

Urine Trouble: Imaging of High-Grade Renal Trauma

Goals & Objectives

- Illustrate the classification of high-grade renal injuries using the American Association for the Surgery of Trauma (AAST) Organ Injury Score (OIS) on Computed Tomography (CT)
- Discuss the optimal CT protocol used in renal trauma, including the importance of excretory phase imaging
- Describe how the AAST classification guides clinical management and the limitations of the grading system on CT

Ling Chen Chien, MD; Mona Vakil, MD; Tarek Hanna, MD; Krystal Archer-Arroyo, MD;
Jonathan Nguyen, DO; Keith Herr, MD

Department of Radiology & Imaging Sciences
Emory University School of Medicine, Atlanta GA



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Background

- Incidence: 25% patients following blunt abdominal trauma and up to 6% patients following penetrating retroperitoneal injury
- Grading: The American Association for the Surgery of Trauma (AAST) Organ Injury Score (OIS) is widely used by surgeons and radiologists to stratify renal injuries based on parenchymal, vascular, and collecting system injury
 - correlates with prognosis and need for intervention
 - grades 4 & 5 ↑ need for endovascular, endourological, or surgical management
- Treatment: recent shift towards nonoperative management in high-grade injuries. Additional helpful imaging features to predict need for intervention:
 - perirenal hematoma size (>3.5 cm)
 - intravascular contrast extravasation
 - site (medial vs. lateral) and complexity of lacerations
 - arterial pseudoaneurysms or arteriovenous fistulas

AAST Grade 4:



Laceration: > 1cm parenchymal depth extending to the **collecting system**. Injury to the collecting system with contrast extravasation (↑) on delayed imaging

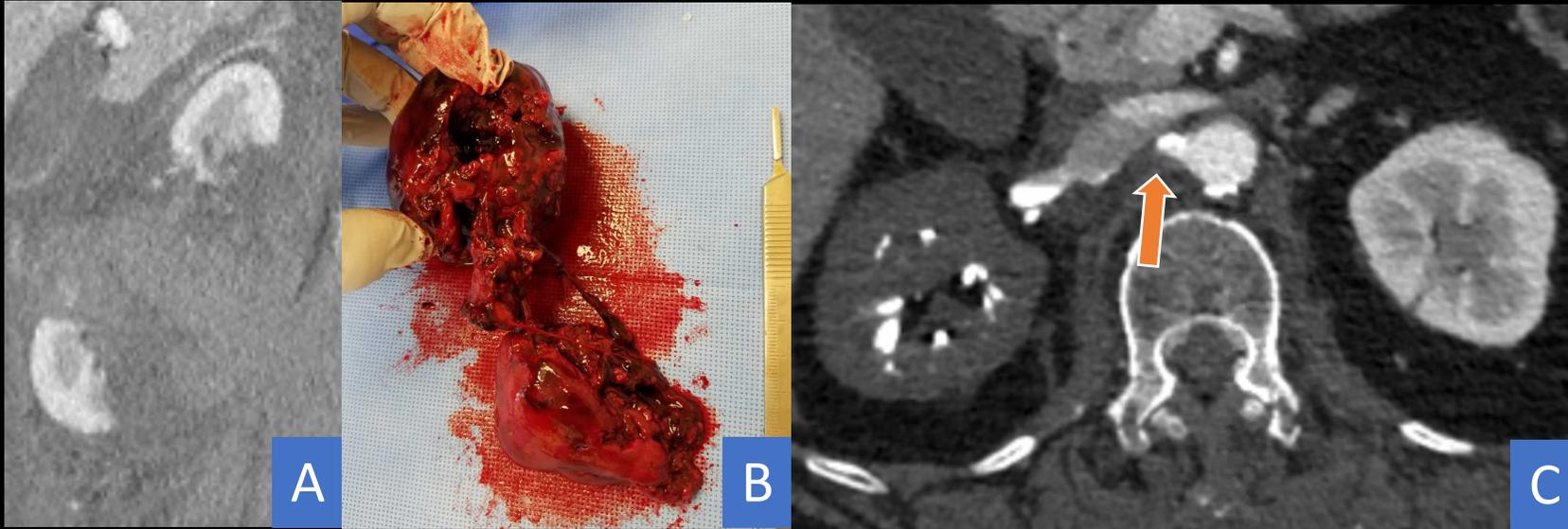
OR

Vascular Injury:

Injury to main renal **artery** or **vein** with contained hemorrhage
Segmental renal artery traumatic dissection or thrombosis
resulting in segmental devascularization without laceration (↑)

TEACHING POINT: Injury to the **collecting system** represents *at least* Grade 4 injury.

AAST Grade 5



Laceration (A,B):
completely shattered kidney

OR

Ureteropelvic disruption (A,B):
complete avulsion or partial tear of ureter at the ureteropelvic junction

OR

Vascular injury (C):
avulsion of the renal hilum which devascularizes the kidney

Multiple cases demonstrating **high-grade** renal injury.

- (a) Sagittal contrast-enhanced CT (CECT) of a patient with transected kidney demonstrates complete destruction of the interpolar region of the right kidney. Intraoperatively, the right kidney was transected with hematoma between the upper and lower poles. No distinct arterial supply to the lower pole could be identified. Upper pole parenchyma was well-vascularized, but was avulsed from the entire collecting system. The kidney could not be salvaged and the patient underwent nephrectomy.
- (b) Surgical specimen of an explanted shattered kidney following MVC with similar transection of the upper and lower poles.
- (c) (c) Axial CECT of a different patient with devascularization of the right kidney demonstrates abrupt termination of the right renal artery (↑) and hypoperfusion of the entire right kidney.

Importance of IV contrast in CT protocols for renal trauma



CASE: 32-year-old male motorcycle crash with flank pain and gross hematuria. (a) Coronal non-contrast CT demonstrates crescentic high density collection along the lateral margin of the left kidney (↑), compatible with large subcapsular hematoma. Pseudoaneurysm is not visible without contrast. (b-d) Coronal (b), sagittal (c), and axial (d) CECT with split-bolus demonstrates a large, contained pool of contrast in the left upper pole consistent with a pseudoaneurysm (↑ in B-D). There are deep parenchymal lacerations (>1 cm), which extend through the cortex and medulla (circles). (e) Urographic images were obtained given multiple deep lacerations extending close to the renal hilum and symptoms of gross hematuria. Delayed excretory image (e) demonstrates an intact collecting system.

AAST Grade with expert commentary:

- Deep lacerations of > 1 cm parenchymal depth **without** collecting system injury make this a **Grade 3 injury**.
- The pseudoaneurysm *does not factor* into AAST grading. In this case, patient underwent IR coil embolization of the left renal branch artery pseudoaneurysm.

Split-Bolus Trauma Protocol



Split-bolus trauma protocol with both renal cortical enhancement (↑) and renal contrast excretion (↑). Excreted contrast extravasation from the right renal **collecting system** (↑), compatible with a **Grade 4 injury**.

Split bolus technique: single-pass acquisition, preceded by 2-3 sequential IV contrast boluses, with aim to **reduce radiation exposure**.

Triple-split-bolus: captures arterial (25-30 sec), portal venous (65-80 sec), and renal excretory phase (5-10 min) in one acquisition.

- **Arterial:** vascular injuries and arterial-origin active extravasation
- **Portal venous:** parenchymal injuries
- **Delayed/Renal excretory:** collecting system and further characterization of solid organ injuries

Note that the split-bolus-protocol is not the current standard for CT imaging of renal trauma due to lack of sufficient evidence.

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