College of Health and Medical Technologies
Department of Radiology Technologies
Computed Tomography

CT urinary tract

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LECTUER 12

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Position of urinary tract (CT) scan

CT urinary tract

A CT of urinary tract (CT urogram) is used to examine the kidneys, ureters and bladder (CT KUB). It is a quick non-invasive technique lets to know the size and shape of these structures to determine if they're working properly and to look for any signs of disease that may affect urinary system.

The doctor may recommend a CT urogram if the patient have signs and symptoms such as pain in his side or back or blood in urine (hematuria) that may be related to a urinary tract disorder.

Indications

- Kidney stones.
- Bladder stones.
- Complicated infections.
- Tumors or cysts.
- Cancer.
- Structural problems.
- signs of infection include high urine attenuation and contrast layering in the dilated collecting system, thickening and hyper enhancement of renal pelvis wall, perinephric inflammatory lesions, and renal cortical thinning.

Kidneys

- Size 12 x 6 x3 cm
- CT density 30-50HU
- Cortex and medulla are not differentiated without contrast
- Anatomic location from xiphoid to umbilicus

Patient Preparation:

- Oral (e.g., water, tea) or intravenous (e.g., saline solution) hydration to physiologic hydration state (not in acute trauma patients and acute renal or ureteral colic).
- Appropriate pain medication in malignancy, trauma, and calculus disease.
- Serum creatine and thyroid parameters checked and appropriately treated prior to IV contrast administration.
- Antecubital intravenous line suitable for power injector pump at 2-3 mL/s.

Patient Positioning: Supine, head first, arms above head.

Tomogram, Scan Range:

-Kidneys and adrenals only: diaphragm to iliac crest; caveat: pelvic kidney.

-Entire upper urinary tract: diaphragm to symphysis pubis.

Multiphase CT of the Kidney:

1) **The initial non-enhanced (native scan) is indicated for**:

a. Diagnosis of nephrolithiasis.

b. Diagnosis of hemorrhage.

c. Diagnosis of angiomyolipoma's.

d. As baseline for confirmation of subsequent enhancement.

2) **Early arterial (arteriographic phase):** typically acquired after a scan delay of 20 seconds.

This phase is indicated for CT arteriogram to show arterial anatomy.

3) Late arterial (cortico-medullary) phase: typically acquired after a scan delay of 45 seconds. In this phase the renal cortex is well enhanced, while the medulla is poorly enhanced. This phase is indicated for:

a. Detection of hyper vascular tumors such as renal cell carcinomas.

b. Evaluation of the normal renal veins (because the renal veins become opacified almost as rapidly as the blood flows into the glomeruli of the renal cortex.

4) Nephrographic phase: typically acquired after a scan delay of 90-200 seconds. The renal cortex & medulla exhibit a similar degree of contrast enhancement. This phase is indicated for:

a. Detection of parenchymal masses.

b. Evaluation of venous thrombosis.

5) Excretory phase: The scan delay for optimal opacification of the collecting system is variable & may range from 3-15 minutes (more than 200 seconds). This phase is useful for evaluation of the collecting system. This phase is indicated for:

a. Detection of urothelial lesions.

b. Detection of filling defects in the renal collection system.

CT IN FLANK PAIN & UROLITHIASIS:

CT is the best investigation for the depiction of calculi causing acute loin pain. Calculi that are 'lucent' on plain radiography are readily detected, and secondary signs of obstruction such as hydronephrosis, hydroureter, nephromegaly, and perirenal and peri ureter streaking are also apparent.

Non-enhanced CT is now preferred over IVU in patients with flank pain because:

1. Non-enhanced CT is much more sensitive for renal & ureteral stones than IVU.
2. Non-enhanced CT is not associated with the risk of contrast medium reaction & nephrotoxicity.
3. Non-enhanced CT is useful for identifying causes of flank pain other than nephrolithiasis such as aortic aneurysm, perirenal abscess & bony fractures.

The visualization of stones by CT is affected by several factors including:

1.stone composition: generally, calcified stones are more visible than non calcified stones such as uric acid stones, struvite stones, & cysteine stones.

2.CT technique: the use of higher KV settings (120 or 140kv), higher tube current (mA), & thinner slice thickness allows visualization of smaller stones than low KV & low mA settings.

