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*
X-ray abdomen and pelvis	4		☢☢☢
CT abdomen and pelvis with contrast	4		☢☢☢☢
US abdomen (FAST scan)	4	To look for free intraperitoneal fluid.	O
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 contrast	9	Detection of associated injuries.	☢☢☢☢
X-ray abdomen and pelvis	7	Detection of associated fractures.	☢☢☢
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
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**

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

Radiologic Procedure	Rating	Comments	RRL*
CT abdomen and pelvis with contrast	9		☢☢☢☢
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
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**

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Summary of Literature Review

No single method of imaging 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.

Most closed upper urinary tract injury occurs after wide-impact blunt abdominal trauma, usually after sudden deceleration (motor vehicle accident) or crash injury (fall from height). The incidence of penetrating injuries from either a gunshot wound or a stab wound is variable but may be associated with more severe renal injuries [1,2]. Regardless of the mechanism, the majority of serious renal injuries are associated with injuries to other organs that may dominate the clinical picture [3]. Isolated renal injuries after blunt trauma are rare, and the majority is relatively minor in most published series. In a series from Cass et al [4] 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 according to the American Association for the Surgery of Trauma organ injury severity scale [5].

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. The amount of hematuria that should trigger radiologic investigation of the urinary tract after localized blunt trauma is controversial.

Nicolaisen et al [6] 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 [7-9]. It can therefore be concluded that investigation of hematuria is warranted in patients with suspected isolated renal injury who 1) have penetrating injury, 2) have gross hematuria, 3) have microscopic hematuria with shock (systolic pressure less then 90 mm Hg in the field or during resuscitation), or 4) are suspected of having major associated intra-abdominal injury.

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 [10]. In another study of patients with renovascular injuries, Knudson et al [11] reported that hematuria was absent in 18% of cases.

Computed Tomography

It is now well established that computed tomography (CT) of the abdomen is the screening study of choice for suspected intra-abdominal injury. Multidetector CT (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 [12]. When available, CT is the examination of choice to evaluate the hemodynamically stable patient with blunt or penetrating trauma to the abdomen [13]. Many trauma surgeons still regard diagnostic peritoneal lavage (DPL) as a viable method for

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detecting intraperitoneal hemorrhage [14]. DPL is sensitive, easy to perform, and universally available; however, it does not differentiate inconsequential bleeding from that which requires laparotomy and, more importantly, cannot detect the site of the bleeding or retroperitoneal injuries [15]. It is now considered an adjunct diagnostic method, particularly if intestinal and mesenteric injuries are suspected [16] or if CT or ultrasound (US) is not available [13]. CT is much more specific than DPL for both intraperitoneal and retroperitoneal injuries [17,18].

CT is now playing a major role in guiding management of patients with renal trauma. 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 accurate preoperative CT, renal exploration need not be performed unless there are major devitalized fragments with associated bowel or pancreatic injury or unless the patient becomes hemodynamically unstable from a major renal laceration and is not manageable by angiographic embolization.

Ultrasound

Because CT is expensive, not universally available on an immediate basis, and exposes many young patients to ionizing radiation, focused abdominal sonography for trauma (FAST) has been touted by some as an alternative to CT. This method, originally pioneered in Europe, has now been advocated by many in the United States. One potential limitation of FAST is that it requires the presence of a qualified sonographer and/or physician to perform and interpret the study. A sensitivity of 98% for detecting free fluid with a specificity of 99% has been reported for ultrasound (US) [23]; this same study reported 100% sensitivity and specificity and a positive predictive value for US in detecting renal injuries. The series, however, included only three patients with renal injuries.

The value of FAST in screening abdominal trauma patients has been recently confirmed by several large studies. Sirlin et al [24,25] 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 [26]. 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 [27].

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 [28] 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 [29]. 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). The value of these limited "one-shot" studies in unstable patients has been questioned [30]; 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 [1]. 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 [31]. CT thus becomes critically important for precise delineation of the nature and extent of injuries [32]. The management of patients with penetrating renal injuries remains more controversial, although even in these cases there is a developing trend towards conservative management [33]. This paradigm shift can be in large part attributed to the accurate staging of such injuries that is provided by CT [34,35].

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 [36].

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 [2,37]. 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; those with microscopic hematuria alone do not need any radiologic evaluation.

Anticipated Exceptions

In pregnant patients, US should be considered as a first-line study.

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 NS (not specified).

Supporting Document(s)

- ACR Appropriateness Criteria® Overview
- Procedure Information
- Evidence Table

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