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American College of Radiology
ACR Appropriateness Criteria®

Clinical Condition: **Renal Trauma**

Variant 1: **Blunt abdominal trauma with microscopic hematuria; no suspicion of associated abdominal injury.**

Radiologic Procedure	Rating	Comments	RRL*
CT abdomen and pelvis with IV contrast	5		☢☢☢
X-ray abdomen and pelvis	4		☢☢☢
CT abdomen and pelvis without IV contrast	4	If patient has contraindication to contrast.	☢☢☢
US abdomen (FAST scan)	4	To look for free intraperitoneal fluid.	O
CT abdomen and pelvis without and with IV contrast	3	Images without contrast do not add significant value to CT with contrast.	☢☢☢☢
US kidneys and bladder retroperitoneal	2		O
X-ray intravenous urography	2		☢☢☢
Arteriography kidney	1		☢☢☢
Rating Scale: **1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate**			***Relative Radiation Level**

Variant 2: **Blunt abdominal injury; suspicion of multisystem trauma, with hematuria.**

Radiologic Procedure	Rating	Comments	RRL*
CT abdomen and pelvis with IV contrast	9	Detection of associated injuries.	☢☢☢
X-ray abdomen and pelvis	7	Detection of associated fractures.	☢☢☢
CT abdomen and pelvis without IV contrast	5	If patient has contraindication to contrast.	☢☢☢
X-ray intravenous urography	4	Limited to use in the operating room if patient is too unstable for preoperative CT or if CT is not available.	☢☢☢
Arteriography kidney	4	Embolizing bleeders, avulsion of pedicle.	☢☢☢
US abdomen (FAST scan)	4	To look for free intraperitoneal fluid.	O
CT abdomen and pelvis without and with IV contrast	3	Images without contrast do not add significant value to CT with contrast.	☢☢☢☢
US kidneys and bladder retroperitoneal	2		O
Rating Scale: **1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate**			***Relative Radiation Level**

Clinical Condition: **Renal Trauma**

Variant 3: **Penetrating abdominal injury; suspicion of multisystem trauma, with or without hematuria.**

Radiologic Procedure	Rating	Comments	RRL*
CT abdomen and pelvis with IV contrast	9		☢☢☢
CT abdomen and pelvis without IV contrast	5	If patient has contraindication to contrast.	☢☢☢
X-ray abdomen and pelvis	4	To look for foreign bodies.	☢☢☢
X-ray intravenous urography	4	Limited to use in the operating room if patient is too unstable for preoperative CT or if CT is not available.	☢☢☢
Arteriography kidney	4	Embolizing bleeders, avulsion of pedicle.	☢☢☢
US abdomen (FAST scan)	4	To look for free intraperitoneal fluid.	O
CT abdomen and pelvis without and with IV contrast	3	Images without contrast do not add significant value to CT with contrast.	☢☢☢☢
US kidneys and bladder retroperitoneal	2		O
Rating Scale: **1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate**			***Relative Radiation Level**

RENAL TRAUMA

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Summary of Literature Review

Introduction/Background

No single method of evaluation can be uniformly applied to all patients suspected of suffering abdominal trauma. The exact approach depends not only on the types of injuries the patient has likely suffered but also on the philosophy of the attending physicians, local practice, and the type of equipment and support available. Moreover, the evaluation of a suspected renal injury cannot be isolated from the evaluation of other suspected intra-abdominal injuries. A variety of different approaches to a given patient may therefore be acceptable. Nevertheless, imaging plays a crucial role in suspected renal trauma in assessing the extent and severity of injury to the affected kidney, evaluating function and anatomy of the opposite kidney, and detecting other injuries [1].

Most closed upper urinary tract injury occurs after wide-impact blunt abdominal trauma, usually after sudden deceleration (motor vehicle accident), crash injury (fall from height) assault, or abdominal injury sustained during contact sport. The incidence of penetrating injuries to the kidney from either a gunshot wound or a stab wound is variable but may be associated with more severe renal injuries [2,3]. Regardless of the mechanism, the majority of serious renal injuries are associated with injuries to other organs that may dominate the clinical picture [4]. Isolated renal injuries after blunt trauma are rare, and the majority are relatively minor in most published series. In a series from Cass et al [5] 241 of 831 patients had what were considered to be solitary renal injuries; however, the vast majority (98%) were minor injuries. Therefore, only five patients in the entire series suffered significant isolated renal injury, but there were 33 significant renal injuries in the group of 590 patients with hematuria who suffered multisystem trauma.

