Review of CT Imaging features in renal trauma correlated to the American Association for the Surgery of Trauma (AAST) Organ Injury Scale

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Learning objectives

To identify the imaging characteristics of renal trauma and correlate these findings with the American Association for the Surgery of Trauma (AAST) organ injury scale and thus improve the recognition of renal trauma, and to standardise the reporting of renal lesions identified in trauma imaging.
Background

The organ injury scale most commonly used to assess renal injury is the grading scale described by the AAST. This system ranks severity into 5 grades based on the degree of parenchymal injury, vascular involvement, and collecting system disruption. This educational exhibit will review the features of each grade and illustrate these with medical illustrations and companion CT examples. The grades are defined in table 1.

Table 1 - The AAST Grading Scale for Renal Trauma

<table>
<thead>
<tr>
<th>Grade</th>
<th>Injury Type and Description</th>
</tr>
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<tbody>
<tr>
<td>Grade I</td>
<td>Contusion: Microscopic or gross hematuria; urologic studies normal</td>
</tr>
<tr>
<td></td>
<td>Hematoma: Subcapsular, non-expanding without parenchymal laceration</td>
</tr>
<tr>
<td>Grade II</td>
<td>Hematoma: Non-expanding perirenal hematoma confirmed to renal retroperitoneum</td>
</tr>
<tr>
<td></td>
<td>Laceration: &lt;1.0 cm parenchymal depth of renal cortex without urinary extravasation</td>
</tr>
<tr>
<td>Grade III</td>
<td>Laceration: &gt;1.0 cm parenchymal depth of renal cortex without collecting system rupture or urinary extravasation</td>
</tr>
<tr>
<td>Grade IV</td>
<td>Laceration: Parenchymal laceration extending through renal cortex, medulla, and collecting system</td>
</tr>
<tr>
<td></td>
<td>Vascular: Main renal artery or vein injury with contained hemorrhage</td>
</tr>
<tr>
<td>Grade V</td>
<td>Laceration: Completely shattered kidney</td>
</tr>
<tr>
<td></td>
<td>Vascular: Avulsion of renal hilum which devascularizes kidney</td>
</tr>
</tbody>
</table>
Imaging findings OR Procedure details

Grade I

The AAST grading scale defines a Grade 1 injury as contusion with microscopic or gross hematuria, and normal imaging or subcapsular haematoma that is non-expanding and without parenchymal laceration [1,2]. Fig. 1 on page 7 details an illustration of this injury and Fig. 2 on page 7 contains a case example.

Grade I injuries comprise up to 28% of the renal injuries seen in trauma cases [3]. Management is usually conservative consisting of observation, bed rest, hydration, serial haematocrit monitoring, and antibiotics [4].

Grade II and Grade III

Grade II renal injury includes a haematoma that is perirenal, non-expanding, and confined to the renal retroperitoneum [1,2]. The Grade II and Grade III AAST Renal Injury both include lacerations without collecting system rupture or urinary extravasation [1,2]. However, they differ in depth, with Grade II injuries being <1.0cm, and Grade III injuries >1.0cm [1,2]. Fig. 3 on page 8 and Fig. 4 on page 9 detail an illustration of Grade II and Grade III injury respectively and Fig. 5 on page 10 and Fig. 6 on page 11 contain case examples.

Grade II and Grade III injuries are seen in 30% and 20% of renal trauma respectively [3]. The management of Grade II and Grade III injuries is also usually conservative (including close observation, bed rest, hydration, serial haematocrit monitoring, and antibiotics) [4]. However, surgical management for Grade III injury can be considered if the patient is already undergoing laparotomy for other abdominal injuries [4].

Grade IV

Grade IV renal injuries are characterised by parenchymal laceration extending through renal cortex, medulla, and collecting system [1,2]. The vascular component of Grade IV injury relates to renal artery or vein damage with contained haemorrhage [1,2]. Fig. 7 on page 12 details an illustration of this injury and Fig. 8 on page 13 and Fig. 9 on page 13 contain a case examples.

Grade IV injuries are seen in 15% of cases with renal trauma [3] and are managed in a similar manner to Grade III injuries, in that surgical management should generally only be considered if the patient is undergoing a laparotomy for other abdominal injuries [4].
Patients with Grade IV are, however, at risk for developing hypertension secondary to compression of the renal vessels leading to decreased blood flow and activation of the renin-angiotensin system (referred to as Page kidney) [4,5].

**Grade V**

Grade V Renal injuries are those that completely shatter the kidney or avulse the renal hilum with consequent devascularisation of the kidney [1,2]. Fig. 10 on page 14 details an illustration of this injury and Fig. 11 on page 15 and Fig. 12 on page 16 contain case examples.