In patients with acute upper urinary tract obstruction, if bolus contrast enhanced CT is performed, the following CT signs are seen:

1.The early cortical–medullary phase (which is normally transient) will be prolonged, occasionally for several hours.

2.Eventually, contrast medium opacifies the medullary pyramids, causing a homogeneously dense nephrogram.

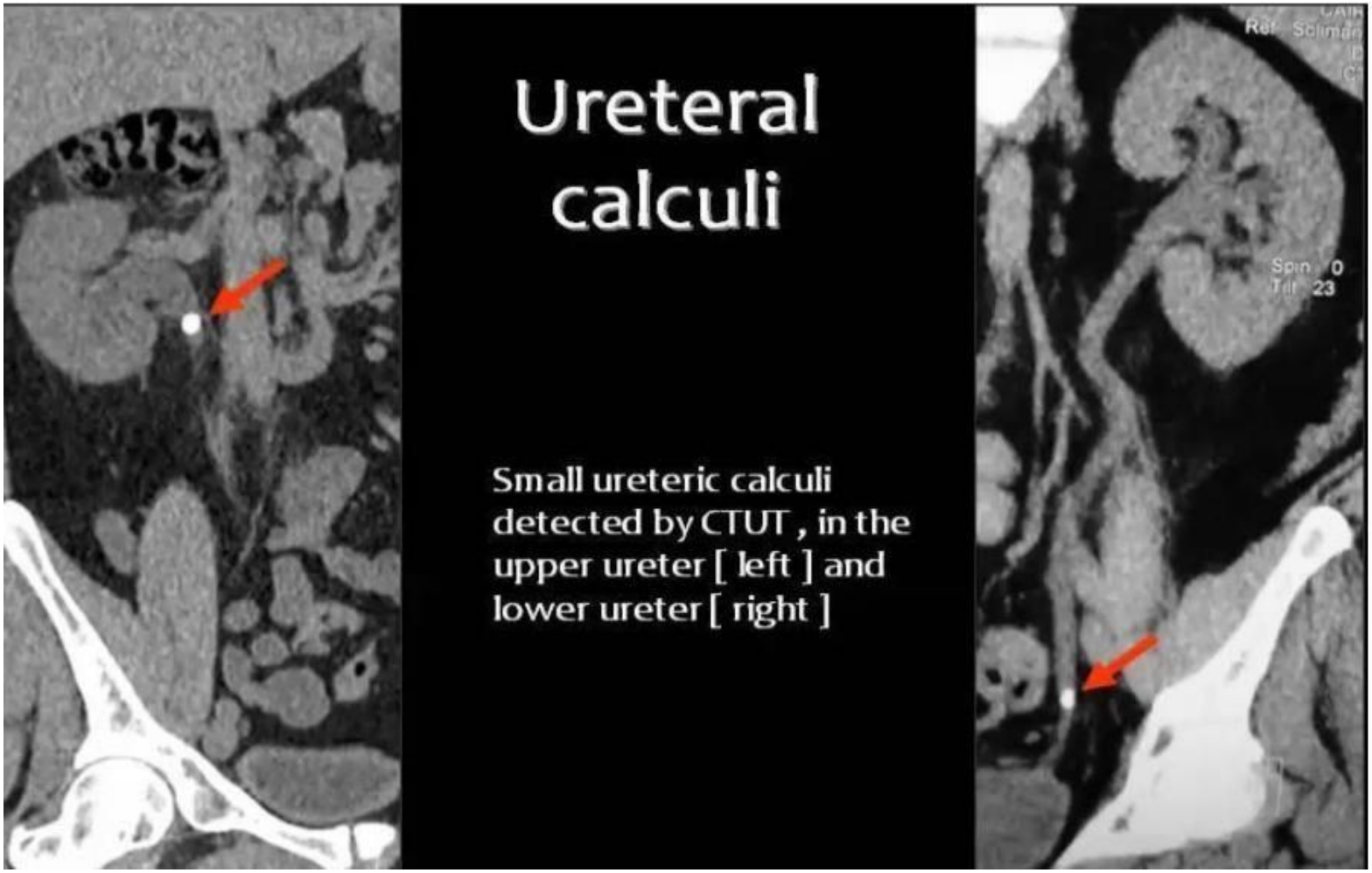
3.If obstruction is unrelieved for several days, the medullary pyramids may actually become more densely opacified than the cortex, creating the "reverse cortical medullary nephrogram" sign.

