urine leak, but is limited in detecting injuries outside of the renal collecting system, and is often not readily available in the acute setting. Magnetic resonance imaging (MRI) is an option for patients with known severe allergy to iodinated contrast, and provides good anatomic detail, but is time consuming and is prone to motion artifact.

The current "gold standard" for trauma imaging is CECT which, in hemodynamically stable patients following trauma to the abdomen and pelvis, should be obtained from the dome of the diaphragm through the floor of the pelvis with a 60-70 second scan delay. Excretory phase CECT through the kidneys, ureters, and bladder at 4-5 minutes after contrast administration is crucial for assessment of urinary tract injury [11]. Active bleeding will be indicated by growth of an extravascular collection of contrast between the early and delayed contrast phases. In the case of renal pelvis rupture, CECT will not only confirm the presence of fluid next to the renal pelvis, but it will also help locate the site of rupture. Urinoma is confirmed by the presence of excreted contrast outside of the renal collecting system.

CECT is superior to other noninvasive imaging modalities for detecting underlying renal disease in the traumatized kidney [12]. When performed for trauma, the studies may reveal, for the first time, an underlying renal pathology that may contribute to the renal pelvis rupture. One large review noted that 4.4% of adult victims and 15.4% of pediatric victims of blunt renal trauma were found to have preexisting renal conditions, with hydronephrosis accounting for 50% of

such cases [13]. In the presented case, right renal atrophy was diagnosed based on a parenchymal thickness of 0.6 cm and length of 8.9 cm. While renal size can vary depending on patient age, sex, and patient size, young adults typically have a renal parenchymal thickness ≥ 1.5 cm and length ≥ 10 cm [14,15]. The combination of renal atrophy and hydronephrosis without hydroureter, suggests chronic ureteropelvic junction obstruction.

Treatment & Prognosis:

Once a renal pelvis rupture has been identified, the goal of management is renal preservation. Immediate open surgery after hematuria leads to a higher nephrectomy rate and in most cases non-invasive treatment is preferred [9,16]. Conservative management of blunt renal trauma in hemodynamically stable patients yields more favorable results with high renal salvage [17]. The current treatment of choice for renal pelvis rupture is the placement of a double J-stent to divert urine outflow [18-20]. If stent placement is unsuccessful, percutaneous nephrostomy tube placement may be required. Any additional injuries to the kidney must also be addressed separately. In our case, the source of hemorrhage into the collecting system was uncertain as no active bleeding was identified during angiography. A small pseudoaneurysm of an interlobar branch of the superior right renal artery was identified and treated with coil and Gelfoam embolization.

Differential Diagnosis:

The clinical findings in renal pelvis rupture are nonspecific and include abdominal pain and hematuria. This results in a broad clinical differential diagnosis, including obstructing renal or ureteral calculus, urinary tract malignancy, urinary tract infection, and glomerulonephritis. Imaging an obstructing urinary tract calculus with CT demonstrates as a radiodense calculus with upstream hydroureteronephrosis. While perinephric fluid may be present, a fluid collection will not typically be seen next to the renal pelvis [21]. Ultrasound is useful for detecting hydronephrosis, though obstructing ureteral calculi are often occult sonographically. Similarly, a urinary tract malignancy will demonstrate as an enhancing mass on CECT with upstream hydroureteronephrosis. Renal pelvis and bladder masses may be visible sonographically, though ureteral masses are often occult. Ultrasound is insensitive for urinary tract infection, though CECT may demonstrate a variety of features, including heterogeneous enhancement of the renal parenchyma, perinephric/periureteral fat stranding, and urothelial thickening and enhancement [22]. Glomerulonephritis is usually occult in the acute setting, but may result in renal enlargement on both CECT and ultrasound.

The diagnosis of renal pelvis rupture is delayed for 36 hours or more in more than 50% of cases [3, 20]. One-third of renal pelvis ruptures are not associated with hematuria [11]. CECT utilizing delayed imaging is highly specific for collecting system rupture with urinoma formation.

