A grayscale X-ray image of the human torso, showing the lumbar and sacral spine, the kidneys, and the pelvic region. The image is used as a background for the text.

KUB and IVP

In the Emergency Department
investigation of Renal Colic

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SpR in Emergency Medicine

R 15

Kidneys, Ureters and Bladder (KUB)

- The historical cornerstone of any evaluation of abdominal pain that could be a stone
- First used 1896
- Sensitivity (64-80%)
- Specificity (82-90%)
- Current debate on its continued role in the ED

Reasons KUB may not visualise a stone

- small stone size
- stone radioopacity / radiolucency
- overlying gas
- overlying stool
- overlying bone.

Reasons KUB may not visualise a stone

- There may not be a stone, and the diagnosis may be incorrect!

Furthermore

- The presence of a renal or ureteric calculus is no guarantee that the patient does not have some other, unrelated medical problem

False Positives

- Many patients have numerous pelvic calcifications that make pinpointing specific stones difficult.
- Any calcific density observed on a KUB radiograph that happens to overlie the course of the ureter is not guaranteed to be a stone.

- Phlebolith (calcareous deposit in a venous wall or thrombus)
- Vascular calcification
- Calcified lymph nodes
- Appendicolith (calcified deposit within the appendix. It is present in approximately 30% of children with acute appendicitis. It may be an incidental finding)
- Faecolith (small pellet of faeces contained within an appendix or diverticulum)
- Granulomas
- Various calcified masses
- Bowel contents
- Radio-opaque carrier for osmotically controlled-release oral system (OROS)

Pros and Cons

- A KUB is cheap, quick, and usually helpful even if no specific stone is seen.
- Good at following the progress of known stones and checking stents.
- The KUB can suggest the fluoroscopic appearance of a stone, which determines whether it can be targeted with lithotripsy
- The KUB is also quite accurate at determining the exact size and shape of a stone; the CT scan 'slice' does not always cross the stone at its widest point.
- Differentiation between a phlebolith and an obstructing calcific stone becomes easier when the KUB radiograph demonstrates a lucent center, identifying the calcification as a phlebolith. This central lucency is not observed as often on CT scans.
- A number of studies have suggested that KUB has a relatively low sensitivity and specificity for stones. In some units in the US the KUB is no longer uniformly required in the modern era, as unenhanced CT scans are regarded as the gold standard. (We work in the NHS though)

Pros and Cons

- It has been suggested that Scout CT can replace the KUB in patients who will be having CT anyway
- A large clinical study in 2000 (Jackman et al) concluded KUB is more sensitive than scout CT for detecting stones. Of the stones visible on plain abdominal x-ray, 51% were not seen on scout CT -To facilitate outpatient clinic follow-up of patients with calculi, KUB should be performed.
- Many urologists, recommend that KUB be obtained in all patients with a clinical presentation of acute flank pain suggestive of renal colic. Knowing the exact size and shape of a stone, its position, fluoroscopic appearance, surgical orientation, and relative radiolucency is an advantage. Also, the progress of the stone can be easily monitored. These advantages far outweigh the few disadvantages associated with performing the examination.
- Sometimes, a KUB is used in addition to the ultrasound to help identify and monitor suspected stones, especially if renal dilation is detected. As with the KUB radiograph alone, any density detected along the expected course of the ureter is not guaranteed to be an actual stone within the collecting system.

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<http://www.bestbets.org/cgi-bin/bets.pl?record=00973>

- KUB alone was found to have sensitivity (64-80%) and specificity (82-90%)
- It is however more useful if used with US to guide the US towards areas suggestive of a stone, shortening evaluation time and improving results
- It is also useful in monitoring the progression of a calculus. Calculi not identified on US or KUB need no further examination.
- KUB is also cheaper and gives off less radiation than other modes e.g. IVU and CT, which should be reserved for patients with symptoms of severe colic.

Clinical bottom line

- KUB is sufficiently sensitive as an initial test for patients presenting with flank pain in the ED. Use alongside US improves its sensitivity for calculi and should be performed before an IVU or CT scan is offered.