In patients with chronic upper urinary tract obstruction, the following CT signs are seen:

1.Moderate and severe hydronephrosis are readily demonstrated by unenhanced CT.

2.Post-obstructive atrophy is diagnosed by CT when hydronephrosis accompanied by parenchymal thinning.

3.On contrast-enhanced images, the thin parenchyma will appear like a shell or rim "rim nephrogram" sign.


Ureteral calculi
Small ureteric calculi detected by CTUT , in the upper ureter [left] and lower ureter [right]

CT urography -CTU

A full CT urography usually involves the acquisition of an unenhanced CT to demonstrate calcification and separate phases after injection of contrast medium to demonstrate the renal parenchyma and the pelvis-calyceal systems and ureters. Images obtained in the prone position, and the use of supplemental saline infusion and diuretic medication, may achieve improved visualization of the distal ureters.

*CT urography has a high sensitivity and specificity for urothelial abnormalities. It is indicated for:

1) Evaluation of patients with hematuria.
Evaluation of the collecting system is traditionally done by IVU.
-The advantage of IVU in these patients is that the radiation dose of several abdomino-pelvic films is lower than that of CT, thus multiple images of the collecting system may be obtained allowing a higher likelihood of imaging all segments of the ureters in an opacified state.

However, the renal parenchyma is poorly evaluated by conventional IVU.

Some centers now use CT urography (CTU) & abandoned the IVU particularly in patients with macroscopic hematuria, as CT has high sensitivity for detection of:
a. small renal cell carcinoma,
b. urinary tract stones
c. transitional cell carcinoma.

2) CTU may also be useful for the detection of ureteric leaks or fistulae.
*The limitations of CTU include suboptimal opacification of the ureters.
*The major disadvantage of CT urography is the radiation dose, which is up to five times higher than that of IVU.

Computed Tomography in Renal Masses:

CT is the most useful technique for investigating and characterizing solid renal masses. This is because;

1. It can accurately assess ‘pseudotumor’ and other normal variants.
2. CT can provide attenuation values that can confirm the presence of fluid in cysts or fat in angiomyolipoma's.
3. As CT scan delineate accurately the perinephric space and the retroperitoneum, it is useful in the diagnosis of complicated renal sepsis and the assessment of the extent of hemorrhage.
4. CT can identify tumor recurrence after radical nephrectomy.

Technique of CT in renal masses:

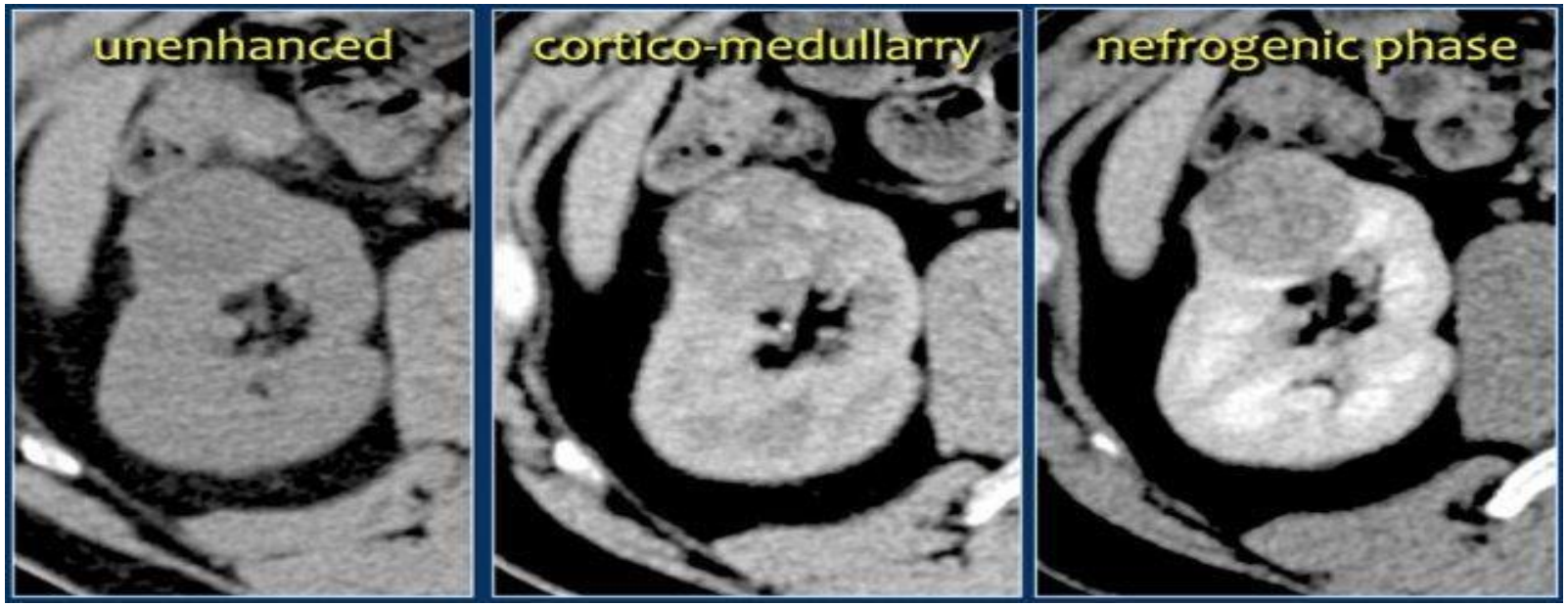
Accurate analysis of renal masses requires the use of both non-enhanced & enhanced images:

