Computerized Tomography Finding of Renal Trauma

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Abstract

Background: Renal injuries are present in 8-10% of patients presenting with blunt abdominal trauma and up to approximately 6% of patients presenting after penetrating injury. Overall, blunt trauma accounts for up to 80% of all renal injuries . Trauma is a leading cause of morbidity and mortality all over the world. Blunt abdominal trauma accounts for more abdominal injuries than the less frequent penetrating injuries. The AAST classification consists of five injury grades, ranging from mild (Grade I) to severe (Grade V). From an imaging standpoint, the AAST classification is based on three main parameters: degree of parenchymal injury, vascular injury and collecting system disruption. The utility of this classification scheme lies in its ability to predict clinical outcome with reasonable accuracy.

Keywords: Computerized Tomography, Renal Trauma

Introduction

Renal injuries are present in 8-10% of patients presenting with blunt abdominal trauma and up to approximately 6% of patients presenting after penetrating injury. Overall, blunt trauma accounts for up to 80% of all renal injuries **(1)**.

Trauma is a leading cause of morbidity and mortality all over the world. Blunt abdominal trauma accounts for more abdominal injuries than the less frequent penetrating injuries **.** Spleen and liver are the most common visceral organs to be affected in blunt trauma to the abdomen, followed by genitourinary injury, involved in only 3%-10% of cases **(2)**.

The kidneys are located high up in the retroperitoneum, well protected and cushioned by the peritoneum and abdominal viscera anteriorly and by the tough musculoskeletal structures of the posterior abdominal wall posteriorly. The kidney is the most commonly injured organ of the genitourinary system and renal injuries account for only 1%-5% of all abdominal injuries **(3).**

Of all the incurred injuries, over 95% are minor injuries and can be managed with conservative therapy with no significant complications. It is only the more grave injuries, like renal fracture or shattering, renal pedicle injury or avulsion and severe pelvi-calyceal system (PCS) injury, which require active intervention or even surgery **(3).**

The AAST classification consists of five injury grades, ranging from mild (Grade I) to severe (Grade V). From an imaging standpoint, the AAST classification is based on three main parameters: degree of parenchymal injury, vascular injury and collecting system disruption. The utility of this classification scheme lies in its ability to predict clinical outcome with reasonable accuracy (**4).**

Although the AAST classification for renal injury is primarily based on findings during surgery, it has been shown to have a strong correlation with MDCT findings (**4).**

Table (1): Grades according to AAST **(5).**

American Association for Surgery of Trauma Renal Injury Scale		
Grade	**Type**	**Description**
I	Contusion	Microscopic or gross haematuria. Urological studies normal.
	Haematoma	Subcapsular, non-expanding without parenchymal laceration.
II	Haematoma	Non-expanding peri-renal haematoma confined to renal retroperitoneum.
	Laceration	< 1.0cm parenchymal depth of renal cortex with no urinary extravasation.
III	Laceration	> 1.0cm parenchymal depth of renal cortex w/out collecting system rupture or urinary extravasation.
IV	Laceration	Parenchymal laceration extending through renal cortex, medulla & collecting system.
	Vascular	Main renal artery or vein injury with contained haemorrhage.
V	Laceration	Completely shattered kidney.
	Vascular	Avulsion of renal hilum that devascularises kidney.