Other injuries associated with injury of the kidneys following multisystem blunt trauma include (in order of decreasing frequency): fractures of the extremities, thoracic injury, pelvic fracture, intra-abdominal injury, head injuries, and diaphragmatic rupture. In the abdomen, injuries to the liver and spleen are most commonly associated with renal injury, followed by injury to the pancreas, the colon, and the small bowel.

Renal injuries are classified into grades 1 to 5 based on the severity of the injury using the American Association for the Surgery of Trauma (AAST) organ injury severity scale [6]:

- Grade 1: Contusion or nonexpanding subcapsular haematoma without parenchymal laceration.
- Grade 2: Nonexpanding perirenal haematoma laceration <1 cm deep without extravasation.
- Grade 3: Laceration >1 cm without urinary extravasation.
- Grade 4: Laceration extending through renal cortex into collecting system, or segmental renal artery or vein injury with contained hemorrhage, or partial vessel laceration, or vessel thrombosis.
- Grade 5: Laceration: shattered kidney, or renal pedicle injury, or avulsion of renal hilum.

Hematuria is a characteristic sign of renal trauma. However, there is no correlation between the degree of hematuria and the severity of the renal injury. Furthermore some major renal injuries can be present in the absence of hematuria [7].

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The amount of hematuria that should trigger imaging of the urinary tract after localized blunt trauma is controversial. Nicolaisen et al [8] found that significant renal injury was limited to the group of patients in whom shock and either gross or microscopic hematuria were present among 306 individuals analyzed retrospectively following blunt trauma. There were no significant renal injuries among the 221 patients who had microscopic hematuria but were not suffering from shock. In patients in the same series who suffered penetrating injuries, however, no such discrimination was possible, and the authors suggest radiologic evaluation of all patients suffering penetrating injury and any degree of hematuria. These observations have now been confirmed in multiple additional studies, both retrospectively and prospectively [9-11]. On the other hand, the absence of hematuria does not exclude the presence of a significant renal injury. In a series of 396 patients suffering renal injury after falling from a height, 20.8% (5 out of 24) of patients with grade 2 to 4 renal injuries had no hematuria [12]. In another study of patients with renovascular injuries, Knudson et al [13] reported that hematuria was absent in 18% of cases.

It can therefore be concluded that radiological investigation for potential renal injury is warranted in trauma patients presenting with the following injuries [14]:

1. Blunt abdominal trauma and gross hematuria.
2. Blunt abdominal trauma, shock (systolic pressure <90 mm Hg in the field or during resuscitation), or other associated injuries and microscopic hematuria.
3. Blunt trauma with injuries known to be associated with renal injury such as rapid deceleration, direct contusion to the flank, flank ecchymoses, or fractures of the lower ribs or thoracolumbar spine, regardless of the presence or absence of hematuria.
4. Penetrating trauma to the upper abdomen or lower thorax regardless of the presence or absence of hematuria.

Computed Tomography

Computed tomography (CT) especially multidetector CT (MDCT), is the gold standard for imaging hemodynamically stable patients with suspected blunt or penetrating intra-abdominal injuries. MDCT has been shown to be a rapid and accurate method for detecting the presence of and grading the extent of abdominal injuries, and it allows for optimal treatment planning [15]. Bretan et al [16] published an image-based classification paralleling the AAST renal injury classification which can be useful to the clinicians managing the patient.

