Calcutta Academy Of Radiology

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INSIDE THIS ISSUE

Advantages and drawbacks of artificial intelligence in Radiology

- Dr. Viral Parekh

Dear friends, colleagues, juniors & seniors; we are happy to publish 18th. Edition of CAR newsletter. There is lot of hue and cry over use of AI in Radiology. No doubt AI is going to revolutionise Radiology but it is also not without its side effects. Here is are pros and cons of AI. Artificial intelligence (AI) in radiology has many potential benefits, as well as some potential drawbacks.

Pros:

- Improved accuracy: AI-powered systems can analyse medical images more quickly and accurately than humans, which can lead to more accurate diagnoses and better patient outcomes.
- Reduced radiation exposure: AI can be used to improve image quality and reduce the need for repeat imaging, which can lead to a reduction in radiation exposure for patients.
- Increased efficiency: AI can help radiologists to work more efficiently, allowing them to analyse more images in less time, which can lead to a more efficient use of healthcare resources.
- Improved image-guided therapy: AI can be used to help physicians plan and perform medical procedures with greater accuracy and precision, which can lead to more effective treatments and better patient outcomes.
- Advancement in medical imaging research: AI can be used to analyse large amounts of data, helping researchers to identify new patterns and correlations that may lead to new treatments and therapies.

Cons:

- Dependency on technology: There is a risk that radiologists will become too reliant on AI, which could lead to a decline in the quality of diagnoses and patient outcomes.
- Job loss: Some radiologists may lose their jobs as a result of increased automation, which could lead to an over-reliance on AI and a decline in the quality of care.
- Data privacy: AI systems require large amounts of data to function effectively. This raises concerns about data privacy and security, which could lead to a breach of patient confidentiality.
- Cost: Implementing AI systems can be costly, which could be a barrier for some healthcare organizations.
- Bias: AI systems are only as good as the data they are trained on, and if the data used to train the system is biased, the system may produce biased results.

It is important to consider these factors when implementing AI in radiology and to ensure that the technology is used in a way that benefits patients and radiologists alike.

This issue would not have been without the help of Dr. Bhavin Jankharia, Dr. Rajesh Botchu , and Dr. Kanchanmani Mishra. We sincerely thank all of them.

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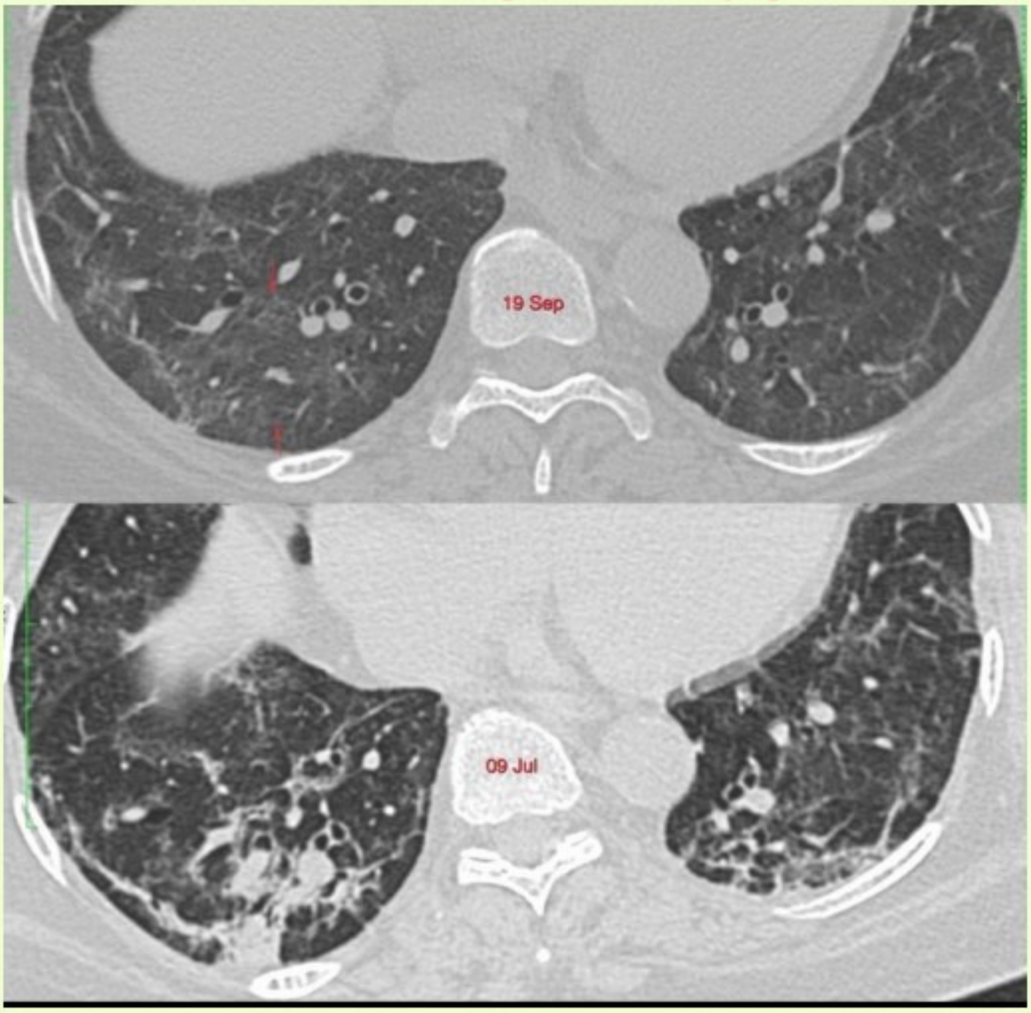
Dr. Bhavin Jankharia needs no introduction to the Radiology fraternity. As you all know he is a renowned Radiologist and academician and has contributed immensely in propagating Radiology education. Presently, he is a Consultant Radiologist at Picture This by Jankharia. He is also a Trustee of Radiology Education Foundation. He has consented to share some of his work with us, which will help all the Residents as well as practicing Radiologists. Here is some information about him in brief.