Conclusion:

We have presented a case of delayed renal pelvis rupture following blunt trauma in the setting of suspected chronic UPJ obstruction. Pre-existing renal abnormalities such as chronic UPJ obstruction lead to increased risk of rupture from trauma. The judicious review of renal anatomy in the setting of trauma can help identify pre-existing renal anomalies and raise index of suspicion for renal injury, including renal pelvis rupture.

TEACHING POINT

There is an increased risk of renal pelvis rupture in trauma patients with pre-existing hydronephrosis or other renal abnormalities. CECT is the preferred imaging modality for evaluating renal injury in the setting of trauma, and requires both portal venous and delayed phase imaging. Delayed phase imaging will not only confirm the presence of urine extravasation, but may also help locate the site of urine leak.

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FIGURES

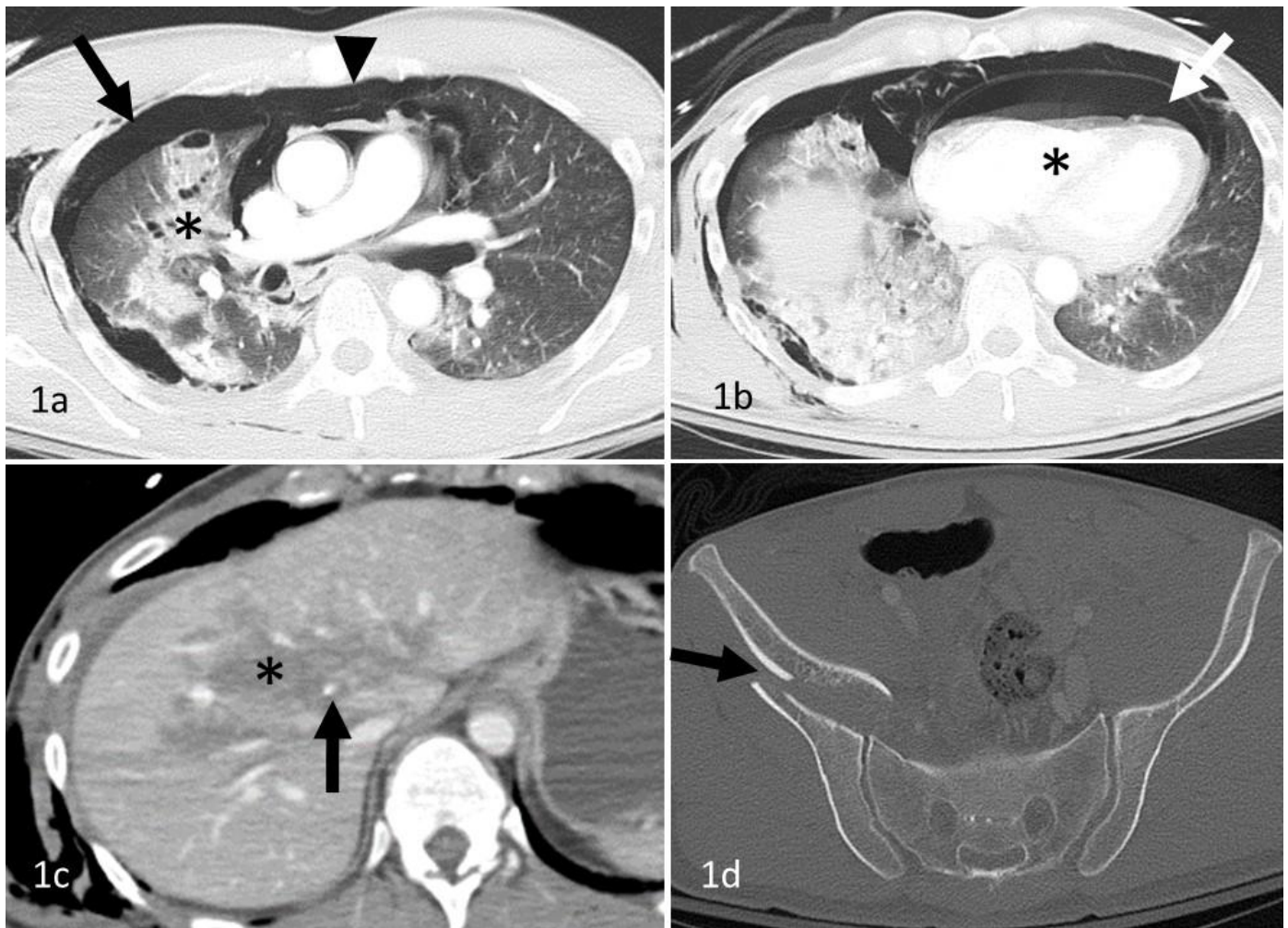


Figure 1: 43 year old male victim of a road traffic accident with multiple injuries.