Intravenous Pyelogram (IVP, Urogram)

- The Gold Standard for the detection and diagnosis of renal and ureteric calculi from 1927. (Swick)
- Only recently displaced as Gold Standard by CT.
- Serial KUBs are obtained immediately before contrast administration and at 1, 5, 10, and 15 minutes afterwards or until visible contrast material fills both ureters.
- Prone films are sometimes obtained to enhance visualization
- When the bladder is full of contrast and the distal ureters contain sufficient contrast for visualization, the patient is asked to void; then a postvoid film is taken.

Advantages of IVP

- The main advantage of the IVP is the clear outline of the entire urinary system that it provides, making visualisation of even mild hydronephrosis relatively easy.
- This effect is enhanced by the osmotic diuretic effect of the contrast medium
- When a patient has multiple pelvic calcifications, identifying the actual stone is simple with the IVP
- IVP can also show nonopaque stones as filling defects.
 - Some urologists prefer the IVP to other imaging studies in the initial evaluation of possible ureteral stones because the size, shape, and position of any calculi are usually very clear and the orientation of the studies is very familiar because it is identical to the types of radiographs performed in endoscopic stone surgeries and shockwave lithotripsy.
 - Another advantage is that IVPs demonstrate renal function and allow for verification that the opposite kidney is functioning normally. Typically, an IVP finding positive for a ureteral stone shows a delayed nephrogram effect and columnization. The ureter is peristaltic so the entire ureter is not usually visualized on a single film except when an obstruction is present, such as from a stone. Even without observing any specific stone, the presence of a nephrogram effect in one kidney with normal function of the opposite kidney is highly suggestive, but not diagnostic, of ureteral obstruction

Disadvantages of IVP

- Disadvantages include the need for intravenous contrast material, Various reactions have been attributed to these agents,
- Nausea & vomiting
- Urticaria, bronchospasm and allergic phenomena
- cardiac arrhythmias
- Seizures
- direct nephrotoxicity (especially in dehydrated or azotemic patients),
- Anaphylaxis.
 - Serious allergic reactions to intravenous contrast occur in 0.1-0.2% of patients. Nonionic contrast media is more expensive but less likely to provoke an allergic response than the older ionic media, especially if the patient has a history of mild or moderate allergic reactions to contrast or injected dye. A history of asthma or multiple drug allergies should also suggest the use of a nonionic agent. Many institutions currently use only the nonionic agent for all intravenous contrast studies, despite the added cost, because of the increased safety it provides.

Other Disadvantages of IVP

- The need for multiple delayed films can take hours
- Filming continues until the entire distal ureter is visible this may contribute to an increased radiation dose.
- Contrast-induced nephropathy is the third leading cause of hospital-acquired ARF. Raised serum creatinine is a relative contraindication
- Patients with uraemia, multiple myeloma, pregnancy, or diabetes, especially if dehydrated, are particularly susceptible
 - Metformin should be discontinued at least 1 day before any intravenous contrast study, particularly in patients with impaired renal function, because of the risk of worsening renal function and the rare development of potentially life-threatening lactic acidosis.
- Acute contrast nephropathy is defined as a 25% or greater increase in serum creatinine levels within 2-3 days of intravenous contrast exposure
- Ischaemia, direct intracellular high–contrast-concentration toxicity and free-radical injury are thought to be the causative mechanisms.