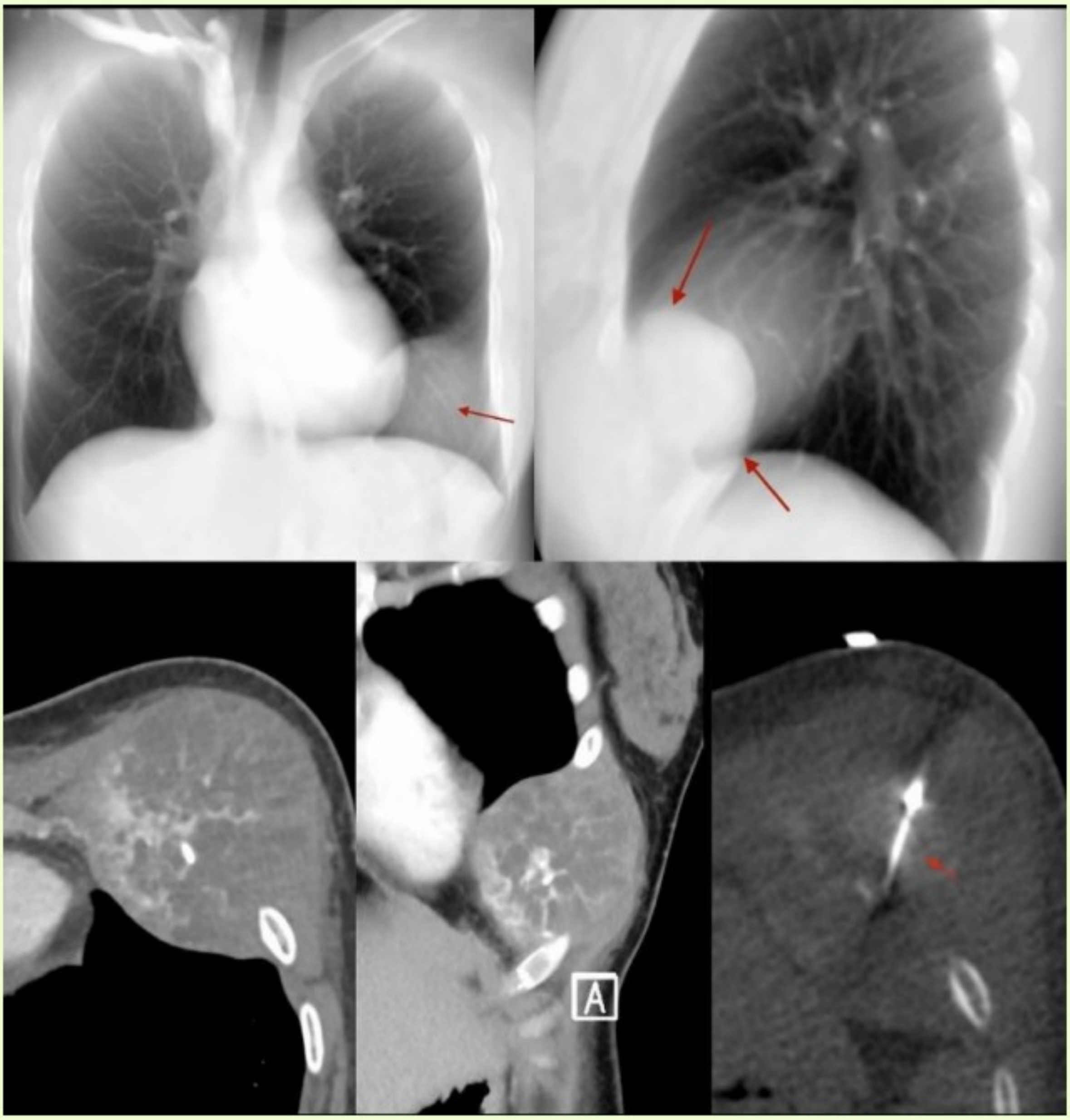
- **He has written 5 books, 35 chapters, 57 articles (PubMed listed)**
- **Presented 32 posters**
- **More than 1500 invited lectures over 27 years**
- **Editor-in-Chief, Indian Journal of Radiology & Imaging (2007-2012)**
- **Latest Book (2019): Computed Tomography of Interstitial Lung Diseases**
- **Hon. Visiting Consultant – Radiology – Tata Medical Centre, Kolkata**

Case I - Melted Sugar, Cotton Candy Sign



This 74-years old individual had a CT scan 1 month after her COViD-19 diagnosis showing consolidation and thick bands in the lower lobes. 10 weeks later, the lesions have resorbed. This appearance has been labeled the "melted sugar" appearance, though I have a feeling that this translation from Mandarin, is likely more "cotton candy", which is what the appearance looks like - wisps of residual ground glass and reticular opacities.

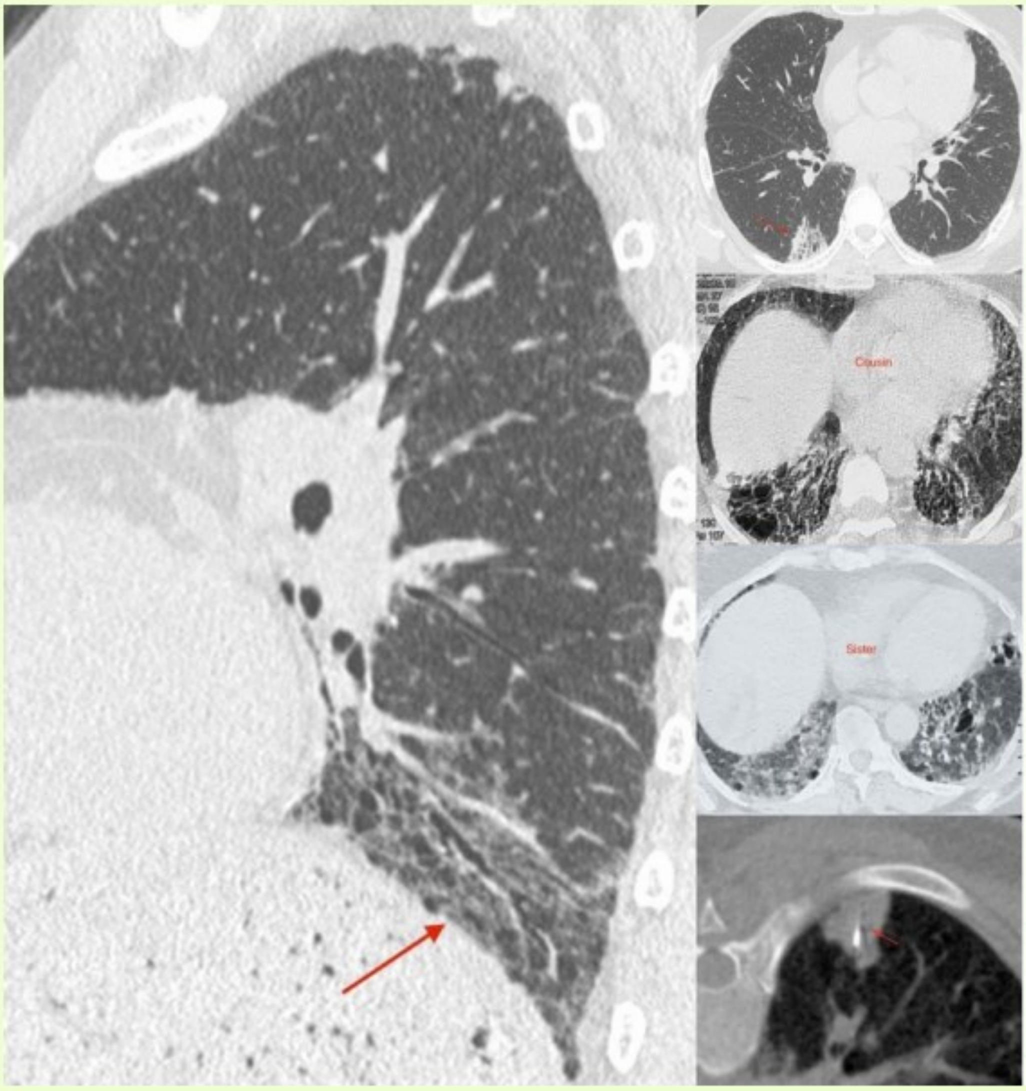
Case II - Rib osteosarcoma



This 20-years old woman presented with a slowly growing mass over the left mid chest wall. The simulated radiographs (using the Mean function on the CT scan) show an extra pleural mass with involvement of the left 6th rib. The CT scan images in the axial and coronal planes show an enhancing mass with an osteoid matrix. The biopsy was obviously simple performed along the plane of expected surgery.

Dr. Bhavin Jankharia, MD

Case III - Familial Pulmonary Fibrosis and the Risk of Malignancy - Adenocarcinoma Lung with FPF



This is a 49-years old man who was known to have a fibrosing ILD. When he came to us, he had a "probable usual interstitial pneumonia" (probable UIP) pattern, which was suggestive of idiopathic pulmonary fibrosis (IPF). He also had a focal wedge-shaped opacity with air bronchiolograms in the superior segment of the right lower lobe, which had grown from an earlier scan (not available). We found later that a cousin of his and another sister both had variable forms of pulmonary fibrosis, suggesting that he and his family had familial pulmonary fibrosis (FPF). All forms of fibrosing ILDs have an increased risk of malignancy.

I biopsied the wedge-shaped lesion with a 20G coaxial biopsy gun. The diagnosis was adenocarcinoma with mucinous component.

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Van neck disease

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Van Neck-Odelberg disease is characterized by an atypical ossification pattern of ischiopubic synchondrosis. Radiologically it mimics stress fracture, neoplasm, infection and post-traumatic osteolysis.

Ischiopubic synchondrosis is a junction between the pubic rami and the inferior ischium. It's formed from hyaline cartilage. [1] The formation begins in the fifth and sixth months of fetal life, and cartilage fusion is complete at the end of the 9-month pregnancy.