Findings: Axial contrast-enhanced CT through the mid chest (1a) with large right pneumothorax (arrow), pulmonary contusion (*), and pneumomediastinum (arrowhead). Axial CT through the heart (1b) demonstrates pneumopericardium (arrow) which results in mass effect on the adjacent heart (*, tension pneumopericardium). A Grade 5 liver laceration (*, 1c) is present. Note internal focus of active arterial bleeding (arrow). Axial CT through the pelvis (1d) demonstrates displaced right iliac wing fracture (arrow).

Technique: Siemens SOMATOM Definition Flash, 100 kVp, Auto mA, 3 mm slice thickness, 100 mL Iohexol 350

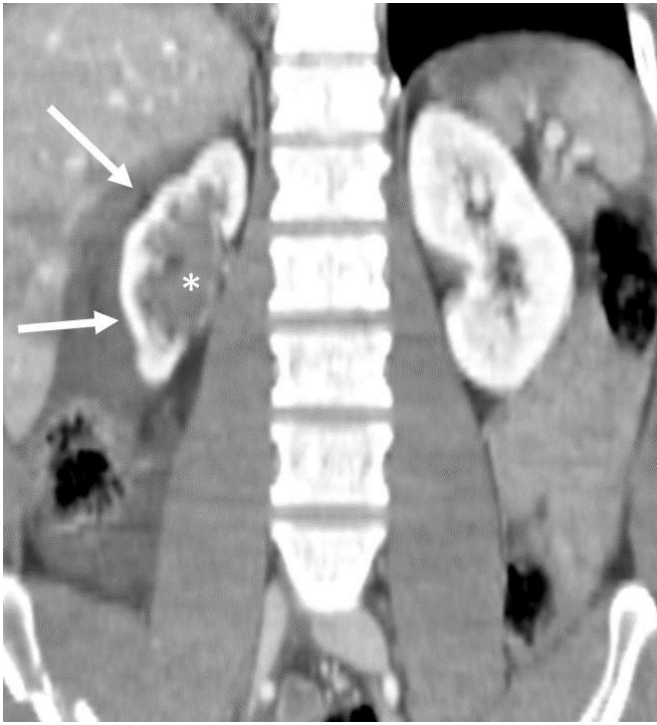


Figure 2 (left): 43 year-old male victim of road traffic accident with right renal atrophy and hydronephrosis.

Findings: Coronal intravenous contrast enhanced CT demonstrates a dilated right renal pelvis (*) with right renal atrophy (arrows). Right kidney long axis measurement is 8.9 cm with parenchymal thickness of 0.6 cm.

Technique: Siemens SOMATOM Definition Flash Dual Source, 100 kVp, Auto mA, 3 mm slice thickness, 100 mL Iohexol 350