Pros and Cons of IVP

Imaging Study (Pro/Con)	Details				
IVP	<table border="1"> <tr> <td data-bbox="291 368 386 911">Pro</td> <td data-bbox="386 368 1742 911"> <ul style="list-style-type: none"> • Clear outline of complete urinary system without any gaps • Clearly shows all stones either directly or indirectly as an obstruction • Nephrogram effect film indicates obstruction and ureteral blockage in most cases, even if the stone itself might not be visible • Shows relative kidney function • Able to diagnose MSK • Ureteral kinks, strictures, and tortuousities often visible • Can modify study with extra views (eg, posterior oblique positions, prone views) to better visualize questionable areas • Stone size, shape, surgical orientation, and relative position more clearly defined • Orientation similar to urologists' surgical approach • Limited IVP study can be considered in selected cases during pregnancy, although plain ultrasound is preferred initially • Lower cost than CT scan in most institutions </td> </tr> <tr> <td data-bbox="291 911 386 1414">Con</td> <td data-bbox="386 911 1742 1414"> <ul style="list-style-type: none"> • Relatively slow; may need multiple delay films, which can take hours • Cannot be used in uraemia, pregnancy, or known significant allergy to intravenous contrast agents • Risk of potentially dangerous reactions to intravenous contrast material[‡] • Cannot detect perinephric stranding or streaking, which is visible only on CT scans • Harder to visualize radiolucent stones (eg, uric acid), although indirect signs of obstruction are apparent • Presence of a radiologist generally necessary, which can cause extra delay • Cannot be used to reliably evaluate other potential pathologies </td> </tr> </table>	Pro	<ul style="list-style-type: none"> • Clear outline of complete urinary system without any gaps • Clearly shows all stones either directly or indirectly as an obstruction • Nephrogram effect film indicates obstruction and ureteral blockage in most cases, even if the stone itself might not be visible • Shows relative kidney function • Able to diagnose MSK • Ureteral kinks, strictures, and tortuousities often visible • Can modify study with extra views (eg, posterior oblique positions, prone views) to better visualize questionable areas • Stone size, shape, surgical orientation, and relative position more clearly defined • Orientation similar to urologists' surgical approach • Limited IVP study can be considered in selected cases during pregnancy, although plain ultrasound is preferred initially • Lower cost than CT scan in most institutions 	Con	<ul style="list-style-type: none"> • Relatively slow; may need multiple delay films, which can take hours • Cannot be used in uraemia, pregnancy, or known significant allergy to intravenous contrast agents • Risk of potentially dangerous reactions to intravenous contrast material[‡] • Cannot detect perinephric stranding or streaking, which is visible only on CT scans • Harder to visualize radiolucent stones (eg, uric acid), although indirect signs of obstruction are apparent • Presence of a radiologist generally necessary, which can cause extra delay • Cannot be used to reliably evaluate other potential pathologies
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Pros and Cons of CT scan

Imaging Study (Pro/Con)		Details
CT scan	Pro	<ul style="list-style-type: none"> • Fast • No intravenous contrast necessary so no risk of nephrotoxicity or acute allergic reactions • With only rare exceptions, shows all stones clearly • May demonstrate other pathology • Can be performed in patients with significant azotemia and severe contrast allergies who cannot tolerate intravenous contrast studies • Clearly shows uric acid stones • Shows perinephric stranding or streaking not visible on IVP and can be used as an indirect or secondary sign of ureteral obstruction • No radiologist needed • Preferred imaging modality for acute renal colic in most EDs
	Con	<ul style="list-style-type: none"> • Without hydronephrosis, cannot reliably distinguish between distal ureteral stones and pelvic calcifications or phleboliths • Cannot assess renal function • Difficult or impossible to identify MSK • No nephrogram effect study to help identify obstruction • Size and shape of stone only estimated • Lacks surgical orientation* • Unable to identify ureteral kinks, strictures, or tortuosities • May be hard to differentiate an extrarenal pelvis from true hydronephrosis • Gonadal vein sometimes can be confused with the ureter • Does not indicate likelihood of fluoroscopic visualization of the stone, which is essential information in planning possible surgical interventions • Needs a KUB radiograph to be a complete study according to many experts[†] • Cannot be performed during pregnancy because of high dose of ionizing radiation exposure • More expensive than an IVP.

Bottom Line...