Unenhanced CT is important in identifying calcification.

Cortico-medullary phase imaging is helpful in demonstrating normal variants, pseudo-tumors, tumor vascularity and the renal veins.

The **nephrographic phase** is best for the detection of renal masses, as the medulla is optimally enhanced and small medullary lesions are visualized better.

For optimal lesion detection and characterization, images should be obtained in **both** phases; however, if only one phase is to be used, in order to minimize radiation dose, it should be the nephrographic phase.



CT scan in the evaluation of UB Tumors:

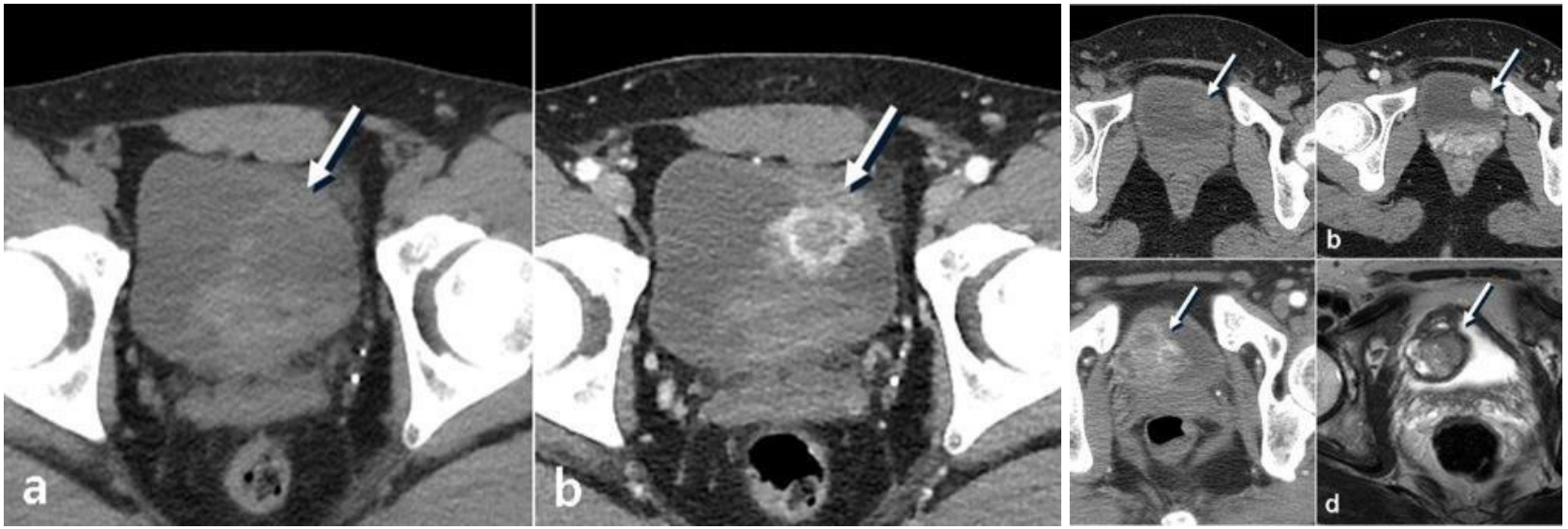
On unenhanced CT, the urine within the bladder is of water density. The bladder wall on CT appears as a rim of soft tissue, the inner margins of which are best seen if the bladder is distended with urine.