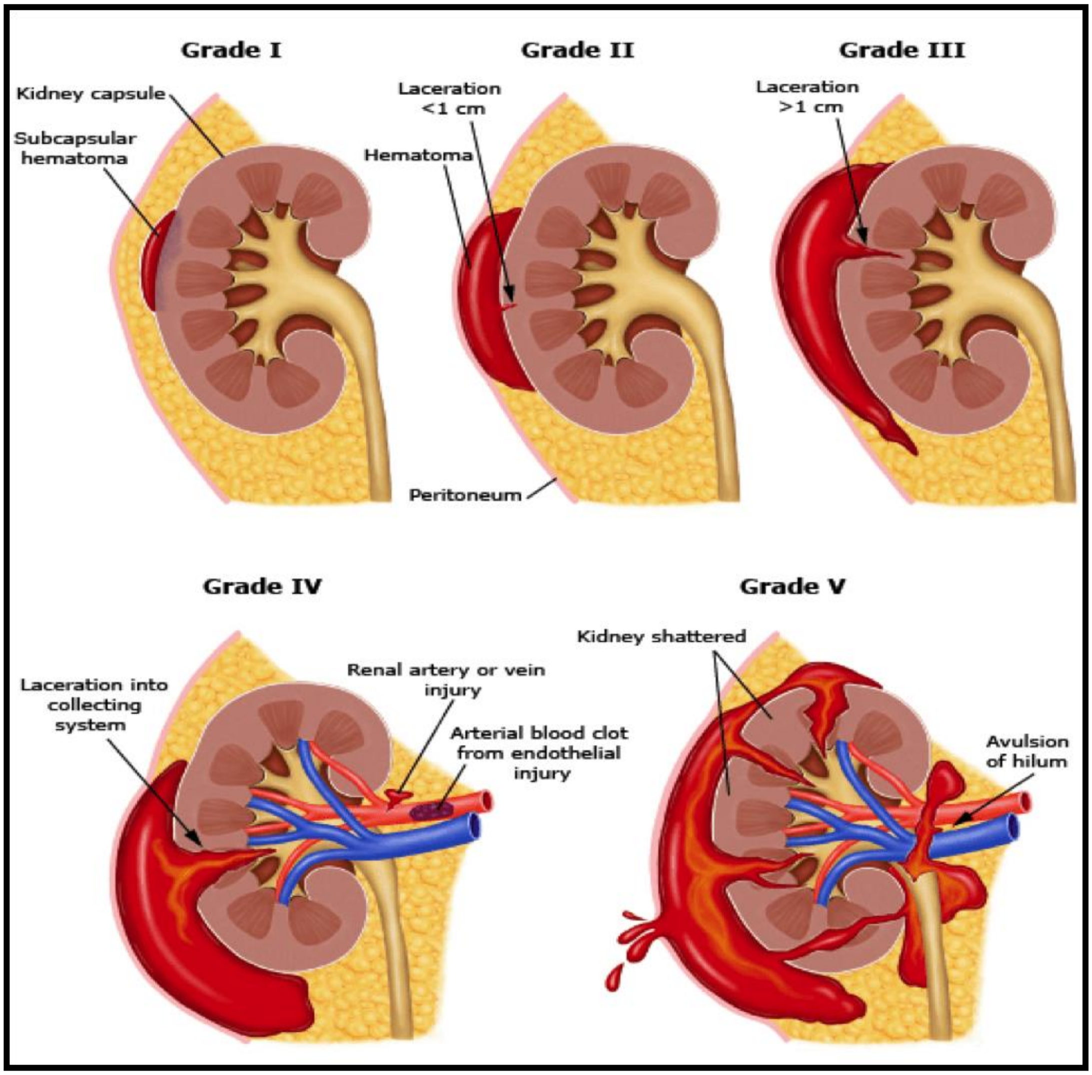


Fig. (1): Grades of renal trauma, **(5).**

Grade I injury

Grade I injury is characterized by contusion or nonexpanding subcapsular hematoma without parenchymal laceration. Other finding would include limited perinephric hematoma and small subsegmental infarct. Grade I injuries account for most renal injuries (approximately 80%) presenting clinically with mild or gross hematuria and are managed conservatively **(6).**