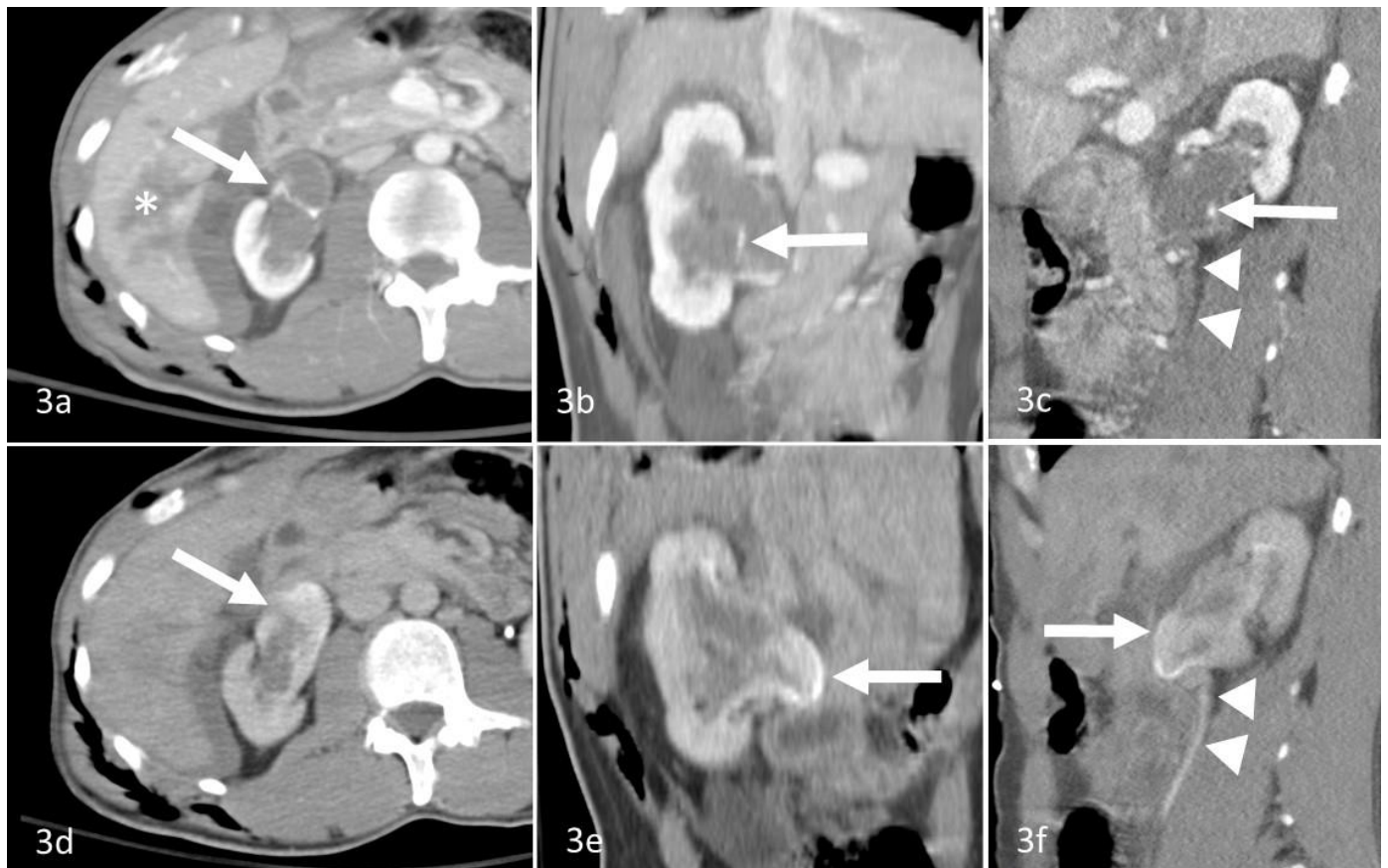


Figure 3: 43 year-old male victim of road traffic accident with active hemorrhage into the right renal pelvis.

Findings: Axial (3a), coronal (3b), and sagittal (3c) contrast-enhanced CT through the right kidney during the portal venous phase demonstrate serpiginous enhancement within the renal pelvis representing active bleeding (arrows). A Grade 5 liver laceration is partially imaged (*, 3a). Nondilated ureter is present (arrowheads, 3c). Axial (3d), coronal (3e), and sagittal (3f) CT during the 7 minute delayed phase demonstrate increased hemorrhage within the right renal pelvis (arrows). Nondilated ureter is present (arrowheads, 3f).