Best Bet Link

<http://www.bestbets.org/cgi-bin/bets.pl?record=00928>

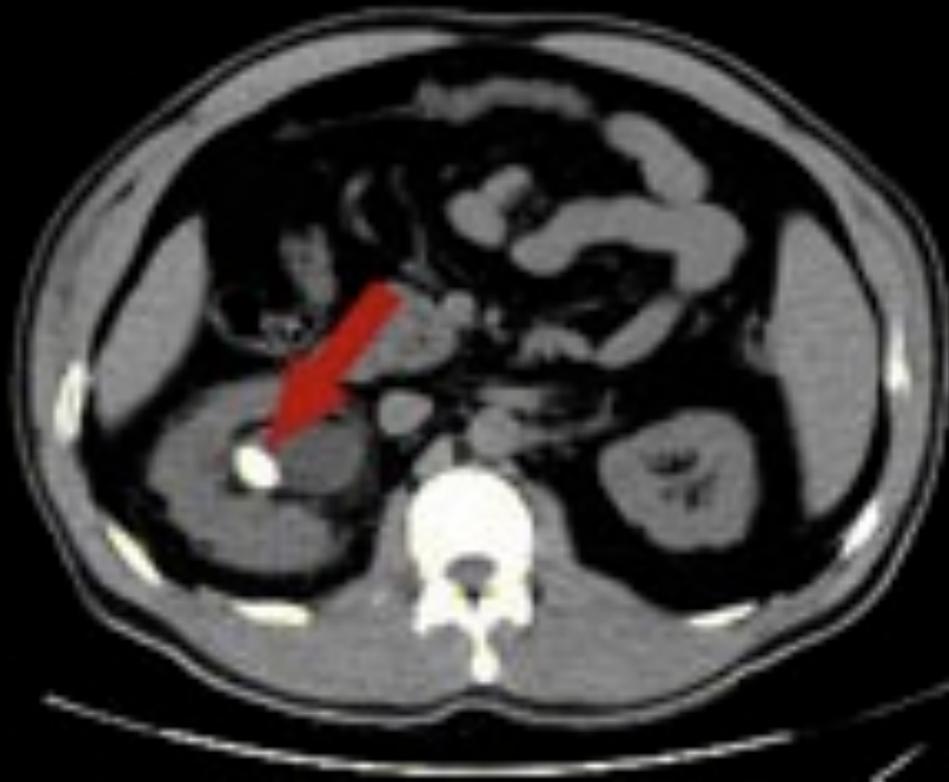
This looks at IVP vs US/S, and agrees they should probably both be used in combination

The question of CT vs IVP has not been covered by a BET.....

Resources within most NHS establishments would probably favour continued use of KUB and IVP for the time being.