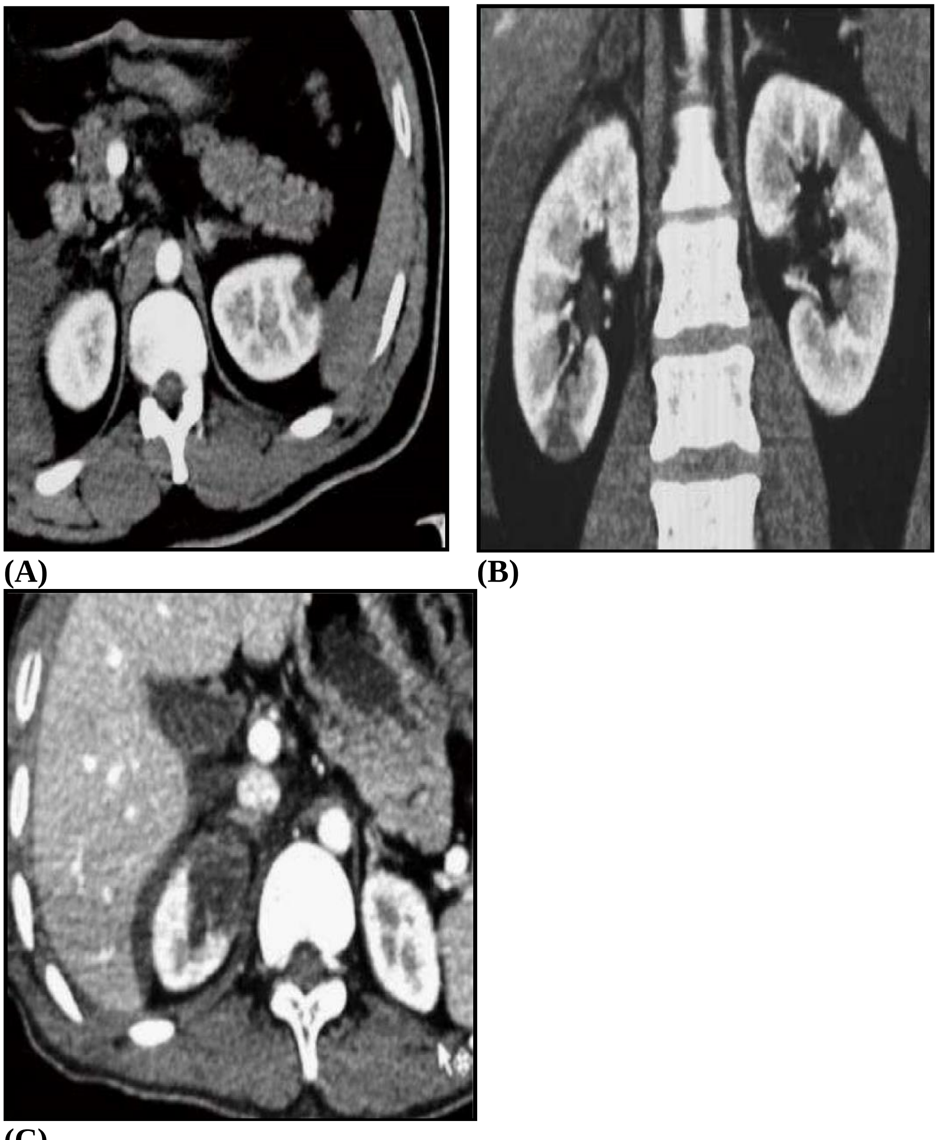


Fig. (2): Grade I renal injury. A: Axial; B: Coronal contrast enhanced computed tomography (CECT) image of a 40-year-old male patient who had sustained a road traffic accident, shows a small contusion at upper pole of left kidney (Grade I injury). Also seen is a small wedge shaped hypodense area of infarct at lower pole of right kidney; C: Axial CECT image of another patient (25-year-old male with blunt trauma) showing a larger area of contusion at upper pole of right kidney **(3).**

Grade II injury

Grade II renal injuries are characterized by nonexpanding perinephric hematoma confined to the retroperitoneum or cortical laceration < I cm deep without involvement of the collecting system. Other associated findings are thickening of the lateroconal fascia, compression of the colon, and displacement of the kidney by the perirenal hematoma. These patients are managed conservatively **(2)**.

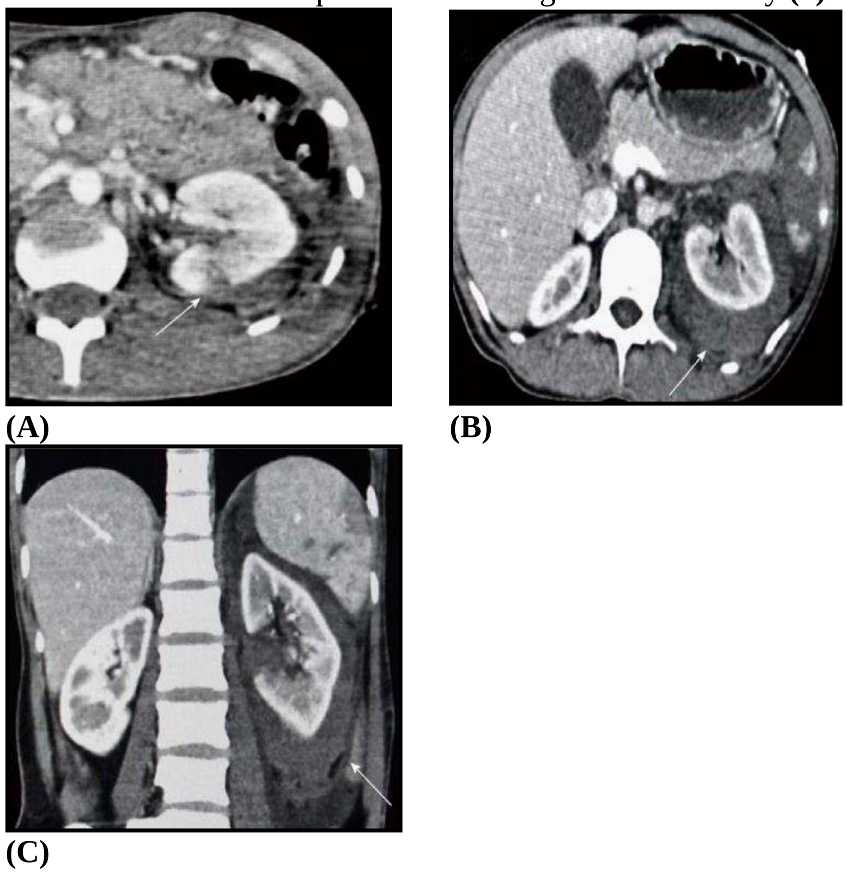
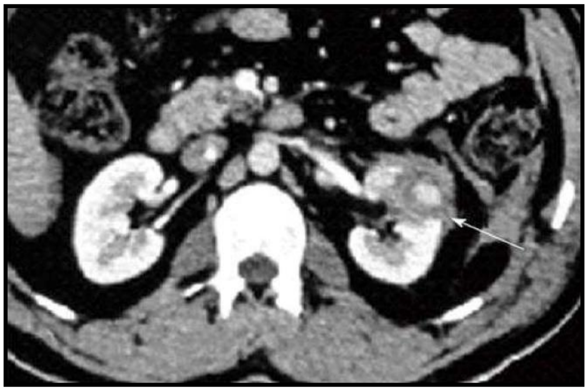