The growth is completed from two ossification centres which are the superomedial pubic centre and posterolateral ischial centre, with cartilaginous tissue extending between these two and is called ischiopubic synchondrosis.[2]

Ossification of cartilaginous tissue is finished in the pubertal period. Due to asymmetric mechanical stress on the pelvis in growing years, synchondrosis expands, which consequently causes delayed ossification.

The clinical presentation is non-specific, like groin and gluteal pain, limping and sometimes inability to walk. [3,4]

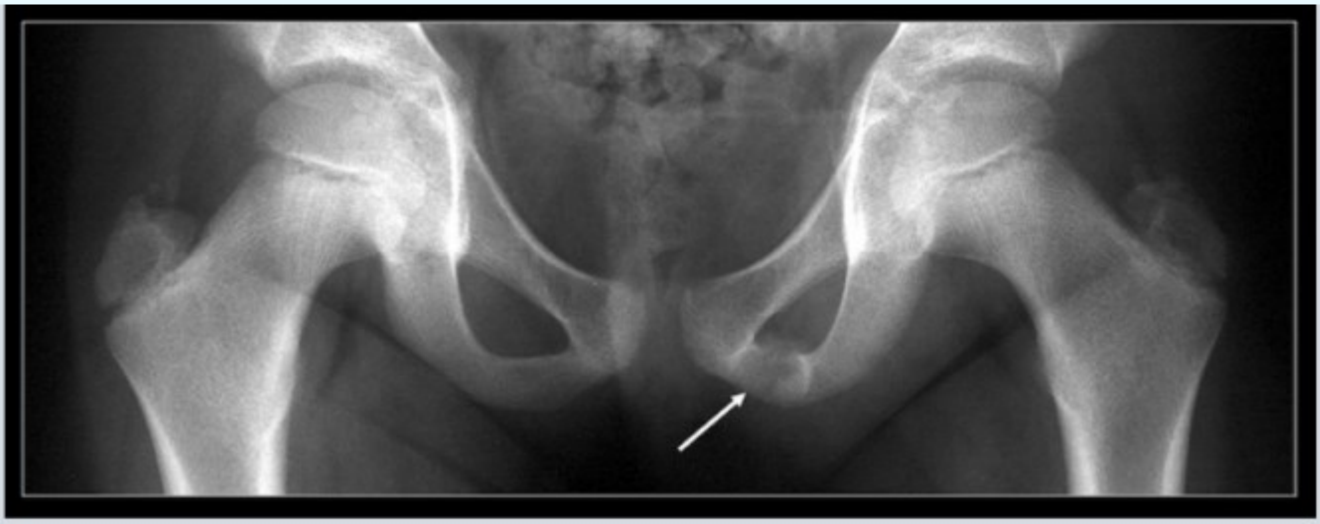

Figure 1: Anteroposterior radiograph of the pelvis reveals expansion and lucent appearance of the left ischiopubic synchondrosis (arrow).

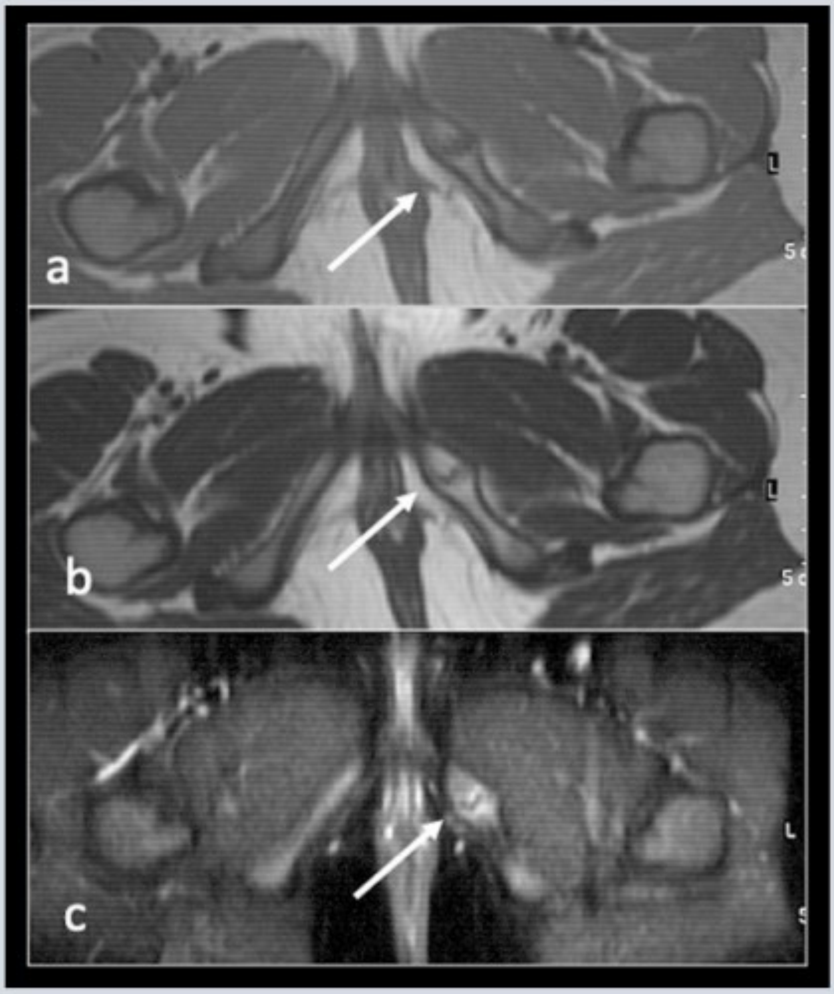

Figure 2: Axial T1(a), T2(b) and proton density fat suppressed (c) images show expanded left ischiopubic synchondrosis with mild oedema.

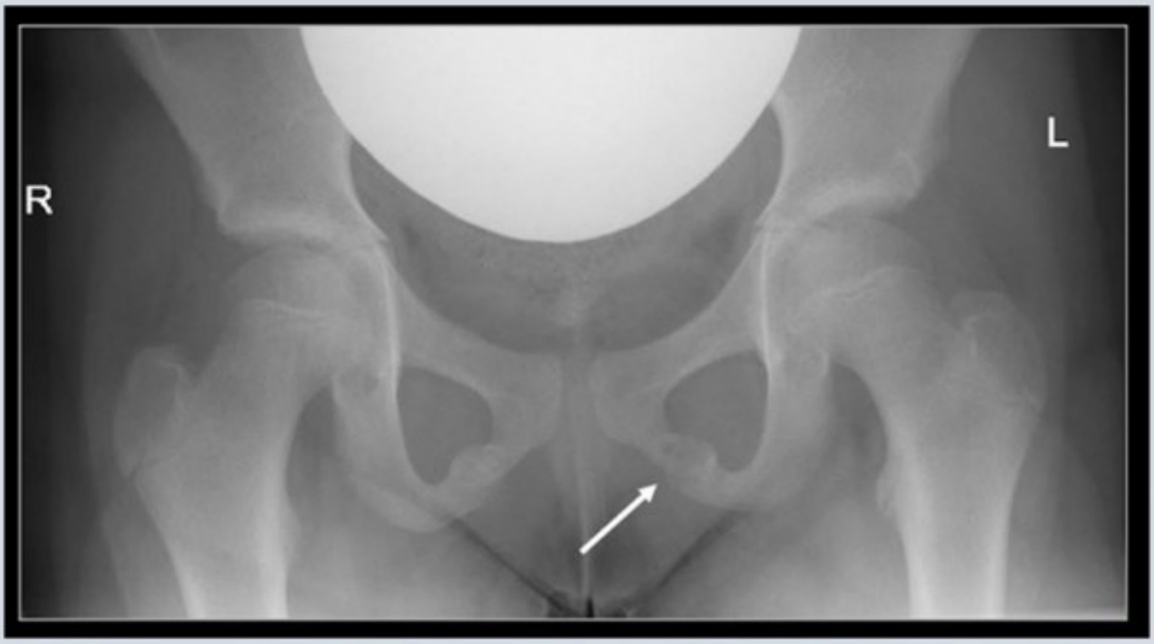

Figure 3: Anteroposterior radiograph of the pelvis reveals expansion of bilateral ischiopubic synchondrosis and a well-appreciable lucent appearance on the left (arrow).