As conservative (nonoperative) management has become the treatment of choice for many renal injuries, CT plays a critical role in guiding management [17,18]. Erturk et al [19] reported that early CT evaluation allowed confident nonoperative management in 17 of 22 patients with renal injuries. Bozeman et al [20] found nonoperative management was effective in 50% of patients with grade 4 or 5 injuries who were hemodynamically stable. Sangthong et al [21] reviewed outcomes in 517 patients with renal artery injuries and reported shorter hospital stays in patients who were observed compared to those treated with nephrectomy or surgical revascularization. Additionally, expectant management has been shown to decrease the number of iatrogenic nephrectomies [22]. Many authorities now believe that with the information afforded by preoperative CT, renal exploration need not be performed unless there are major devitalized fragments or associated bowel or pancreatic injury, or unless the patient becomes hemodynamically unstable from a major renal laceration and is not manageable by angiographic embolization.

CT protocols will vary depending on available equipment and the patient's clinical presentation. However, it is generally agreed that for optimal detection of renal injuries intravenous contrast needs to be administered. In trauma patients, CT images are usually acquired in the portal venous phase of enhancement, allowing for detection of renal parenchymal injuries. The ability of acquiring multiple phases may be beneficial in some cases. A delayed phase should be added if ureteral injury is suspected. If a vascular injury is suspected, vascular phase imaging may be useful [23,24].

In the trauma patient, rapid diagnosis of intra-abdominal hemorrhage is essential. Traditionally, diagnostic peritoneal lavage (DPL) was widely used for detecting intraperitoneal hemorrhage. DPL is sensitive, easy to perform, and universally available; however, it does not differentiate inconsequential bleeding from that which requires laparotomy and, more importantly, it cannot detect the site of the bleeding or retroperitoneal injuries [25]. It is now considered an adjunct diagnostic method, particularly if intestinal and mesenteric injuries are suspected [26] or if CT or ultrasound (US) is not available [17].

Ultrasound

Focused abdominal sonography for trauma (FAST), originally pioneered in Europe, is now widely used in many trauma centers in the United States and allows for rapid detection of intra-abdominal hemorrhage.

Advantages of FAST are that it can be performed rapidly at the patient's bedside, is noninvasive, and does not expose patients to ionizing radiation. The value of FAST in screening abdominal trauma patients has been recently confirmed by several large studies. Sirlin et al [27,28] reported that among 3,679 patients with negative findings on US, 99.9% were confirmed as true negative by clinical or radiographic follow-up. In another series of 4,029 patients suffering from blunt abdominal trauma, the accuracy of FAST was reported to be 95%. The authors concluded that hypotensive patients with positive FAST could be triaged directly to laparotomy, without need for CT [29]. However, there is a statistically significant correlation between the presence of a falsely negative FAST US and an underlying pelvic fracture or a renal injury [30]. While the role of FAST in the hemodynamically unstable trauma patient is well recognized, its utility in the hemodynamically stable patient is more controversial, as CT is usually required for precise delineation of underlying injuries [31]. One potential limitation of FAST is that it requires the presence of a qualified sonographer and/or physician to perform and interpret the study.

With regard to evaluation of renal injuries, a significant limitation of US for imaging of renal trauma is that no functional information is provided. A review of the role of US in patients with renal trauma by McGahan et al [32] showed that only 22% of renal parenchymal abnormalities were identified prospectively and that abnormalities were detected more commonly with severe injuries. A more recent study of the role of US in diagnosing solid abdominal organ injuries reported a sensitivity of 45.7% and specificity of 64.1%. These numbers improve significantly if contrast-enhanced US is used; however, this technique is not available in the United States [33]. There is little information concerning the use of color Doppler for assessing renal blood flow after trauma.

Intravenous Urography

In patients who are hemodynamically unstable, only limited information about the status of the urinary tract can generally be obtained. A single view of the abdomen following a large dose of intravenously administered contrast material ("one-shot" intravenous urography [IVU]) is generally all that can be obtained; such a study is insufficient to diagnose a renal injury but can give information about the location and status of the uninjured kidney(s) and verify function in the opposite kidney. The value of these limited "one-shot" studies in unstable patients has been questioned [34]; a retrospective review of 239 such studies showed that the preoperative urographic assessment of contralateral renal function played no role in the management of a renal injury. The authors of this study felt that delaying definitive therapy merely to obtain the urographic study was not justified.

