American College of Radiology
ACR Appropriateness Criteria®

Clinical Condition: **Hematuria**

Variant 1: **All patients except those with generalized renal parenchymal disease or young females with hemorrhagic cystitis.**

Radiologic Procedure	Rating	Comments	RRL*
X-ray intravenous urography	8		Low
CT urography	8		Med
US kidneys and bladder	6	May miss ureteral and urothelial lesions; abdomen x-ray, retrograde pyelography, and cystoscopy are useful adjuncts.	None
X-ray retrograde urography	5		Med
MRI urography	4		None
CT abdomen and pelvis	4	CT may follow IVP or US if initial findings are ambiguous.	High
INV angiography kidney	4	Rarely, vascular malformations may cause hematuria and require angiography for diagnosis.	IP
CT virtual cystoscopy	2		High
X-ray abdomen	2	It is assumed that an abdomen film will be part of the indicated IVP. If an IVP is not performed, KUB may be performed along with US.	Low
NUC scintigraphy urinary tract	2		Med
MRI abdomen and pelvis	2		None
Rating Scale: 1=Least appropriate, 9=Most appropriate			*Relative Radiation Level

Clinical Condition: **Hematuria**

Variant 2: **Due to generalized renal parenchymal disease.**

Radiologic Procedure	Rating	Comments	RRL*
US kidneys and bladder	8	For renal volume and morphology and as localizer for biopsy.	None
X-ray chest	6	For cardiopulmonary and pleural manifestations of renal diseases.	Min
X-ray retrograde urography	3		Med
INV angiography kidney	2		IP
CT virtual cystoscopy	2		High
CT urography	2		Med
NUC scintigraphy urinary tract	2		Med
MRI urography	2		None
MRI abdomen and pelvis	2		None
CT abdomen and pelvis	2	Routine.	High
X-ray abdomen	1		Low
X-ray intravenous urography	1		Low
Rating Scale: 1=Least appropriate, 9=Most appropriate			*Relative Radiation Level

Variant 3: **Hemorrhagic cystitis in females less than 40 years old (hematuria completely clears with therapy).**

Radiologic Procedure	Rating	Comments	RRL*
MRI abdomen and pelvis	2		None
INV angiography kidney	2		IP
CT virtual cystoscopy	2		High
MRI urography	2		None
NUC scintigraphy urinary tract	2		Med
CT urography	2		Med
X-ray retrograde urography	2		Med
CT abdomen and pelvis	2	This and other imaging are rarely needed for diagnosis. Routine.	High
X-ray abdomen	1		Low
US kidneys and bladder	1		None
X-ray intravenous urography	1		Low
Rating Scale: 1=Least appropriate, 9=Most appropriate			*Relative Radiation Level

HEMATURIA

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Summary of Literature Review

Hematuria is one of the most common presentations of patients with urinary tract diseases and of patients referred for urinary imaging. This review summarizes practice for the radiologic approach to such patients. It is limited to adults and does not refer to patients, whose hematuria coexists with other clinical situations reviewed in other ACR Appropriateness Criteria® topics, including acute trauma, infection, renal failure, symptoms of acute stone disease, known renal masses, and prostatism. It is also limited to initial tests; follow-up of normal or abnormal first tests is beyond its scope.

The initial decision to be made is whether all patients with any degree of hematuria need imaging evaluation. Patients whose urinary tracts have no detectable abnormalities normally release small amounts of blood into the urine, so that several red cells per high-power field may be seen upon microscopic examination of the spun sediment. This fact, together with the low prevalence of clinically detectable disease in some groups of patients with asymptomatic microscopic hematuria, has led some investigators to suggest that minimal microhematuria in an asymptomatic young adult needs no evaluation [1].

Unfortunately, no threshold number of red blood cells per high-power field has been found that separates patients with clinically important disease from those with no detectable urinary tract abnormalities. The distinction between gross and microscopic hematuria is not a useful guideline to distinguish between patients who need evaluation and those who do not, and the ranges of red cells per high-power field in patients with "normal" hematuria and those in whom microhematuria indicates important or even life-threatening disease have sufficient overlap that many authorities claim that any amount of hematuria, no matter how slight, should be considered an indication of urinary tract malignancy until proven otherwise [2,3], and that all cases of hematuria therefore need complete work-up.

There may, however, be specific circumstances in which complete radiologic work-up is not necessary [4]. Young women with a clinical picture of simple cystitis and whose hematuria completely and permanently resolves after successful therapy, can probably be spared any imaging [5-7]. Patients who have clear-cut evidence of glomerulopathy also constitute a special group; although they should probably have chest radiography [8] to search for any of the numerous manifestations of glomerulonephritis (including cardiac enlargement, pleural and pericardial effusions, pulmonary congestion and edema, and pulmonary bleeding) and ultrasound (US) (to display the site and number of kidneys prior to biopsy and to screen for renal morphologic abnormalities that may coexist by chance in a patient with glomerulonephritis), they probably do not need extensive work-up to exclude a surgical lesion that may be bleeding [7,9-11]. However, the decision to pursue this course requires firm demonstration that the glomerular abnormality is responsible for the bleeding; such evidence includes heavy proteinuria (sufficient to indicate that plasma proteins, rather than proteins in red cells, account for the protein in the urine), red cell casts, or (in institutions that have reliable traditions of identifying such abnormalities) evidence of severe red cell dysmorphism. Patients on anticoagulants have a sufficiently high prevalence of important disease that work-up cannot be forgone [12].