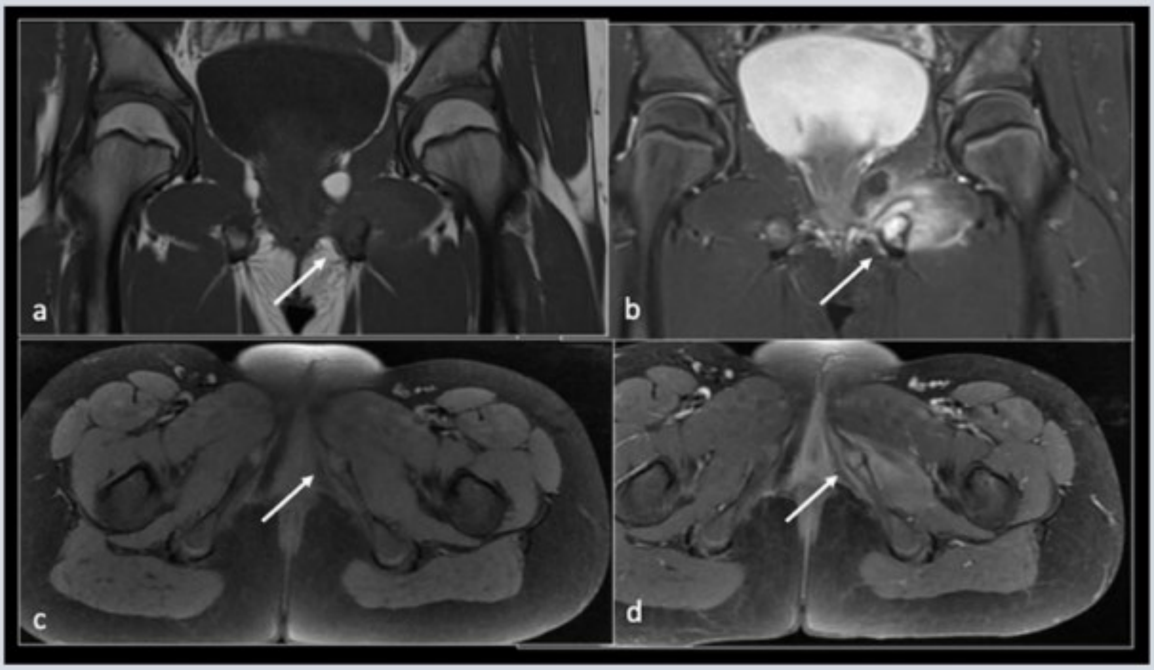

Figure 4: Coronal T1(a), T2FS (b), axial T1 fat suppressed (c) and post contrast T1 fat suppressed axial (d) show osseous and soft tissue oedema of the left ischiopubic synchondrosis and adjacent obturator externus muscle.

Figure 5: Bone scan shows increased uptake in the left ischiopubic synchondrosis (arrow).

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Imaging of the Urinary Tract

Dr. Bijon Kundu and Dr. Kanchanmani Mishra

The imaging modalities available to assess the urinary tract are

1. Plain radiograph
2. Intravenous Urogram
3. Ultrasound
4. Computed tomography
5. Micturating Cysto-Urethrogram (MCU)
6. Ascending Urethrogram
7. Combined ascending urethrogram and MCU
8. Magnetic resonance imaging
9. Antegrade pyelography
10. Retrograde pyelography
11. Percutaneous nephrostomy
12. Digital subtraction catheter angiography of the renal artery

PLAIN ABDOMINAL RADIOGRAPH

A plain radiograph of the abdomen should be obtained before any contrast examination because calcification may later be masked by the contrast medium. It is important that the kV (kilovolt) should be kept low to increase the chance of detecting calcification in the urinary tract. As small renal calculi may be hidden by bowel shadows, at least two views of the renal area may be required. A simple routine is to expose a full-length radiograph in inspiration and a coned view of the kidneys in expiration. The change in position of the kidneys in the different phases of respiration will show whether a calcification is intrarenal (because its position is constantly related to the kidney) or separate from the kidney. During deep inspiration, calcified costal cartilage (which may overlie the renal area in expiration) is lifted up and, at the same time, the descending diaphragm displaces the kidneys caudally. If there is doubt about the presence of a calculus, an oblique view or tomography can be done. The perirenal fat gives a lucent outline to the kidneys and allows an assessment of their position to be made. Any mass related to them may be suspected by careful scrutiny of the plain radiographs. The loss of outline of a psoas muscle may point to retroperitoneal pathology but it is a notoriously inaccurate sign. The full-length radiograph should include the bladder base and, in male patients, the prostatic urethra, particularly when there are lower tract symptoms, in order not to miss a urethral calculus. The outline of the bladder can be appreciated and for this reason, the patient should empty the bladder before investigation: a large bladder residue may then be recognized. A careful examination of the bones should be made, particularly the lumbar spine and sacrum in a child with enuresis where a spina bifida or sacral anomaly (so easily missed) may be the underlying problem.

The plain radiographs are not indicated for assessing neoplasms of the urinary tract. However, a renal mass may be visible as a soft tissue shadow with displacement of retroperitoneal fat. Calcification can also be detected on plain radiograph. Pattern of calcification may help in differentiating benign from malignant masses. Eighty percent of peripheral calcifications are seen in renal cysts, in 20 percent they are noted in malignant lesions. Renal masses that contain central, irregular calcifications are usually malignant.

Skeletal metastasis may also be detected. They appear as lytic expansile foci. Multiple osteomas or bone islands are another abnormality associated with renal mass, particularly in patients with tuberous sclerosis.

Fig. 1 Sclerotic skeletal metastases of prostate

1. INTRAVENOUS UROGRAM

The IVU is still a valuable procedure for examination of the urinary tract. It gives excellent anatomical images of the pelvicalyceal systems and, to some extent, an indication of renal function. Patient preparation in the form of bowel preparation is probably unnecessary as tomography can be employed when overlying gas and faecal shadows are a problem. Overhydration should be avoided but fluid restriction is no longer considered necessary. In patients with impairment of renal function it is imperative that there should be no fluid restriction. Dehydrated patients are more prone to intratubal obstruction, leading to oliguria or anuria from protein precipitation in the renal tubules which may cause even more serious renal impairment. Patients at particular risk are those with myeloma and diabetes. Other techniques should therefore, be considered for this patient population.

While patients should be allowed to drink normally, it may be advisable to ask them to avoid solid food for 4h before the intravenous contrast examination as they are then less likely to vomit, should there be a reaction to the contrast medium.

Contrast media

Minor reactions such as hot flushes and nausea are common and should not cause undue alarm. It is likely that anxiety may promote contrast reactions and so quiet reassurance should be offered as a routine practice. Non-ionic and low osmolar contrast media have been shown to cause fewer serious side-effects than ionic media, and most centres now exclusively use these safer agents.

The quantity of contrast medium administered should be related to the weight of the patient (300 mg kg-1 body weight). If the patient is well hydrated the dose may be increased to 600 mg kg-1 body weight. The contrast medium should be injected rapidly so that a bolus reaches the kidneys. This high concentration arriving at the glomeruli will produce a high concentration in the nephrons, and thus a denser nephogram and subsequent pyelogram than would otherwise be the case.

Sequence of imaging

In order to obtain a good demonstration of the renal outlines, a radiograph coned to the renal area should be taken immediately after the injection of contrast medium (the 1-min film). This will coincide with the highest concentration of contrast medium in the nephrons and from this nephogram, the size and outline of the kidneys will be seen.

An image at 5 min coned to the renal area will show early filling of the pelvicalyceal system and the relationship of the calyces to the renal outline. Again, tomography or oblique images may be useful. Some advocate abandoning the immediate 1-min nephogram image, as the 5-min tomogram will give an equally good demonstration of the renal outlines, allowing the number of films in the IVU series to be reduced. This decreases the total radiation dose to the patient, the importance of which is now well understood. If there is any doubt about the renal outlines, ultrasound is far better than urography.