Penetrating Injury

In patients who are suspected to have suffered a penetrating renal injury, CT is also the method of choice for assessment [2]. In patients with limited posterior stab wounds, CT should be performed for assessment, since exploratory surgery is not mandatory.

In recent years, there has been a growing trend towards nonoperative management of renal injuries in the hemodynamically stable adult and pediatric patient. This practice is well established for managing blunt abdominal trauma and even after penetrating injuries in selective cases [35]. CT thus becomes critically important for precise delineation of the nature and extent of injuries [36].

The management of patients with penetrating renal injuries remains more controversial, although even in these cases there is a developing trend towards conservative management [18]. This paradigm shift can be in large part attributed to the accurate staging of such injuries that is provided by CT [37,38].

Renal Angiography and Embolization

Another important trend is the use of arteriography and embolotherapy for nonoperative management of persistent or life-threatening traumatic renovascular injuries. Although, arteriography has a high degree of specificity in detecting the bleeder, it is usually performed as part of a therapeutic embolization and directed towards a suspected abnormality detected on contrast-enhanced CT [39]. The additional contrast load administered during embolotherapy does not seem to have long-term impact on renal function. Embolotherapy has been shown to be safe and effective in the management of renovascular injuries and may be associated with shorter hospital stay compared to surgical intervention [40].

Both the Societe Internationale D'Urologie and the European Association of Urology have published consensus documents on issues concerning the diagnosis and management of renal injuries [3,14]. Their recommendations are not substantially different from those in this summary.

Summary

- Assessment of the nature and extent of the renal injury is most important in those patients in whom there will be an attempt to avoid exploratory surgery.
- In hemodynamically stable patients being assessed for wide-impact blunt injury in a major trauma center where CT is available immediately on a 24-hour basis, CT is the imaging method of choice and gold standard.
- In institutions where there would be a significant delay in obtaining high-quality CT, it is acceptable to use DPL or FAST to look for the presence of intraperitoneal fluid and "one-shot" IVU to assess the kidneys.
- In patients who suffer suspected anterior penetrating renal injury, CT should be used as a first-line study if radiographic assessment is desired. Similarly, CT is the study of choice to evaluate the effect of limited posterior stab wounds.
- The preferred treatment of patients with suspected isolated blunt renal injury is perhaps the most controversial issue. Most such patients do not have evidence of multisystem trauma but are suspected of renal injury because of hematuria. Studies have demonstrated that the incidence of significant renal injury in this group of patients is low, and that those with microscopic hematuria alone do not need any radiologic evaluation.

Relative Radiation Level Information

Potential adverse health effects associated with radiation exposure are an important factor to consider when selecting the appropriate imaging procedure. Because there is a wide range of radiation exposures associated with different diagnostic procedures, a relative radiation level (RRL) indication has been included for each imaging examination. The RRLs are based on effective dose, which is a radiation dose quantity that is used to estimate population total radiation risk associated with an imaging procedure. Patients in the pediatric age group are at inherently higher risk from exposure, both because of organ sensitivity and longer life expectancy (relevant to the long latency that appears to accompany radiation exposure). For these reasons, the RRL dose estimate ranges for pediatric examinations are lower as compared to those specified for adults (see Table below). Additional information regarding radiation dose assessment for imaging examinations can be found in the ACR Appropriateness Criteria® Radiation Dose Assessment Introduction document.

Relative Radiation Level Designations		
Relative Radiation Level*	**Adult Effective Dose Estimate Range**	**Pediatric Effective Dose Estimate Range**
O	0 mSv	0 mSv
☢	<0.1 mSv	<0.03 mSv
☢☢	0.1-1 mSv	0.03-0.3 mSv
☢☢☢	1-10 mSv	0.3-3 mSv
☢☢☢☢	10-30 mSv	3-10 mSv
☢☢☢☢☢	30-100 mSv	10-30 mSv

*RRL assignments for some of the examinations cannot be made, because the actual patient doses in these procedures vary as a function of a number of factors (eg, region of the body exposed to ionizing radiation, the imaging guidance that is used). The RRLs for these examinations are designated as "Varies".