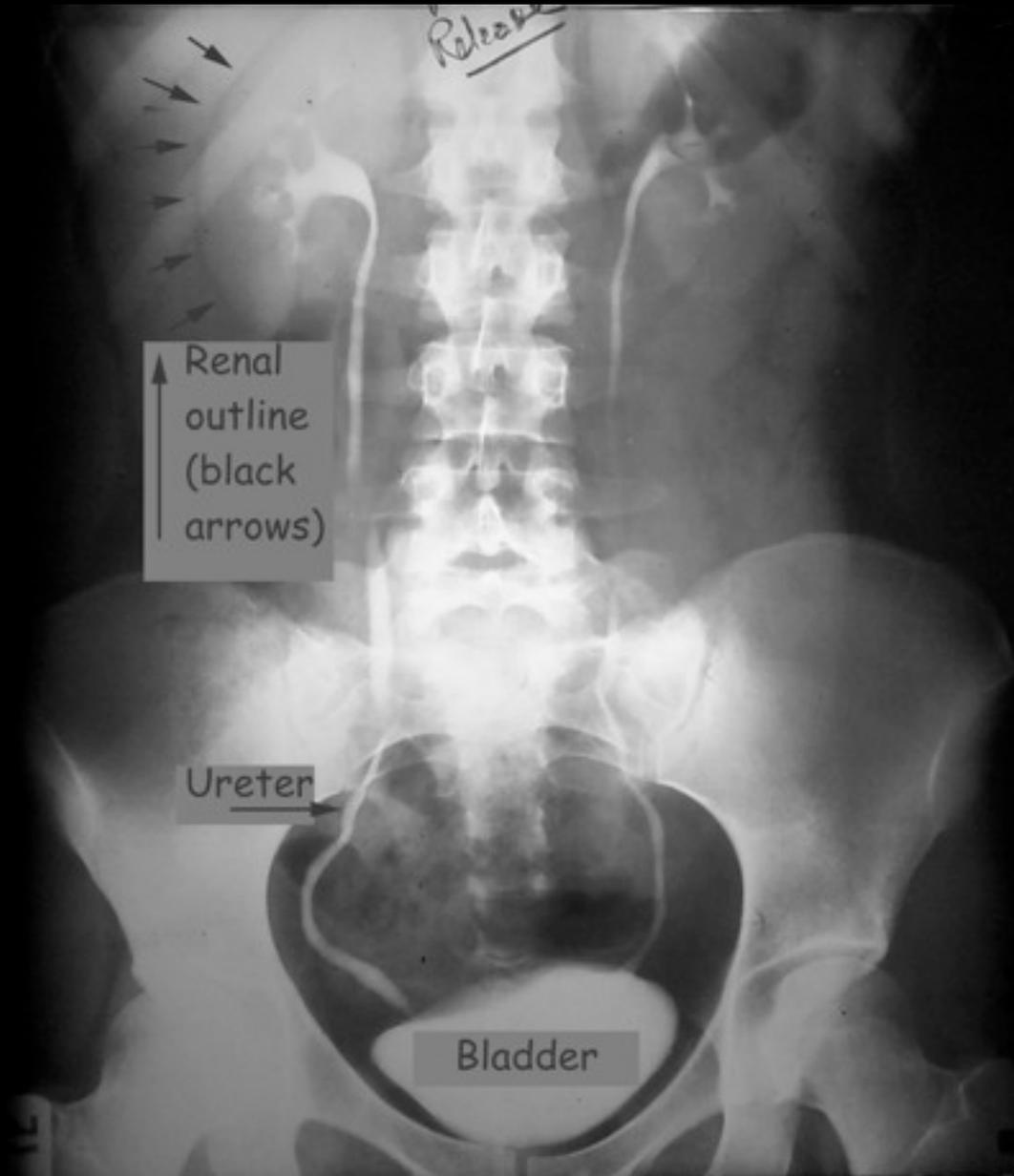
Sunday, 19 July 2009







AP view of the abdomen and pelvis. The image shows the lumbar spine, the pelvic girdle, and the upper femurs. The abdominal cavity is visible, showing the outlines of the kidneys and the bowel. There are some faint, indistinct markings in the abdominal region, possibly representing calcifications or soft tissue abnormalities. The overall image quality is somewhat grainy, typical of a standard radiograph.