If the presence of an obstruction in the lower ureter is suspected, a full-length radiograph at 5 min will usually show the full length of a normal ureter owing to the osmotic diuretic effect of the contrast medium. At a later stage of the IVU the distal ureter may be obscured by contrast medium in a full bladder. If the immediate image shows only one normally situated kidney, the full-length 5-min radiograph may disclose a pelvic kidney.

Provided there is no evidence of obstruction at 5 min, the pelvicalyceal system is best demonstrated by applying abdominal compression with a special pneumatic belt and obtaining an image coned to the renal area after 3–4 min of compression (the 10-min film). The pelvis and calyces then become distended with contrast medium, helping to display abnormal filling defects, and pushing aside normal vessels which may cause an impression upon a calyceal neck.

Recent abdominal surgery or evidence of an abdominal aortic aneurysm are obvious contraindications to the use of abdominal compression, and it is ineffective in the obese patient. When calyces overlap each other, or there is a suspicion of an abnormality related to them, a posterior oblique radiograph coned to the dependent kidney can help. Abdominal compression is uncomfortable for the patient so the belt should be released as soon as the relevant images of the pelvicalyceal systems have been obtained. A full-length radiograph at this stage will best demonstrate the ureters. If there is any hold-up of contrast medium in a ureter, further views are indicated; either a prone view, when contrast medium will collect in a more dependent portion of the ureter, or an oblique view, when the relationship of the ureter to a possible phlebolith will be seen. The bladder will be well filled at this stage and oblique

views may help to show any irregularity of the wall of the bladder or demonstrate the relationship of a pelvic mass to the bladder. At least two views of the ureters are required when a urothelial abnormality is suspected, in order to differentiate a peristaltic contraction from a stricture or a tumor. A full-length, postmicturition radiograph will offer a further view of the ureters and also show free drainage of the contrast agent from the kidneys, which can be particularly helpful if earlier films show rather baggy pelvicalyceal systems and obstruction is to be excluded.

Each urogram should be tailored to answer a specific clinical question. In some cases, there may be a need for several tomograms of the kidney to address a specific renal problem. To compensate for this and to avoid additional irradiation of the patient, views of the bladder may be omitted; this organ can in any case be better studied by ultrasound. In other cases, the initial 1-min image may be omitted if fine detail of the inner urothelial lining of the upper urinary tract is required, e.g., in the follow-up of a patient with a known urothelial tumor. Tailoring the urogram in this way can decrease the radiation dose given to the patient.

Excretory urography, however, lacks specificity for accurately characterizing the lesion. Expansile masses cause contour abnormalities, calyceal splaying, stretching, and draping. Infiltrating renal mass produce little parenchymal mass effect and maybe seen as a filling defect in the collecting system.

Fig 2:
Right-sided renal cell carcinoma

Fig 3:
IVU : Bladder tumour.

2. ULTRASOUND

Ultrasound (US) is an exceedingly useful technique for examination of the urinary tract. The advantages of using a non-invasive test, which is painless and does not involve irradiation to either patient or operator, are obvious. When a renal mass is found at IVU, then an ultrasound examination will easily and rapidly differentiate a tumor from a cyst. Combining a limited IVU, with its ability to demonstrate the pelvicalyceal system in detail, and ultrasound, which will show abnormalities of the renal outline, is a very efficient method of imaging the urinary tract accurately.

US provides information about renal length which is used to estimate renal mass and the presence or absence of hydronephrosis. The normal length in the adult ranges between 11 and 14 cm. Women tend to have smaller kidneys than men. The normal adult renal length approximates to the height of three lumbar vertebral bodies (nearly four in children). A difference in renal size of over 2 cm is usually significant.

Ultrasound is very useful for detection of renal masses and characterizing them as solid or cystic. Ultrasound may also be useful when CT pseudo-enhancement is noted, leading to a simple renal cyst being mischaracterized as a solid mass. Color Doppler sonography can evaluate the renal vein and IVC for presence of a thrombus. The vascular flow within a renal mass, identified by colour and power Doppler is strongly associated with clear cell carcinoma. The vascular distribution at power Doppler could add information in differentiation of small solid renal masses. Peripheral or mixed peripheral and penetrating patterns are seen in all RCCs and some benign angiomyolipomas and oncocytomas, whereas intratumoral focal penetrating pattern is characteristic of angiomyolipomas

Fig 4:
Normal kidney

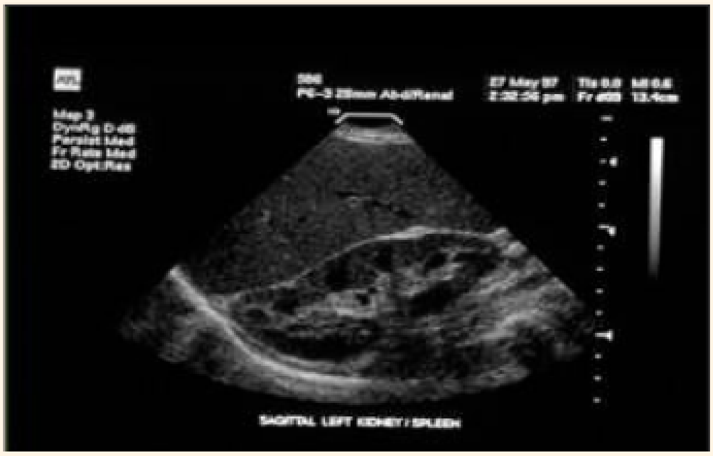

Fig 5:
Normal kidney and spleen.

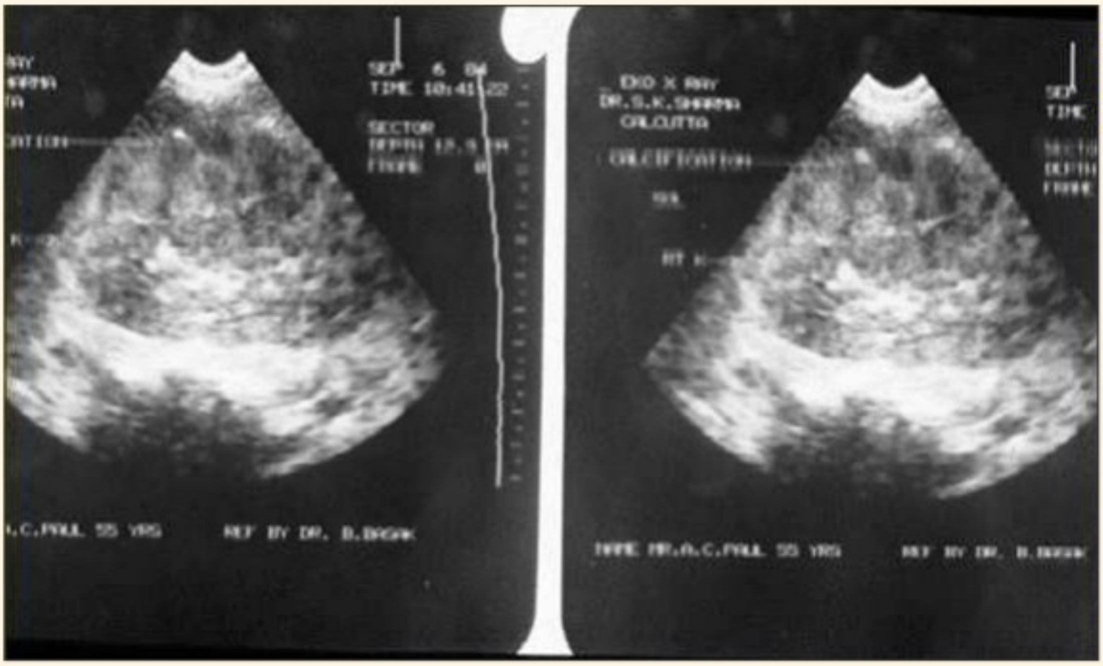

Fig 6: Renal cell carcinoma.