Supporting Documents

For additional information on the Appropriateness Criteria methodology and other supporting documents go to www.acr.org/ac.

References

1. Ramchandani P, Buckler PM. Imaging of genitourinary trauma. *AJR Am J Roentgenol.* 2009;192(6):1514-1523.

2. Kansas BT, Eddy MJ, Mydlo JH, Uzzo RG. Incidence and management of penetrating renal trauma in patients with multiorgan injury: extended experience at an inner city trauma center. *J Urol.* 2004;172(4 Pt 1):1355-1360.
3. Santucci RA, Wessells H, Bartsch G, et al. Evaluation and management of renal injuries: consensus statement of the renal trauma subcommittee. *BJU Int.* 2004;93(7):937-954.
4. Shariat SF, Jenkins A, Roehrborn CG, Karam JA, Stage KH, Karakiewicz PI. Features and outcomes of patients with grade IV renal injury. *BJU Int.* 2008;102(6):728-733; discussion 733.
5. Cass AS, Luxenberg M, Gleich P, Smith CS. Clinical indications for radiographic evaluation of blunt renal trauma. *J Urol.* 1986;136(2):370-371.
6. Moore EE, Shackford SR, Pachter HL, et al. Organ injury scaling: spleen, liver, and kidney. *J Trauma.* 1989;29(12):1664-1666.
7. Carroll PR, McAninch JW, Klosterman P, Greenblatt M. Renovascular trauma: risk assessment, surgical management, and outcome. *J Trauma.* 1990;30(5):547-552; discussion 553-544.
8. Nicolaisen GS, McAninch JW, Marshall GA, Bluth RF, Jr., Carroll PR. Renal trauma: re-evaluation of the indications for radiographic assessment. *J Urol.* 1985;133(2):183-187.
9. Herschorn S, Radomski SB, Shoskes DA, Mahoney J, Hirshberg E, Klotz L. Evaluation and treatment of blunt renal trauma. *J Urol.* 1991;146(2):274-276; discussion 276-277.
10. McAndrew JD, Corriere JN, Jr. Radiographic evaluation of renal trauma: evaluation of 1103 consecutive patients. *Br J Urol.* 1994;73(4):352-354.
11. Mee SL, McAninch JW, Robinson AL, Auerbach PS, Carroll PR. Radiographic assessment of renal trauma: a 10-year prospective study of patient selection. *J Urol.* 1989;141(5):1095-1098.
12. Brandes SB, McAninch JW. Urban free falls and patterns of renal injury: a 20-year experience with 396 cases. *J Trauma.* 1999;47(4):643-649; discussion 649-650.
13. Knudson MM, Harrison PB, Hoyt DB, et al. Outcome after major renovascular injuries: a Western trauma association multicenter report. *J Trauma.* 2000;49(6):1116-1122.
14. Lynch TH, Martinez-Pineiro L, Plas E, et al. EAU guidelines on urological trauma. *Eur Urol.* 2005;47(1):1-15.
15. Fang JF, Wong YC, Lin BC, Hsu YP, Chen MF. Usefulness of multidetector computed tomography for the initial assessment of blunt abdominal trauma patients. *World J Surg.* 2006;30(2):176-182.
16. Bretan PN, Jr., McAninch JW, Federle MP, Jeffrey RB, Jr. Computerized tomographic staging of renal trauma: 85 consecutive cases. *J Urol.* 1986;136(3):561-565.
17. Jansen JO, Yule SR, Loudon MA. Investigation of blunt abdominal trauma. *Bmj.* 2008;336(7650):938-942.
18. Santucci RA, Fisher MB. The literature increasingly supports expectant (conservative) management of renal trauma--a systematic review. *J Trauma.* 2005;59(2):493-503.
19. Erturk E, Sheinfeld J, DiMarco PL, Cockett AT. Renal trauma: evaluation by computerized tomography. *J Urol.* 1985;133(6):946-949.
20. Bozeman C, Carver B, Zabari G, Caldito G, Venable D. Selective operative management of major blunt renal trauma. *J Trauma.* 2004;57(2):305-309.
21. Sangthong B, Demetriades D, Martin M, et al. Management and hospital outcomes of blunt renal artery injuries: analysis of 517 patients from the National Trauma Data Bank. *J Am Coll Surg.* 2006;203(5):612-617.
22. Broghammer JA, Fisher MB, Santucci RA. Conservative management of renal trauma: a review. *Urology.* 2007;70(4):623-629.
23. Alonso RC, Nacenta SB, Martinez PD, Guerrero AS, Fuentes CG. Kidney in danger: CT findings of blunt and penetrating renal trauma. *Radiographics.* 2009;29(7):2033-2053.
24. Santucci RA, Bartley JM. Urologic trauma guidelines: a 21st century update. *Nat Rev Urol.* 2010;7(9):510-519.
25. Himmelman RG, Martin M, Gilkey S, Barrett JA. Triple-contrast CT scans in penetrating back and flank trauma. *J Trauma.* 1991;31(6):852-855.
26. Ekeh AP, Saxe J, Walusimbi M, et al. Diagnosis of blunt intestinal and mesenteric injury in the era of multidetector CT technology--are results better? *J Trauma.* 2008;65(2):354-359.
27. Sirlin CB, Brown MA, Andrade-Barreto OA, et al. Blunt abdominal trauma: clinical value of negative screening US scans. *Radiology.* 2004;230(3):661-668.
28. Sirlin CB, Brown MA, Deutsch R, et al. Screening US for blunt abdominal trauma: objective predictors of false-negative findings and missed injuries. *Radiology.* 2003;229(3):766-774.