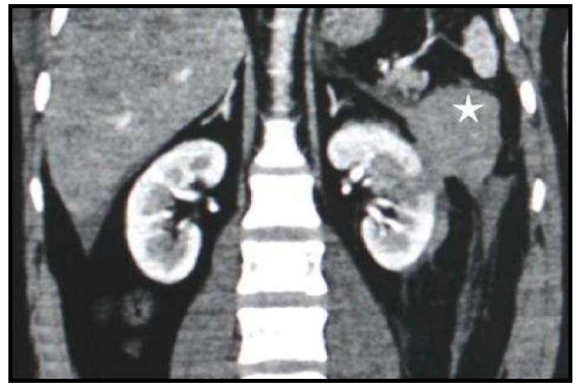
Fig. (3): Grade II renal injury. A: Axial contrast enhanced computed tomography (CECT) section of 24-year-old male patient who had blunt trauma to the abdomen, showing a small superficial irregular and linear hypodense area of laceration (arrow) involving the posterior cortex of left kidney with mild perinephric hematoma. No pelvicalyceal system injury; B: Axial; C: Coronal CECT images of27-year-old male patient with blunt trauma showing perirenal hypodensity (arrows) surrounding the left kidney and confined within the Gerota's fascia **(7).**

Grade III injury

It is only the depth of the renal laceration which differentiates a Grade II injury from Grade III. Grade III renal injuries are characterized by nonexpanding perinephric hematoma confined to the retroperitoneurn and by laceration extending more than 1 cm in depth. The laceration may involve the medulla but there is no PCS injury which is determined on the excretory phase image by demonstrating a lack of urinary extravasations **(8).**



(A)



(B)

(C)

Fig. (4): Grade III renal injury. Contrast enhanced computed tomography (CECT) images of a 27- year-old male patient who had a stab injury in the left flank. A: Axial section showing a deep laceration (arrow) reaching up to the hilum; B: Coronal section showing the deep laceration at mid pole with disruption of the para-renal fascia and a large hematoma (star) lateral to it; C: Axial delayed image in excretory phase showed no excreted contrast extravasation **(9).**

Grade IV injury

Grade IV injury includes injuries of the main renal artery or vein with contained hemorrhage and injury leading to segmental devascularization and lacerations involving the PCS. In addition, multiple renal lacerations, expanding subcapsular hematomas and fractured kidney are included in this grade. The presence of a hematoma in the perihilar location and medial aspect of the kidney or deeper lacerations extending up to the hilum should raise the possibility of PCS injury and an excretory phase scan is needed to confirm the urinary leak **(10).**