The outer margin of the bladder wall is smooth and generally well delineated by per vesical fat.

Following intravenous (IV) injection of contrast medium: arterial phase CT can differentiate between the epithelial and muscular layers of the mass.

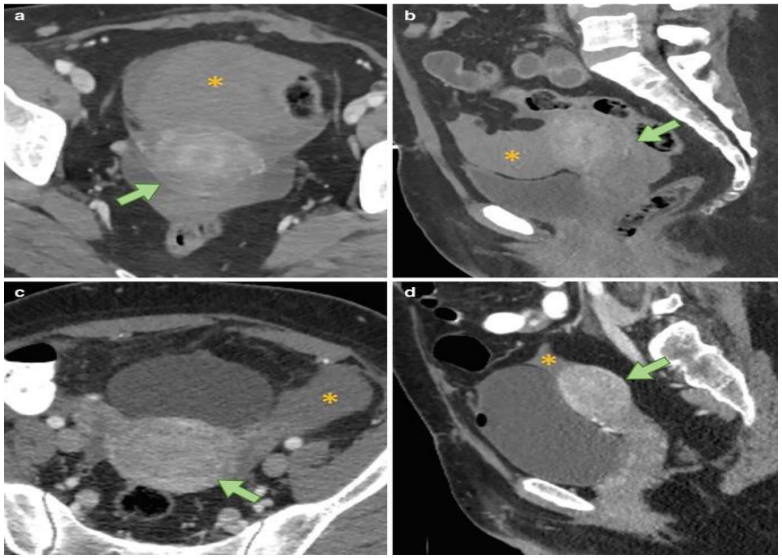
On delayed CT urine within the bladder will be opacified and, since contrast-laden urine is heavier than non-opacified urine, urine–contrast differentiation is often seen on transverse images.

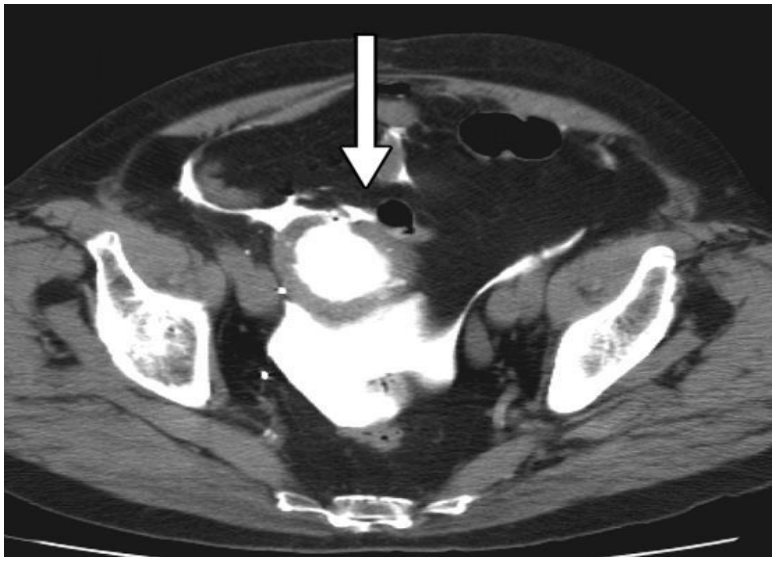
The delayed phase is helpful for the evaluation of intraluminal filling defects; however, demarcation of the bladder wall can be indistinct.



CT in Trauma of Genitourinary System:

CT has become the primary diagnostic tool for the rapid and accurate assessment of acute traumatic genitourinary injuries, as well as for the diagnosis of related complications.