29. Lee BC, Ormsby EL, McGahan JP, Melendres GM, Richards JR. The utility of sonography for the triage of blunt abdominal trauma patients to exploratory laparotomy. *AJR Am J Roentgenol.* 2007;188(2):415-421.
30. Hoffman L, Pierce D, Puumala S. Clinical predictors of injuries not identified by focused abdominal sonogram for trauma (FAST) examinations. *J Emerg Med.* 2009;36(3):271-279.
31. Natarajan B, Gupta PK, Cemaj S, Sorensen M, Hatzoudis GI, Forse RA. FAST scan: is it worth doing in hemodynamically stable blunt trauma patients? *Surgery.* 2010;148(4):695-700; discussion 700-691.
32. McGahan JP, Richards JR, Jones CD, Gerscovich EO. Use of ultrasonography in the patient with acute renal trauma. *J Ultrasound Med.* 1999;18(3):207-213; quiz 215-206.
33. Valentino M, Serra C, Zironi G, De Luca C, Pavlica P, Barozzi L. Blunt abdominal trauma: emergency contrast-enhanced sonography for detection of solid organ injuries. *AJR Am J Roentgenol.* 2006;186(5):1361-1367.
34. Stevenson J, Battistella FD. The 'one-shot' intravenous pyelogram: is it indicated in unstable trauma patients before celiotomy? *J Trauma.* 1994;36(6):828-833; discussion 833-824.
35. Demetriades D, Hadjizacharia P, Constantinou C, et al. Selective nonoperative management of penetrating abdominal solid organ injuries. *Ann Surg.* 2006;244(4):620-628.
36. Alsikafi NF, McAninch JW, Elliott SP, Garcia M. Nonoperative management outcomes of isolated urinary extravasation following renal lacerations due to external trauma. *J Urol.* 2006;176(6 Pt 1):2494-2497.
37. Cheng DL, Lazan D, Stone N. Conservative treatment of type III renal trauma. *J Trauma.* 1994;36(4):491-494.
38. Matthews LA, Smith EM, Spirnak JP. Nonoperative treatment of major blunt renal lacerations with urinary extravasation. *J Urol.* 1997;157(6):2056-2058.
39. Sofocleous CT, Hinrichs C, Hubbi B, et al. Angiographic findings and embolotherapy in renal arterial trauma. *Cardiovasc Intervent Radiol.* 2005;28(1):39-47.
40. Sarani B, Powell E, Taddeo J, et al. Contemporary comparison of surgical and interventional arteriography management of blunt renal injury. *J Vasc Interv Radiol.* 2011;22(5):723-728.