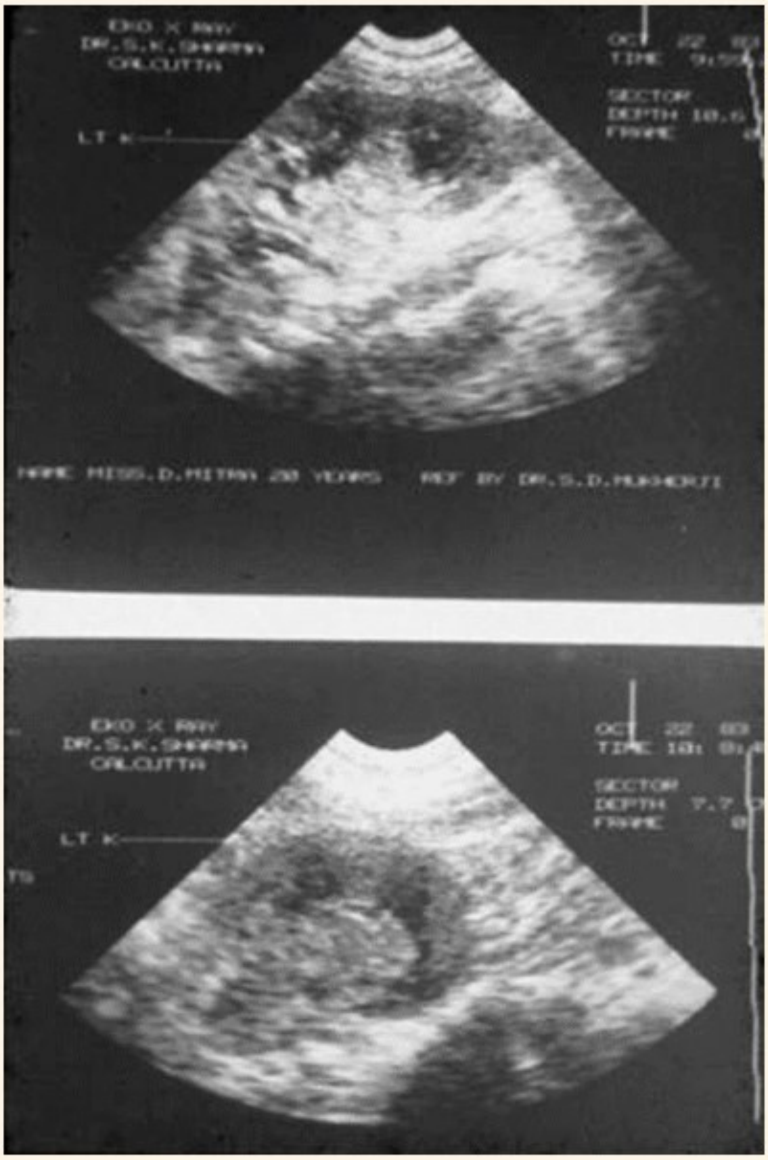

Fig 7: Papilloma left renal pelvis.

3. COMPUTED TOMOGRAPHY

Computed tomography (CT) has become the preferred investigation for acute loin pain, hematuria renal mass, renal arteries and more recently, the urothelium (CT urography). Multidetector CT systems allow thin slices to be acquired for large body areas in a single breath hold. The large data sets of isotropic or near isotropic voxels allow multiplanar interrogation. A variety of post-processing techniques may be utilized for image analysis and display.

CT has high sensitivity for detection of small renal cell carcinoma, urinary tract calculi and transitional cell carcinoma

CT is the best investigation for the depiction of ureteric obstruction and secondary signs of obstruction such as hydronephrosis, hydroureter, nephromegaly, while perirenal and periureteric streaking are also apparent. CT is also the preferred investigation for detecting renal masses and recent evidence supports its use for the detection of urothelial tumors.

Multislice CT enables a comprehensive single test evaluation for the presence of renal masses, assessment of the urothelium, renal parenchyma, renal arterial and venous configurations, and the anatomy of the ureters. The spatial resolution and speed of acquisition currently greatly exceed that of MR imaging. Catheter angiography is now rarely performed in these patients.

For characterization of a renal mass, the examination is to be performed before and after administration of I.V contrast; the different phases of renal enhancement arterial (15-20 s delay), corticomedullary (35-80s), nephrographic (85-180s) and excretory (3min or more) need to be evaluated.

The nephrographic phase is ideal for detection of masses as there is maximal and homogenous parenchymal enhancement. This allows better delineation of renal masses which do not enhance at the same level as renal parenchyma. During imaging in corticomedullary phase, small renal masses may be indistinguishable from renal medulla. During excretory phase, masses may be of same attenuation as the parenchyma which has enhanced.

Single-detector and multidetector spiral CT have dramatically refined the diagnostic evaluation of renal disorders by allowing rapid image acquisition through the entire kidney during various phases of contrast enhancement after the administration of a single bolus of intravenous contrast material. The technique should be tailored according to the specific clinical problem involved. However, some aspects are common to all dedicated renal CT studies. Because unopacified bowel loops may simulate perinephric masses and retroperitoneal adenopathy, patients undergoing renal CT should receive oral contrast medium.

CT protocol for evaluation of the kidneys consists of both non-enhanced and contrast- enhanced CT scans obtained in suspended respiration, to overcome the motion artifact. To avoid artifactual differences in attenuation values, the same peak kilovoltage, milliampere-second setting, section thickness, and field-of-view should be used for both pre-contrast and post-contrast scans when small renal masses are being evaluated. The accuracy of attenuation values should also be tested by measuring the attenuation value of the gall bladder contents before and after intravenous administration of contrast medium. Apparent enhancement of the gall bladder contents suggests that mild enhancement of a renal mass may be spurious.

Images should be acquired with 1- to 3mm collimation, subsecond scan time, and a pitch of up to 2:1 to allow coverage of the area of interest in single breath-hold. Multislice scanners allow acquisition of 1- to 2.5-mm slices through the region of interest in a single breath-hold. Non-enhanced scans permit contrast enhancement of a renal lesion to be measured and also ensure that renal parenchymal calcifications, renal calculi, renal and perinephric hemorrhage and fat, and calcification in a renal mass will not be obscured by contrast medium.

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Non-enhanced scans also help differentiate hyperdense cyst from renal solid tumor.

Fig 8:
Right renal neoplasm. Non-contrast CT.

Corticomedullary Phase

Administration of an intravenous contrast medium is a fundamental requirement for CT evaluation of most renal lesions. Enhancement of a mass indicates that the lesion is vascular and is therefore possibly a neoplasm. Contrast medium should be administered rapidly with a mechanical injector through an antecubital vein as a 150- ml bolus containing 40 to 45 g of iodine at a rate of 2 to 4 ml per second. The corticomedullary phase occurs 25 to 70 seconds after the start of contrast administration. The corticomedullary phase begins as contrast material enters the cortical capillaries and peritubular spaces and filters into the proximal cortical tubules. The renal cortex can be differentiated from the renal medulla at this stage because (1) the vascularity of the cortex is greater than that of the medulla, and (2) contrast material has not yet reached the distal aspect of the renal tubules. The resultant CT nephogram has been termed a cortical nephogram. Corticomedullary phase images should always be obtained when information about the renal vasculature is desired or when there is a possibility that a detected renal mass may represent an aneurysm or an arteriovenous malformation or fistula.

Fig 9:
Right renal neoplasm. Cortico-medullary phase

Dr. Bijon Kundu & Dr. Kanchanmani Mishra

Maximal opacification of the renal vein and arteries occurs during this phase, allowing confident diagnosis of tumor extension to the vein.

Nephrographic Phase

This begins as the contrast material proceeds from the cortical vessels and extracellular interstitial space and enters the Loops of Henle and collecting tubules. A homogeneous or tubular nephogram result in which corticomedullary differentiation is lost. The nephrographic phase starts about 80 seconds and lasts up to 180 seconds after the start of injection, and it offers the best opportunity to distinguish the normal renal medulla from a renal mass. The nephrographic phase is the most valuable for detecting renal masses and characterizing indeterminate lesions.

Fig 10:
Right renal neoplasm : nephrographic phase

Excretory Phase

Approximately 180 seconds after the start of the contrast injection, the excretory phase begins. The contrast material is excreted into the collecting system, so the attenuation of the nephogram progressively decreases. This phase is occasionally helpful to better delineate the relationship of a centrally located mass with the collecting system. This phase is also useful for evaluating urothelial masses.