CT technique for renal trauma:

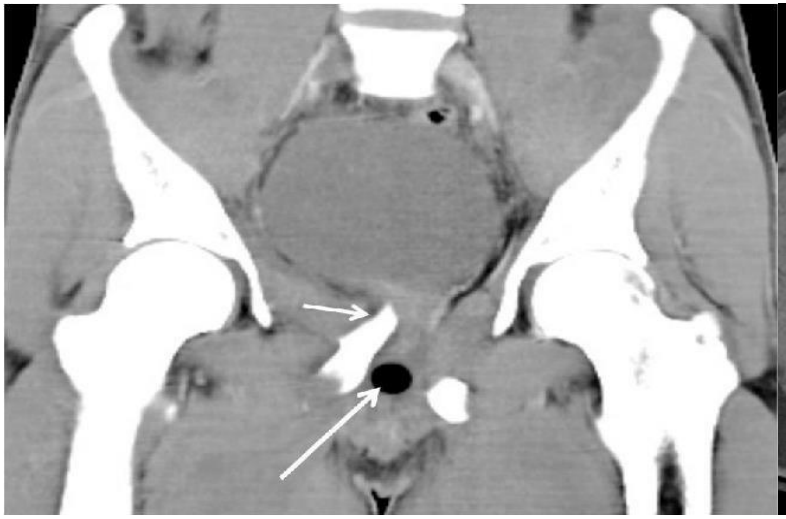
In general, the kidneys and proximal collecting systems are evaluated by non- enhanced films as part of the abdominal–pelvic CT study without special protocols.

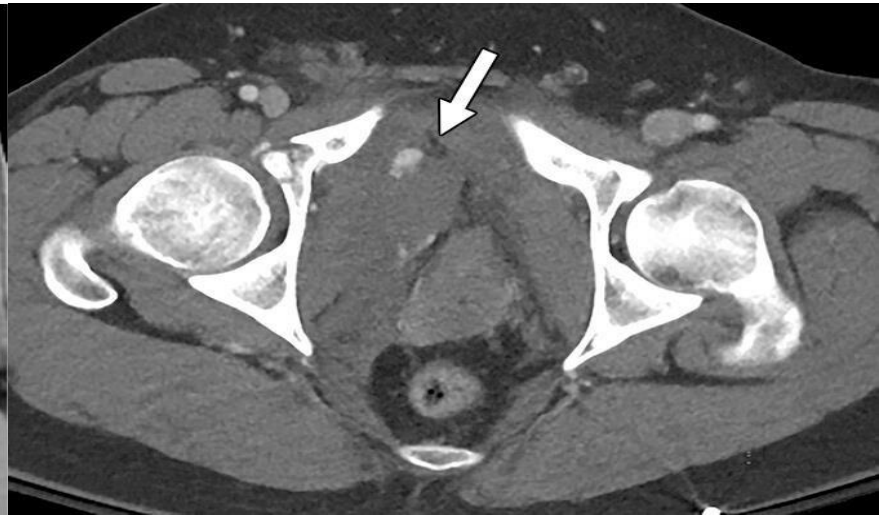
Then IV contrast is given &reprographic phase images are acquired to detect renal parenchymal injury. Then a delayed CT of the abdomen and pelvis is performed at 2–3 min after the initial examination to detect potential collecting system injury, ureteral injury and some bladder injuries.

The delayed examination is performed using one-half the exposure as the initial CT study, which in our experience provides adequate image quality to detect contrast extravasation.

In patients with pelvic injury (suspected UB injury):

In patients with pelvic fractures already undergoing a pelvic CT study, CT cystography is done. Contrast material (up to 400 ml) is infused into the U.B through a catheter. Then the pelvis is examined with a full bladder and after voiding.