Technique: Siemens SOMATOM Definition Flash, 100 kVp, Auto mA, 3 mm slice thickness, 100 mL Iohexol 350

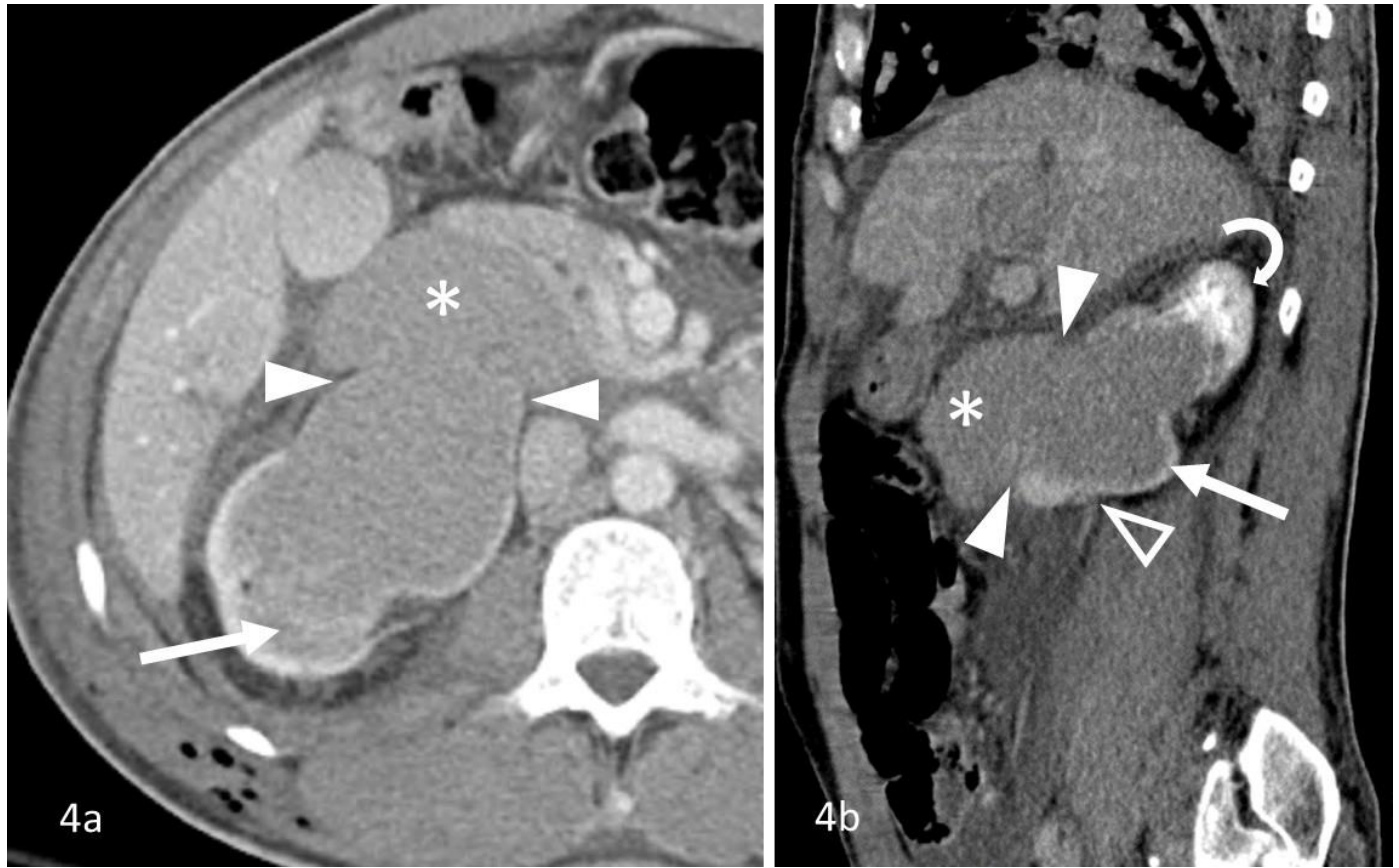


Figure 4: 43 year-old male victim of road traffic accident with active hemorrhage into the right renal pelvis and delayed renal pelvis rupture.