Fig 11:
Right renal neoplasm : excretory phase

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Computed Tomographic Urography

CT urography is a relatively new technique that is progressively replacing conventional intravenous urography (IVU). It is being increasingly used for indications such as hematuria of unknown cause because of its ability to examine the entire genitourinary tract in a single study. However, it remains limited in evaluation of the urothelium compared with IVU because of its lower spatial resolution.

There are two major approaches for performing CT urography. Hybrid CT urography is a combination of CT and IVU that uses projection radiographs along with acquisition of CT images after intravenous contrast injection. CT-only urography does not involve projection radiographs and uses CT alone to obtain two- and three-dimensional reformatted images to produce images similar to those obtained with IVU.

Computed Tomographic Hybrid Urography

This technique combines the advantages of CT and IVU in imaging the urinary collecting system; it therefore does not require postprocessing of the CT images to produce coronal reformatted images. This technique may require imaging of the patient in two different locations. There are several problems associated with moving the patient between different procedure rooms, such as additional time and resources and possibly insufficient pueblo-calyceal distention at the time of the radiography. Therefore, an alternative approach has been developed at the Mayo Clinic in an attempt to solve this problem. A multidetector CT scanner configured with a special tabletop apparatus is used to obtain both CT and radiographic images at the same location without moving the patient. This tabletop is capable of receiving a combined slip-on grid/ standard film cassette. This system requires the installation of a ceiling- mounted X-ray tube above the CT table and the attachment of an auxiliary CT tabletop with a hollow bay under the patient surface in which to place the radiographic cassette.

With this technique, an abdominal radiograph, a non-enhanced renal CT, and a multiphasic contrast-enhanced renal CT scan, followed by overhead excretory urographic and postvoid radiographs, are obtained. An alternative method of obtaining projection images without moving the patient from the CT table is the use of the CT scanned projection radiography (SPR) technique (scout view, topogram or scanogram). The spatial resolution of CT SPR is inferior to that of conventional radiography, whereas the contrast resolution of opacified structures is similar to that of conventional radiography. This CT urography approach, the combination of helical CT scans and enhanced CT SPR urographic images, is attractive because modification of the CT tabletop and installation of a ceiling-mounted X-ray tube is not required; therefore, this technique can be performed on any multidetector-row CT equipment. Preprocedural bowel preparation helps to reduce gas and fecal material, enhancing the visualization of the collecting system. In IVU abdominal compression is applied after the intravenous contrast medium injection for better opacification and distention of the intrarenal collecting system and the ureter. It is important to use a low-osmolar iodinated contrast medium. Ten-minute decompressed film images help to visualize almost the entire ureters. Twenty-minute and postvoiding films are useful for bladder evaluation.

Computed Tomography–Only Computed Tomographic Urography

This technique is based on the acquisition of non-enhanced and enhanced CT scans of the abdomen and pelvis, including the essential acquisition of thin-section helical CT scans of the urinary tract during the excretory phase of enhancement. No bowel preparation is necessary for this type of CT urography. Multiplanar two- and three- dimensional reformation images are produced from axial source images obtained during the excretory phase. Optimal distention and opacification of the collecting system are the keys to detection of urothelial abnormalities. Abdominal compression improves opacification of the collecting system compared with CT scans without compression. Caoili and associates described four-phase multidetector CT urography as comprising a non-enhanced scan, a nephrographic-phase scan with abdominal compression, and two excretory-phase scans, one obtained 200 seconds after the injection of contrast material with compression and the other at 300 seconds after release of compression. Renal, pelvic, ureteral, and bladder abnormalities are better visualized on compression-release excretory-phase images. Three-dimensional images are particularly helpful in the diagnosis of papillary abnormalities such as renal tubular ectasia and papillary necrosis.

Alternative techniques can be used to achieve optimal visualization of the collecting systems, such as normal saline chase and diuretic injection. CT urography with supplemental saline administration can significantly improve opacification of the distal ureters. Patient position (supine or prone) during CT examination does not affect ureteral visualization. The distal ureters are the most difficult segments to opacify and have a better chance to opacify if a saline infusion technique is used (250-ml saline chase after the intravenous contrast administration). Intravenous injection of low-dose diuretics (10 mg of furosemide) before intravenous contrast injection allows less dense, homogeneous opacification of the collecting system. Alternatively, oral water (1000 ml within 15 to 20 minutes) before the examination can cause sufficient opacification of the calyces and ureters in most instances. Evaluation of axial CT images (source images) with a wide window setting is important for accurate diagnosis. Coronal or oblique multiplanar reconstruction images help to define the location and extent of the lesions shown on axial images. Maximum intensity projection (MIP) images resemble conventional IVU images and may be preferred by physicians.

Fig 12:
Coronal Maximum Intensity Projection image of the CT urogram in the excretory phase demonstrates the opacified ureters.

Table - Computed Tomography Urography Protocol

Phase	Timing	Range	Slice Thickness	What to Detect
Nonenhanced	Precontrast	Lung bases to pubicsym-physis	5 mm	Calculi, hemorrhage/hemorrhagiccysts
Nephrogram [*]	100 sec	Lung bases to pubicsym-physis	3 mm	Renal tumors, renal vein thrombosis
Excretory [*] [†]	5-8 min	Lung bases to base of bladder	2 or 3 mm	Papillary necrosis, urothelialcarci-noma

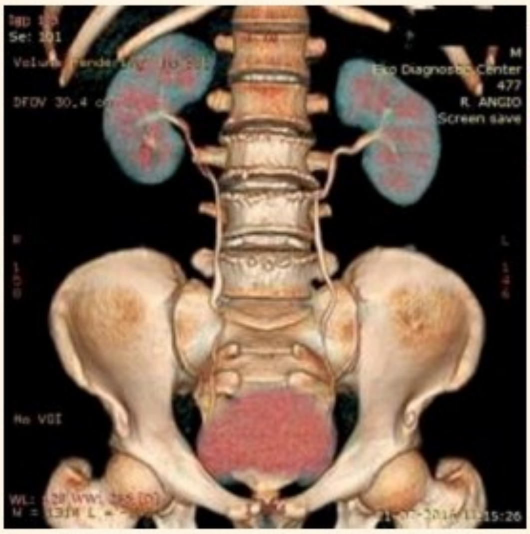


Fig 13:
Three-dimensional volume-rendered image of the ex-cretory phase of the CT urogram demonstrates the kid-neys, ureters, and bladder.