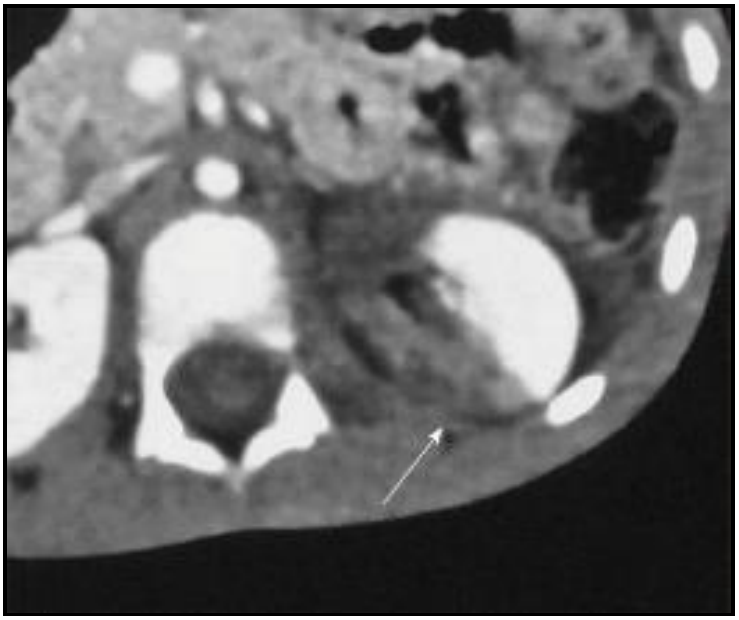
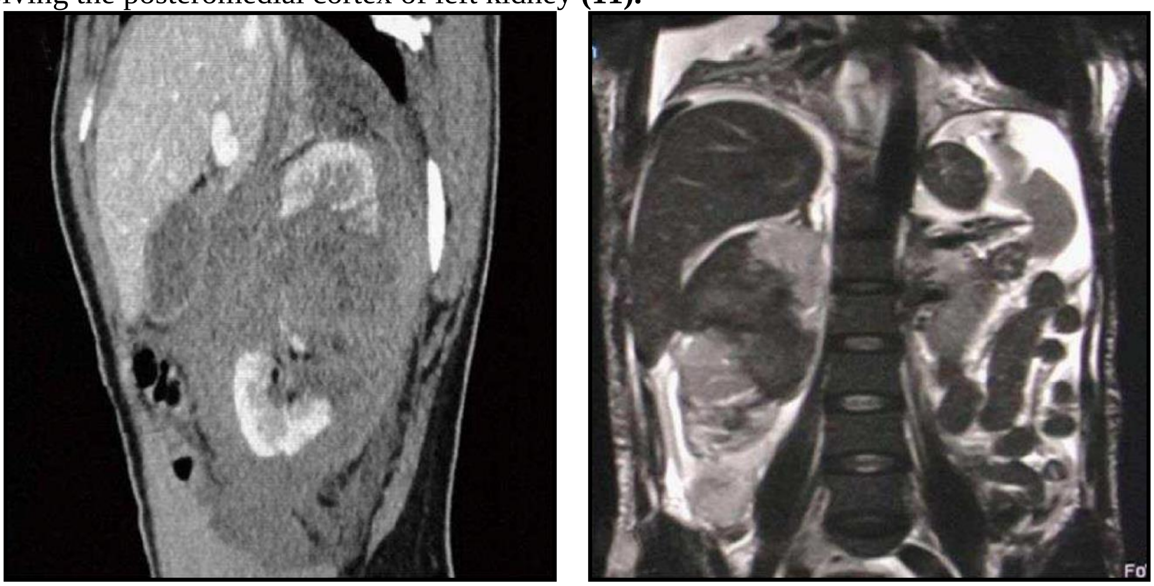
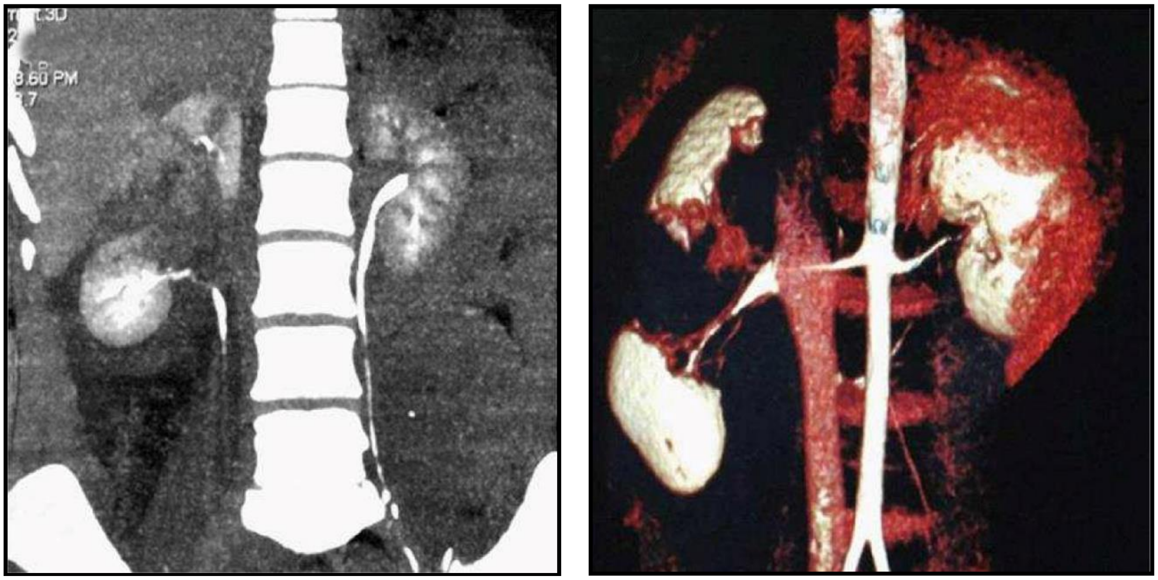


Fig. (5): Grade IV renal injury (Segmental infarction). Contrast enhanced computed tomography axial section o f a 6-year-old child who sustained blunt trauma. Sharply marginated nonenhancing hypodense area involving the posteromedial cortex of left kidney **(11).**