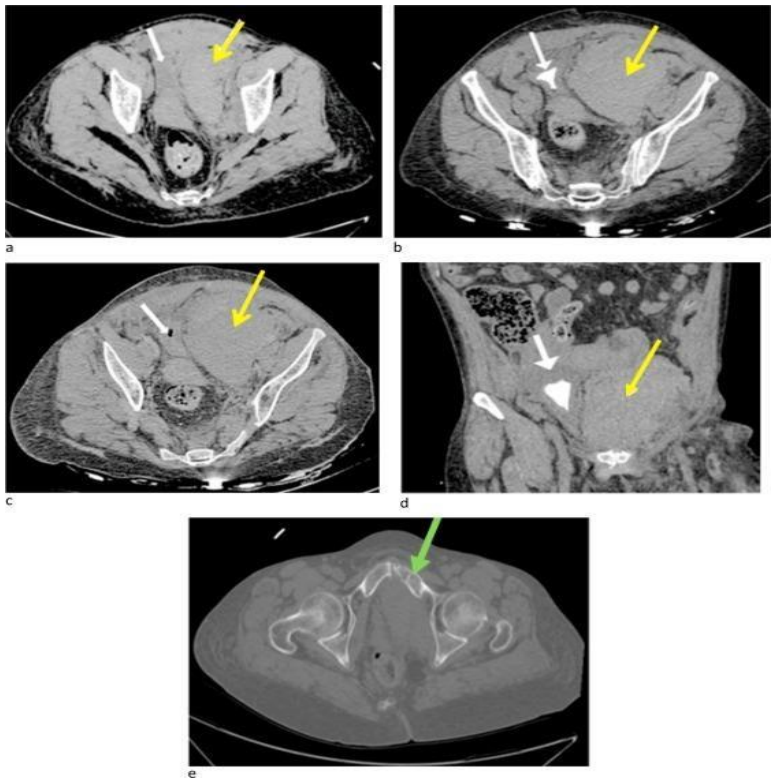


CT cystography is indicated in the following conditions:

1. When there are pelvic fractures (excluding acetabular fractures only).
2. When there is gross hematuria or free pelvic

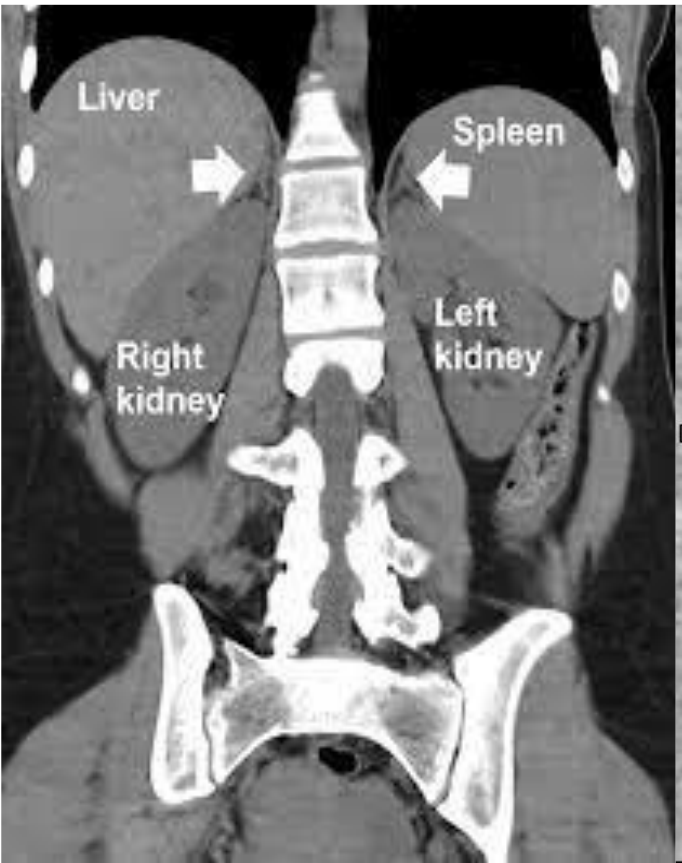
fluid, or pelvic hematoma of unknown source.

The absence of shock and microscopic hematuria is a strong negative predictor for bladder injury. While bladder injuries will frequently be seen on standard CT with intravenous contrast bolus and a clamped bladder catheter, this antegrade approach to bladder distension cannot reliably exclude bladder injury.



CT adrenals

CT of the adrenal glands is a study utilized in patients with incidentally discovered adrenal lesions on other studies, in order to characterize the lesions, and to seek adrenal abnormalities in patients with hormonal biochemical abnormalities.



Indications

-Characterize incidentally discovered adrenal nodules and seek adrenal abnormalities when clinically suspected.

To characterize adrenal nodules on the basis of the density on non contrast and post contrast imaging, and washout characteristics.