Findings: Axial intravenous contrast enhanced CT of the abdomen (4a) performed during the venous phase 21 hours after Figure 1, 2, and 3 demonstrates increased right hydronephrosis with layering internal hemorrhage (arrow). Hemorrhagic collection (75 HU) anterior to the renal pelvis (*) represents extravasated urine and hemorrhage through the ruptured renal pelvis anterior wall (arrowheads). Sagittal 4 minute delayed image (4b) demonstrates right kidney (curved arrow), dilated renal pelvis with layering hemorrhage (arrow), renal pelvis rupture (closed arrowheads), and hemorrhagic collection anterior to the pelvis (*). Note the ureteropelvic junction located posterior and inferior to the site of renal pelvis rupture (open arrowhead).

Technique: Siemens Sensation Open 40 slice, kVp 120, mA 193, 3 mm slice thickness, 100 mL Iohexol 350

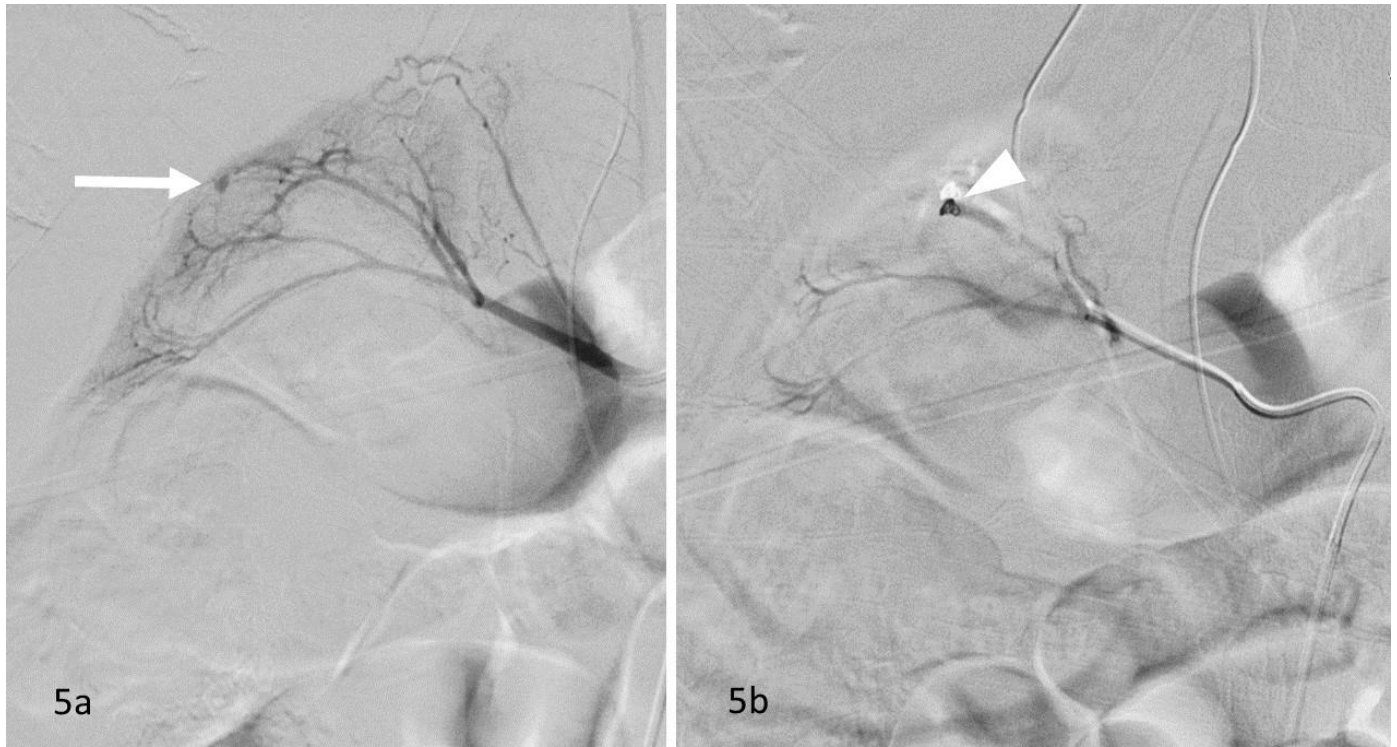


Figure 5: 43 year-old male victim of road traffic accident with active hemorrhage into the right renal pelvis and delayed renal pelvis rupture.