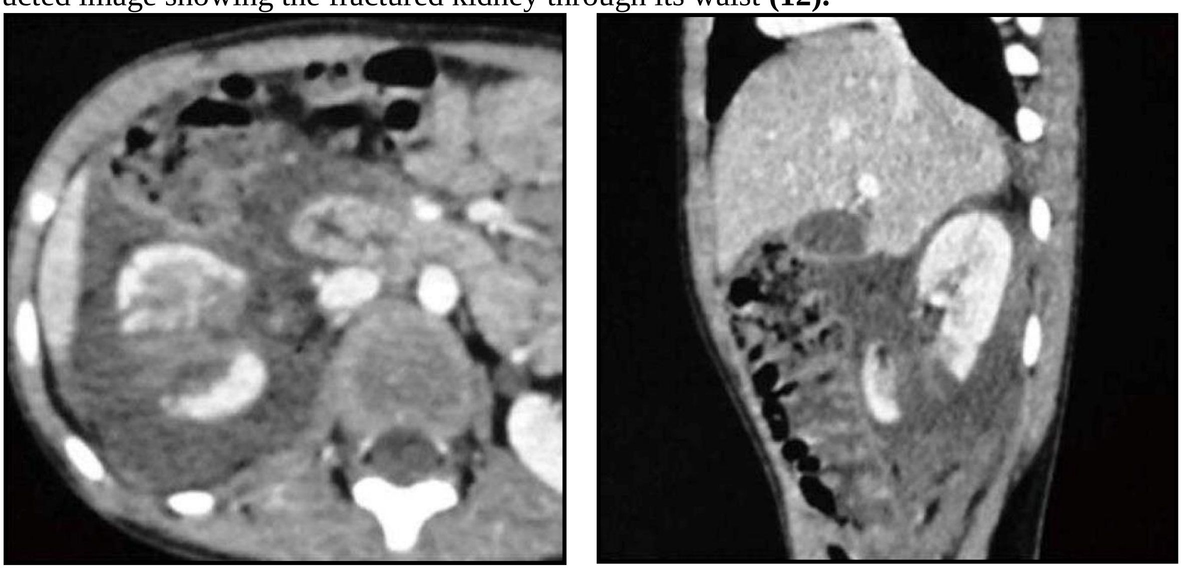


(A) **(B)**



(C) **(D)**

Fig. (6): Grade IV injury (Fractured kidney). Contrast enhanced computed tomography (CECT) and magnetic resonance imaging (MRI) images of a 58-year-old female patient who sustained renal tubular acidosis and had significant hematuria. A: Sagittal CECT; B: Coronal T2 weighted MRI section showing a large laceration with hematoma extending through the mid pole of the right kidney dividing the kidney into two parts and separating the poles wide apart; C: Coronal maximum intensity projection image of the excretory phase did not show any urinary leak with opacification of the ureter; D: Volume rendered reconstructed image showing the fractured kidney through its waist **(12).**



(A) **(B)**

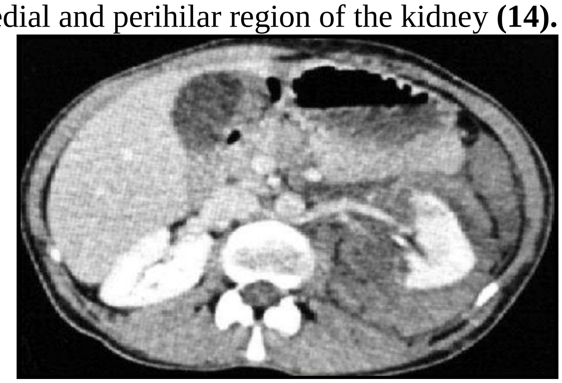
(C)

(D)

Fig. (7): Grade IV injury (Laceration involving the pelvicalyceal system). Contrast enhanced computed tomography (CECT) images of a 7-year-old male who had a fall from height with resulting blunt trauma to the abdomen. A: Axial; B: Sagittal section showing deep laceration in lower pole of the right kidney extending up to the renal hilum; C: Sagittal section; D: Thick coronal maximum intensity projection image of the excretory phase shows leakage of excreted opacified urine (arrow) through the laceration suggesting PCS injury with resultant urinoma (a) formation around lower pole of right kidney **(13)**

Grade V injury

Grade V is the highest grade of renal injury, characterized by avulsion of the pelvi-ureteric junction. It occurs as a result of a sheering injury at this point of fixation as it gets stretched over the transverse process and leads to PUJ disruption. They can be partial or complete, with the presence of a hematoma or urinoma in the medial and perihilar region of the kidney **(14).**



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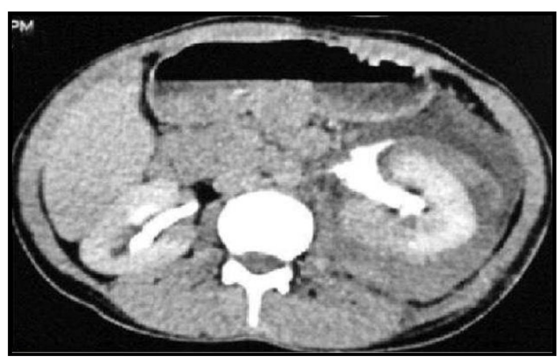