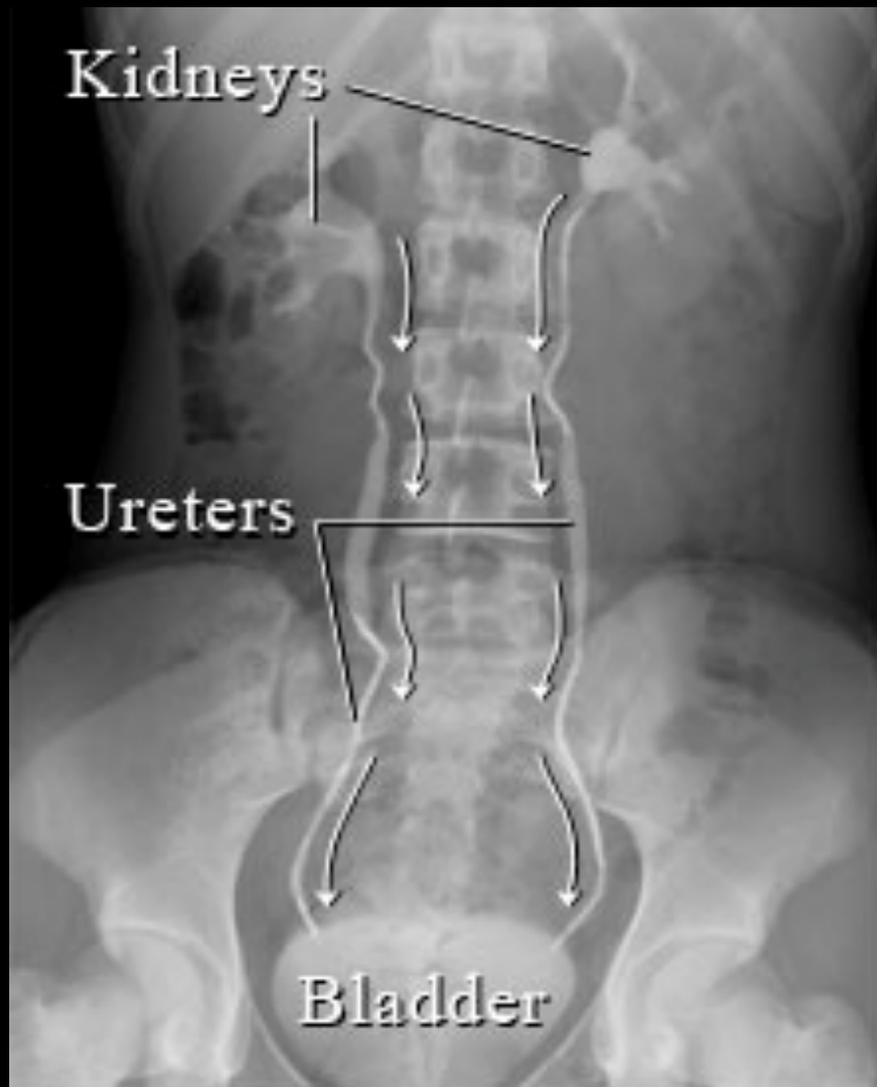


Figure 1

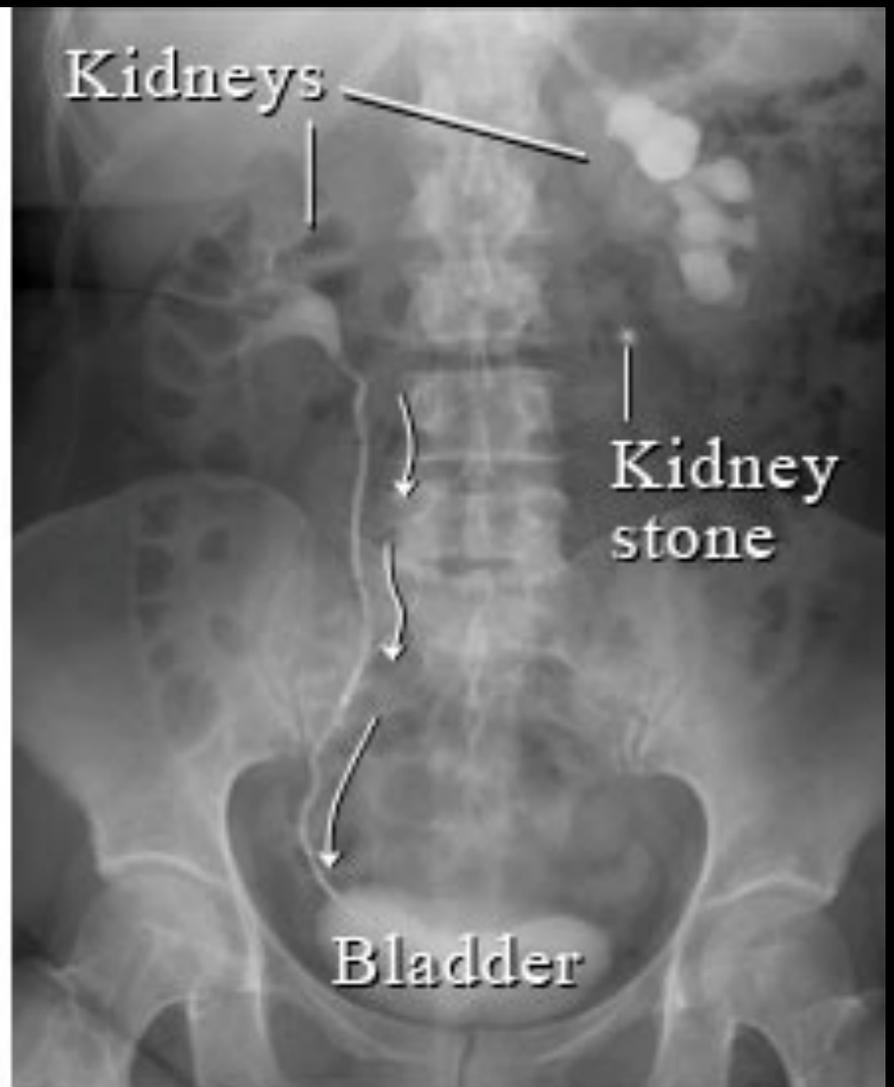


Figure 2