Nodules with lipid density measurements on the non contrast series can be diagnosed as lipid rich adenomas, and in nodules that are not lipid rich, washout calculations can be used to differentiate between lipid poor adenomas and indeterminate lesions, with differentials for the latter including adrenocortical carcinoma and pheochromocytoma

Technique

patient position

supine with their arms above their head

scout

diaphragm to iliac crests

scan extent

diaphragm to iliac crests

scan direction

craniocaudal

scan delay

non

contrast series: no delay

portal venous phase series:

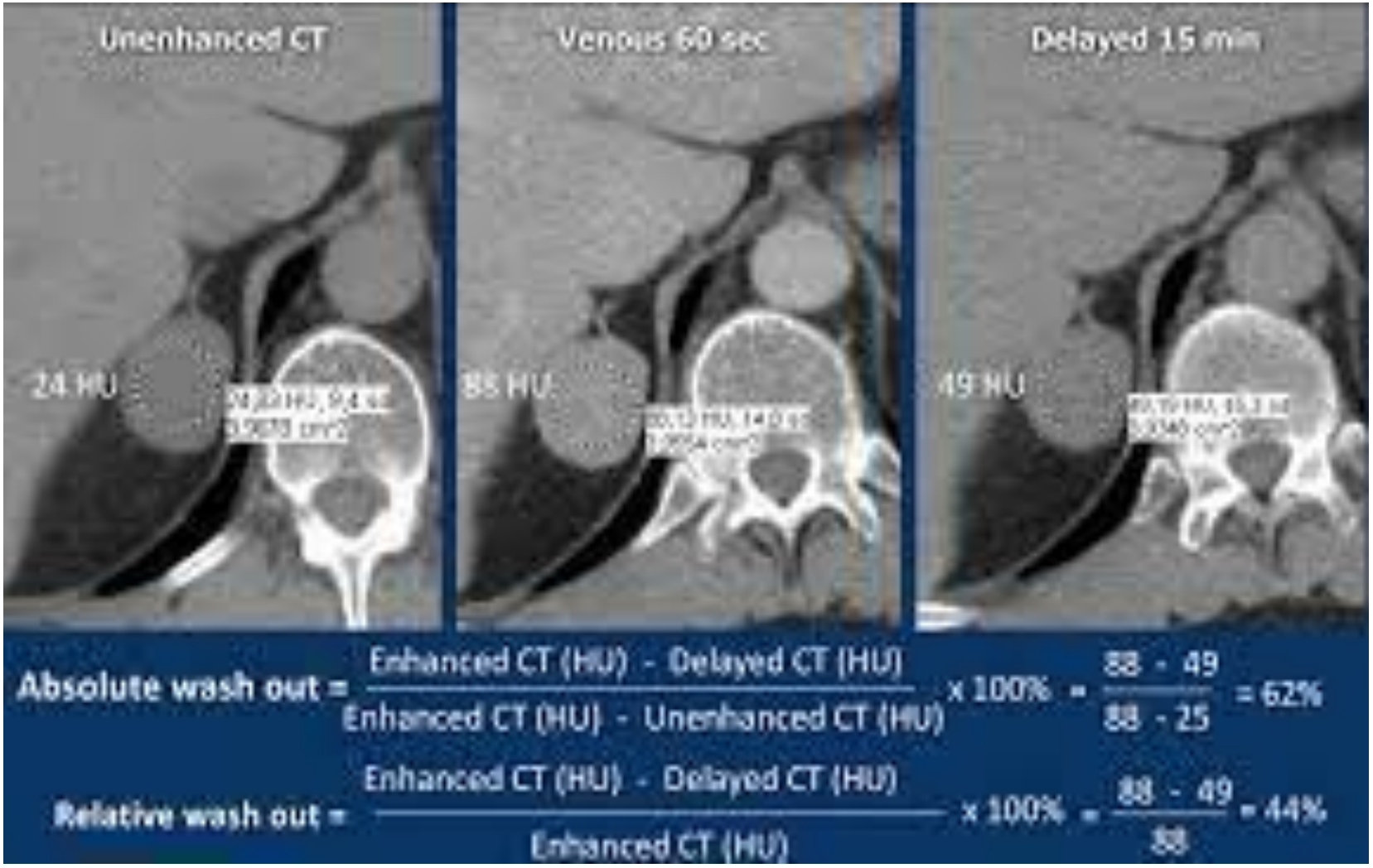
60 70 second delay

delayed phase series:

15 minute delay

respiration phase

inspiration, breath hold


Unenhanced CT
Venous 60 sec
Delayed 15 min
24 HU
88 HU
49 HU
Absolute wash out = Enhanced CT (HU) - Delayed CT (HU) / Enhanced CT (HU) - Unenhanced CT (HU) x 100% = 88 - 49 / 88 - 25 = 62%
Relative wash out = Enhanced CT (HU) - Delayed CT (HU) / Enhanced CT (HU) x 100% = 88 - 49 / 88 = 44%

THANK YOU