Grade V injuries are seen in 7% of renal trauma [3] and are usually managed with exploratory laparotomy [4]. Similar to Grade IV injuries, patients with a grade V injury are at greatest risk of developing hypertension with the same mechanism as in Grade IV injury (renin-angiotensin system activation) [4].

Table 2 summarises the prevalence, management, and follow-up for the 5 grades of injury.

**Table 2 - Prevalence, management, and follow-up for renal injury**

<table>
<thead>
<tr>
<th>Grade</th>
<th>Prevalence</th>
<th>Management</th>
<th>Follow-Up</th>
</tr>
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<tbody>
<tr>
<td>I</td>
<td>28%</td>
<td>- Observation, bed rest, hydration, serial haematocrit monitoring, and antibiotics</td>
<td>- Twice yearly blood pressure checks for 2 years, followed by lifelong annual blood pressure checks - Confirmation of resolution of non-visible haematuria at 6 months</td>
</tr>
<tr>
<td>II</td>
<td>30%</td>
<td>- As per Grade I</td>
<td>- Follow-up as per Grade I - Urological outpatient follow-up at 4-6 weeks</td>
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- Ultrasound with Doppler before outpatient follow-up

<table>
<thead>
<tr>
<th>Grade</th>
<th>Percentage</th>
<th>Treatment</th>
<th>Follow-up</th>
</tr>
</thead>
</table>
| III   | 20%        | - As per Grade I
- Surgical repair if the patient is undergoing a laparotomy for other abdominal injuries |
|       |            | - Follow-up as per Grade II |
| IV    | 15%        | - As per Grade III |
|       |            | - Follow-up as per Grade II |
|       |            | - Radionuclide scan at 6-12 weeks |
| V     | 7%         | - Usually surgical management |
|       |            | - Follow-up as per Grade IV |
Grade 1

Fig. 1: Illustration depicting the typical features of a Grade I kidney injury, with a hematoma and contusion, but no laceration.

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Fig. 2: CT Scan with axial portal venous phase showing a right kidney Grade I injury with an 8-9mm subcapsular haematoma within the lateral aspect of the right kidney without a focal, visible underlying renal laceration.

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**Fig. 3:** Illustration depicting the typical features of a Grade II kidney injury. Note the superficial laceration.

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Fig. 4: Illustration depicting the typical features of a Grade III kidney injury, with a deep laceration not involving the collecting system.

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Fig. 5: CT Scan with axial parenchymal phase showing a left kidney grade III injury with wedge-shaped or linear opacification defects and perirenal hematoma. There is no collecting system rupture or urinary extravasation.

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**Fig. 6:** CT Scan with axial phase (left) and with axial delayed phase (right) showing Grade III injury. In this case, a left renal laceration separated the kidney into two parts. There was no involvement of the renal hilum and a large perinephric haematoma surrounds the kidney. On the delayed scans, there was no excretion of the lacerated lower pole, while the remaining kidney showed persistent nephrogram with no definite excretion into the renal pelvis.

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**Grade 4**

**Fig. 7:** Illustration depicting the typical features of a Grade IV kidney injury, with a deep laceration extending through the collecting system, and a large contained area of haemorrhage.
Fig. 8: CT Scan with coronal portal venous phase showing Grade IV injury with a heterogenous right kidney with a parenchymal defect extending through the cortex to the medulla.

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**Fig. 9:** CT Scan with coronal portal venous phase (left) and delayed phase (right) showing Grade IV injury in the left kidney. This injury was caused by a gunshot wound and the metallic projectile traversed through the left upper quadrant, lacerating the upper pole of the left kidney. There is a moderate amount of urine leakage demonstrated on the delayed images.

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**Grade 5**

**Fig. 10:** Illustration depicting the typical features of a Grade V kidney injury, with a shattered parenchyma, and avulsed hilum.

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Fig. 11: CT Scan with axial portal venous phase showing a left kidney that is non-enhancing and completely devascularised.

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**Fig. 12:** CT Scan with coronal arterial phase (left) and coronal delayed phase (right) showing a Grade V injury. This patient has a right sided Grade V shattered kidney with complete devascularisation of the right kidney. The heterogeneously enhancing mass located medial to the right kidney represents a large para-pelvic haematoma which has active extravasation of contrast, representing active bleeding.

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Conclusion

Utilisation of the AAST system of classification of renal injury is an appropriate tool to standardise the reporting of renal trauma identified on CT Scanning.
Personal information

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References