All other adult patients—especially those specifically referred for evaluation of hematuria—require imaging evaluation [6,7,13]. This evaluation will almost always be accompanied by cystoscopy, since many bleeding urinary tract lesions arise in the lower tract and no imaging procedure is highly sensitive in diagnosing most of them. It goes without saying that a complete history, physical examination, urine analysis, and appropriate serologic tests should precede or accompany the imaging examinations. At the time of cystoscopy, bilateral retrograde pyelography is often employed to evaluate the upper tracts for pathology [4].

There is not universal agreement about the first imaging examination to choose. Traditionally, excretory urography (IVP) was standard [4,6], but the establishment of this practice preceded the development of high-quality

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US [14], computed tomography (CT), and magnetic resonance imaging (MRI). Subsequently, real-time US was investigated and found to be useful in the search for bleeding urinary tract lesions. Very recently, a combination of urinary tract CT with various ways of obtaining IVP-like images of the collecting systems, ureters, and bladder has been proposed, as have similar formats of MRI examinations (CT urography and MR urography). (Urinary tract scintigraphy [15] possesses insufficient spatial resolution to screen for any but large intrarenal or obstructing lesions.)

There is some literature dealing with the choice between US and excretory urography as the initial imaging study for patients with hematuria [14,16,17]. With respect to the wide range of abnormalities [3,17,19] that may be encountered in such patients (including urinary tract neoplasms of all sorts, stone disease, inflammatory processes, congenital abnormalities, vascular lesions, and obstruction from a wide variety of lesions), both exams are felt to have moderately high sensitivity. Precise comparisons of the two are lacking for several reasons: false-negative rates have not been evaluated in large numbers of patients due to the cost and invasiveness of the follow-up procedures that would be necessary; sensitivities need to be individually evaluated for each of the many kinds of lesions, so that a careful comparative study would require thousands of patients for appropriate statistical power; and there has been little careful definition of the patient groups in whom the two modalities have been compared. Nevertheless, it appears that there are only slight differences between the two modalities with regard to the rate of diagnosing clinically important lesions [20].

US and urography tend to miss different sorts of lesions. US is not likely to detect nonobstructing ureteral stones or small urothelial abnormalities, and urography with nephrotomography may miss small exophytic anterior and posterior renal masses and small bladder lesions [21,22]. The choice of exam may be affected by clinical circumstances (a positive urinary cytologic analysis may make urography crucial, whereas serious risk factors for contrast reactions may make US more appropriate). When US is negative and the source of hematuria remains obscure, urography should be added; if urography is negative, CT (or US) may be ordered [6,22,23]. When US is used as the primary screening modality, the yield from imaging may be increased by adding a plain film of the abdomen.

CT of the entire urinary tract can be augmented by images of the contrast-opacified collecting systems, ureters and bladder (24); the combined exam is known as CT urography. The IVP-like portions of the exam may be obtained by exposing film (or direct digital) images when contrast administered for the CT has opacified the hollow urinary organs. Images may alternatively be produced by reformatting delayed CT images to show this anatomy. Presumably, the pyelogram portion of this exam could be comparable to a standard IVP exam, and the CT should be more sensitive and specific (both statistically and pathologically) than US or nephrotomography with regard to focal renal parenchymal abnormalities. For these reasons, a distinction should be made between routine CT of the abdomen and pelvis that may not be optimized for the urinary tract and a dedicated CT urogram that is tailored to evaluate the urinary tract for sources of hematuria. The latter study typically employs oral water instead of oral positive contrast media. A noncontrast CT of the kidneys is obtained to evaluate renal calculi. This is followed by the injection of iodinated contrast media with the acquisition of a high-resolution (1-2 mm thick sections) nephrographic phase and high-resolution delayed (5-10 minutes) phase. The latter can be reconstructed to evaluate the urinary tract and bladder. Some investigators employ a hybrid of CT urography and IVP-like delayed images to form one complete study, which is also known as CT urography. CT urography, taken as a group, has shown equal or superior sensitivity to IVP for causes of hematuria [25,26].

MR urography currently serves as an alternative imaging technique for children and pregnant women and for patients with a contraindication to iodinated contrast media [27]. It has the potential to be useful in the search for important abnormalities that cause hematuria. Initial work demonstrating the feasibility of its performance has been published. But the examination has not been adopted in clinical practice, is expensive, and has not been evaluated for efficacy, so it cannot be recommended as an initial examination.

Several authors have suggested that virtual cystoscopy, the acquisition of high-resolution CT images reconstructed to allow virtual “fly-throughs” of bladder, be used to evaluate the bladder for causes of hematuria [28]. Virtual cystoscopy is inaccurate for small lesions and lesions located near the ureteric orifices. The urethra cannot be evaluated. Thus, while promising, virtual cystoscopy cannot replace actual cystoscopy.

In summary, most adults with hematuria of any degree require urinary tract imaging. Glomerulopathies may be appropriately investigated with renal US and chest radiography; most other patients require urography, CT urography, or US and a few carefully chosen patients may need no imaging at all.

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