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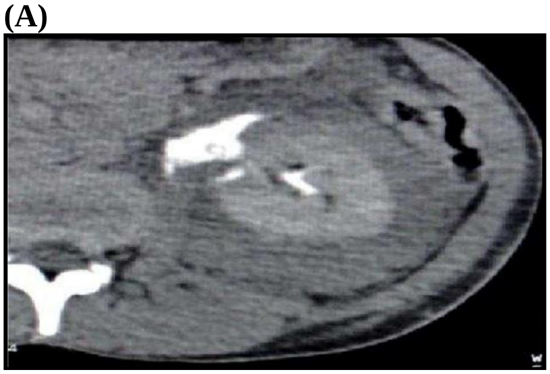


(C)

(D)

Fig. (8): Grade V injury (Ureteropelvic junction injury). Contrast enhanced computed tomography images of a 30-year-old female patient who sustained blunt abdominal trauma. A: Axial section showing deep laceration in posteromedial cortex of left kidney involving the hilum with perinephric and perihilar hematoma; B: Excretory phase axial section showing leak of opacified urine from the pelviureteric junction which tracks along the medial aspect of kidney; C: Axial maximum intensity projection (MIP); D: Coronal MIP image showing the extravasated opacified urine from the renal pelvis and tracking in the retroperitoneum along the course of ureter **(15).**

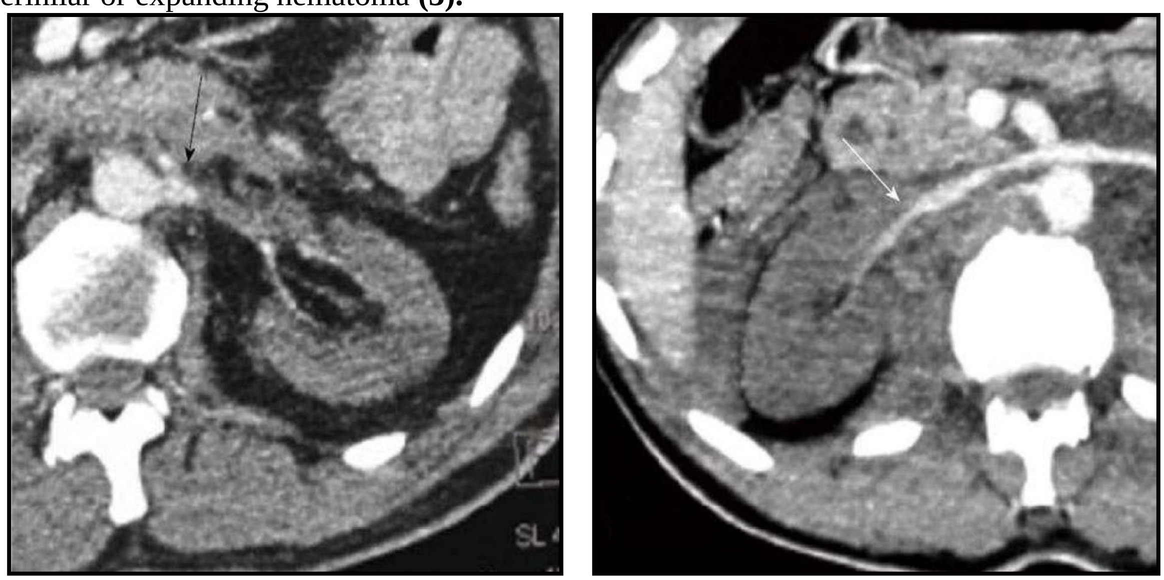
Other types of injuries include renal pedicle injury and shattering of renal parenchyma with or without urinary or arterial contrast extravasation. Renal pedicle injury can lead to thrombosis of the artery or vein and subsequent devascularization of the kidney or complete laceration leading to the avulsion of the renal pedicle. It is commonly seen in injuries where there is sudden deceleration injury or hyperextension of the spine leading to stretching of the renal vessels in the retroperitoneum and intimal tear with subsequent thrombus formation that occludes the main renal artery. The site of occlusion is seen as the cut off of the main renal artery on a contrast enhanced CT scan with the absence of renal parenchymal enhancement. There would be no perinephric hematoma. In some cases, there may be an intact blood supply from capsular, peripelvic and periureteric vessels which produce a thin capsular and subcapsular enhancement, referred to as the "cortical rim sign" **(16).**

Another finding that may suggest devascularization is retrograde filling of the ipsilateral renal vein from the inferior vena cava.