Findings: Digital subtraction angiogram through the superior right renal artery (3 right renal arteries were present) demonstrates no active bleeding, though small distal pseudoaneurysm of an interlobar branch (arrow) was noted (5a). Digital subtraction angiogram performed following coil and Gelfoam embolization of the feeding artery (5b) demonstrates coil (arrowhead), with absent filling of the distal interlobar artery and pseudoaneurysm.

Technique: Digital subtraction angiography of the superior right renal artery. Injection of 87 cc (total exam volume) Iohexol 350 in posterior-anterior projection.

Etiology	Etiologies for renal pelvis rupture include: <ul style="list-style-type: none"> • Blunt trauma (most commonly ureteropelvic junction avulsion) • Obstructing urinary stones and tumors • Pregnancy • Congenital causes of hydronephrosis (e.g. posterior urethral valves, ureteroceles, vesicoureteral reflux).
Incidence	Renal pelvis rupture is a rare occurrence. Delayed renal pelvis rupture in the setting of chronic UPJ obstruction has not previously been reported.
Gender Ratio	No clear gender predilection
Risk Factors	<ul style="list-style-type: none"> • Renal displacement from the usual anatomical position increasing susceptibility to traumatic injury • Renal fibrosis and muscular atrophy related to chronic hydronephrosis.
Treatment	Conservative management is preferred, often with placement of a double J-stent ureteral stent to divert urine outflow, or percutaneous nephrostomy. Underlying renal pathology management.
Prognosis	Conservative management in hemodynamically stable patients yields more favorable results with high renal salvage. Open surgery after hematuria leads to a higher nephrectomy rate.
Imaging Findings	<ul style="list-style-type: none"> • CECT (gold standard) demonstrates fluid next to the renal pelvis, with excreted contrast extending through the renal pelvis defect on delayed imaging. • Ultrasound demonstrates fluid next to the renal pelvis. • Nuclear medicine renal scintigraphy utilizing Tc99m-MAG3 demonstrates radiotracer outside of the collecting system. This is not routinely performed in the setting of acute trauma.

Table 1: Summary table for renal pelvis rupture

Differential diagnosis	Ultrasound	Computed tomography
Renal pelvis rupture	Fluid surrounding the renal hilum, outside of the collecting system.	Presence of fluid next to the renal pelvis. Urinoma formation confirmed by excreted contrast outside of the collecting system on delayed phase CECT.
Obstructing renal calculus	Distended renal collecting system. An obstructing ureteral calculus may not be visualized.	Dilated renal collecting system and ureter to the level of obstruction. Radiodense renal calculus will be seen in the renal collecting system or ureter.
Urinary tract malignancy	Distended renal collecting system. Renal pelvis and bladder mass may be seen sonographically, though obstructing ureteral mass may not be visualized.	Enhancing soft tissue mass in the renal parenchyma or collecting system on CECT.
Urinary tract infection	Often occult on imaging. Urothelial thickening involving the kidney, ureter, or bladder may be seen.	Often occult on imaging. May see urothelial thickening and enhancement. Pyelonephritis may demonstrate heterogeneous parenchymal enhancement (striated nephrogram) with perinephric fat stranding.
Glomerulonephritis	Often occult on ultrasound in the acute setting. May see renal enlargement related to edema.	Usually occult. May see renal enlargement related to edema

Table 2: Differential diagnosis table for renal pelvis rupture

ABBREVIATIONS

CECT = Contrast-enhanced computed tomography
 CT = Computed tomography
 HU = Hounsfield Unit
 UPJ = Ureteropelvic junction

KEYWORDS

Rupture; Renal Collecting System; Ureteropelvic Junction; Trauma; Hydronephrosis; Kidney; Computed Tomography

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