Renal pedicle avulsion on the other hand is a complete tear of all the layers of the vessel wall and so will have a hematoma around the aorta and renal hilum with active contrast extravasation from the disrupted stump. There will be no renal perfusion. These patients show signs of hemodynamic instability and it may prove lethal if not managed in time. Renal vein injuries are extremely uncommon **(17).**

On a CECT, there may be the presence of a filling defect in the enlarged renal vein or signs of back pressure changes, such as nephromegaly with differential and delayed progression on the nephrogram compared to the normal opposite kidney **(18).**

A complete transaction of the renal vein may not be assessed on CT but may be suspected in the presence of a large perihilar or expanding hematoma **(3).**



(A) **(B)**

Fig. (9): Grade V injury (Renal vascular injury). Devascularization following renal artery thrombosis. A: Axial contrast enhanced computed tomography (CECT) section at the level of left renal artery of a 48-year-old male patient who had blunt trauma to the abdomen, showing non-enhancing left kidney with abrupt cut off of the enhancing proximal segment of left main renal artery (arrow) with non-enhancing distal segment; B: Axial CECT scan of a different patient shows reflux of contrast in to the right renal vein (arrow) from inferior vena cava of the devascularized right kidney, also a sign seen in devascularized kidneys **(3).**

(A)

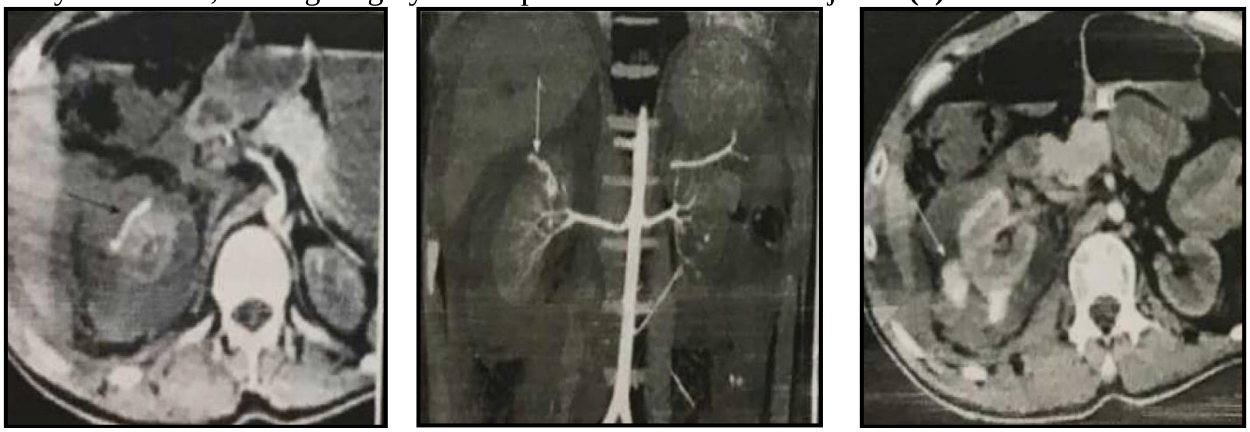
(B)

(C)

Fig. (10): Grade V injury (Shattered Kidney). Contrast enhanced computed tomography (CECT) images of an l8-year-old male patient who had blunt trauma to the abdomen. A: Axial section; B: Coronal section of abdomen showing a large hematoma replacing the entire right kidney with extensive perinephric hematoma. Also seen is ill- defined area of active contrast extravasation (arrow) within the hematorna; C: Coronal thick maximum intensity projection image showing the arterial branch from which was actively bleeding within the hematoma. **(19).**

Draw backs of ASST classification

The ASST does not describe pseudoaneurysm or active bleeding in any of the grades as it is a surgical grading system based on the appearance at surgery, but there are several radiological grading systems which classify them into higher renal injury categories needing either close follow up or surgical or endovascular interventions. In a well preserved renal function, a pseudoaneurysm or focal arterial extravasation could be effectively embolized, leaving surgery as an option for more severe injuries **(7)**.



(A) **(B)** **(C)**

Fig. (11): Vascular injury (Active contrast extravasation). Contrast enhanced computed tomography (CECT) of a 25-year-old male patient who sustained renal tubular acidosis. A: Axial section; B: Coronal thick maximum intensity projection (MJP) image in the late arterial phase showing an area of contrast extravasation (arrow) along the anterior surface of upper pole of right kidney which do not confine to any vascular structure, which in the immediate delayed phase (C) is seen to spread over an area (arrow) in the perinephric region and has a density higher than the adjacent vessels **(3).**

Modification of AAST classification

Grades I, II and III remain unchanged

<u>Change in Grade IV</u>

- **Originally:** renal lacerations involving the collecting system, injuries involving the main renal artery or vein with contained hemorrhage, and segmental renal infarctions.
- **Revision:** adds segmental arterial and venous injury, and laceration to the renal pelvis or pelvi-ureteric junction. Shattered kidney is now in Grade IV from Grade V.

<u>Change in Grade V</u>

- **Originally:** included shattered kidney, pelviureteric junction injury and laceration or avulsion of main renal artery or vein.
- **Revision:** now includes only vascular injury (arterial or venous), i.e., laceration, avulsion or thrombosis **(20).**

Conflicts of Interest: The authors declare no conflict of interest.

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