Fig 14:
CT Perfusion

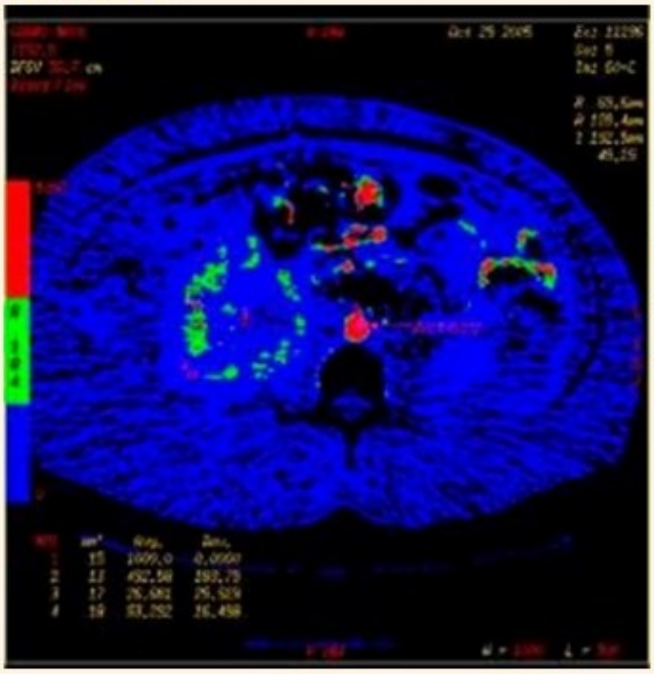


Fig 15:
BV

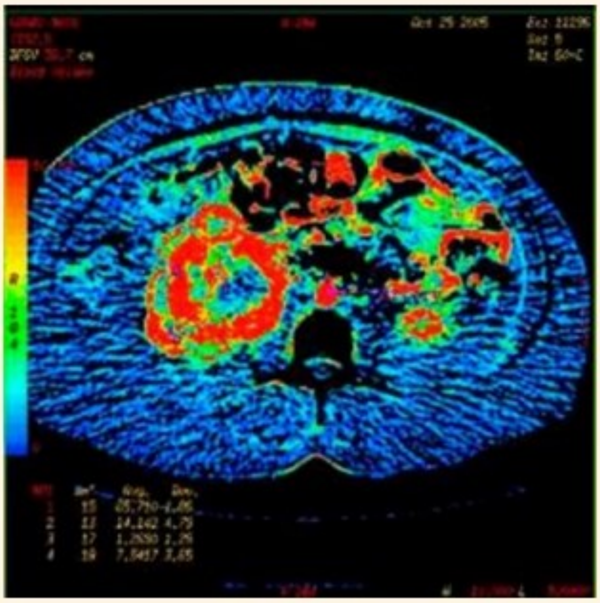


Fig 16: BF

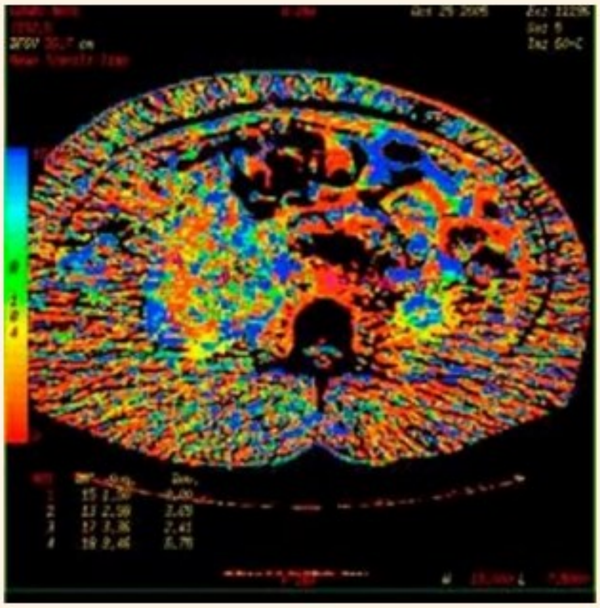


Fig 17: MIT

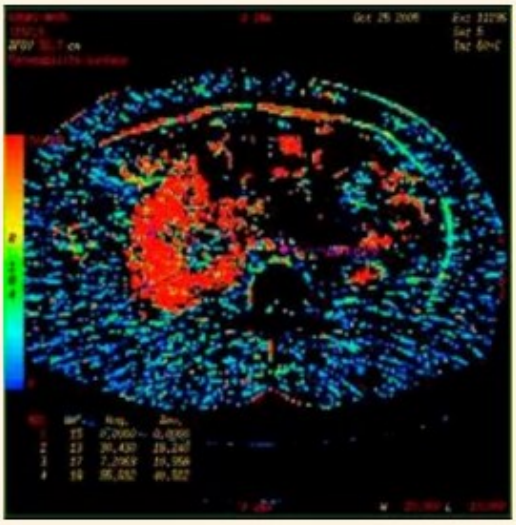


Fig 18: PS

Magnetic Resonance Imaging Techniques

Gadolinium-enhanced renal MRI is an attractive alternative to other techniques for evaluation of native and transplanted kidneys because it can be used in patients with iodine allergies. Recent studies have shown a possible association of gadolinium- based MR contrast agent administration in patients with renal insufficiency with development of a condition called nephrogenic systemic fibrosis (NSF). As of late December 2006, the U.S. Food and Drug Administration (FDA) had received reports of 90 such cases. Worldwide, the FDA has reported more than 200 cases. Use of gadolinium-based MR contrast agent in patients with renal insufficiency is not routinely recommended. Although this relationship is still unclear, it has significantly decreased the number of contrast-enhanced MRI studies being done in patients with renal failure who are otherwise unable to receive CT intravenous contrast because of increased risk of contrast-induced nephropathy.

NSF, initially called nephrogenic fibrosing dermopathy because of its dominant cutaneous findings, is an acquired, idiopathic, systemic disorder that is restricted to patients with renal disease, particularly those undergoing dialysis. Patients with severe renal failure, whether acute or chronic, and those with acute renal failure of any severity who have hepatorenal syndrome or are in the perioperative period of liver transplantation are at greater risk of developing NSF. Characteristic cutaneous changes consist of indurated plaques and papules, most commonly on the extremities and trunk, with almost no involvement of the face. The condition is debilitating and potentially fatal. Diagnosis of NSF is made on the basis of histopathologic findings, which include thickened collagen bundles with surrounding clefts, mucin deposition, and a proliferation of fibroblasts and elastic fibers, with complete absence of signs of inflammation. Besides dermatologic changes, NSF also results in fibrosis of other organs such as skeletal muscle, myocardium, lungs, kidneys, and testes.

Several studies have demonstrated an association of NSF with prior gadolinium administration, raising the possibility of gadolinium as the etiologic factor in this disorder. Radiologists should avoid using gadolinium-based contrast agents with high- risk patients unless the diagnostic information is essential and cannot be obtained any other way. The FDA recommends prompt dialysis for patients already receiving hemodialysis after administration of a gadolinium-based contrast agent. It is unknown whether dialysis prevents NSF, but data indicate that it does speed up the elimination of the agent from the body. There is no effective treatment for NSF; the condition leads to increased morbidity and mortality and is an absolute contraindication to contrast administration in severe renal insufficiency (glomerular filtration rate <30 ml/min).

Dynamic gadolinium-enhanced gradient echo imaging achieves coverage of the entire kidney during breath-holding, thereby reducing respiration-induced phase artifacts. Gadolinium-enhanced fat-suppressed T1-weighted spin echo technique images the kidneys with significantly fewer artifacts than does conventional spin echo imaging. The ability of dedicated renal CT scanning and gadolinium-enhanced MRI to detect and characterize renal lesions greater than 1 cm is similar, although MRI is superior in detecting polar lesions because of its ability to image directly in nonaxial planes. Because CT is more generally available, quicker, and less expensive than MRI, it is usually preferred to MRI for evaluating patients with suspected renal masses.

MRI is the preferred modality, however, for determining the cephalic extent of an intracaval tumor in a patient with renal cell carcinoma (RCC) when this finding is not adequately documented by CT. Other indications for renal MRI are the need for differentiation between hemorrhagic renal cysts and renal neoplasms, characterization of small renal masses that are indeterminate on CT or ultrasonography, evaluation of renal donors, visualization of renal blood vessels (MR angiography [MRA]), and evaluation of transplanted kidneys.

The MRI pulse sequences, and the precise imaging parameters used depend on the nature of the available MRI equipment and on the clinical problem. Conventional spin echo sequences may be used for evaluating the kidneys. The development of newer and faster imaging techniques, such as fast-spin echo and gradient echo imaging, are preferred. T1-weighted gradient echo in-phase and opposed-phase images from the top of the liver to the inferior pole of the kidney are obtained to study the anatomy and also evaluate the liver for any metastatic disease from renal tumor. This technique also allows assessment of the presence of fat in the renal lesion.

A T2-weighted fast-spin echo sequence with fat saturation is obtained in the axial plane corresponding to the T1-weighted gradient sequence. Coronal T2-weighted (very long echo time [TE], such as half-Fourier acquisition single-shot turbo spin echo [HASTE] and single-shot fast spin echo [SSFSE]) images are also acquired to identify renal cysts. T1- and T2-weighted sequences help identify hemorrhagic cysts. Gradient echo images are helpful for evaluating renal masses.

Fig 18:
T1W MRI: Wilm's tumor right kidney

MR imaging also plays an important role in the staging of pelvic malignancy. Functional techniques, new contrast agents such as lymphotrophic superparamagnetic nanoparticle (LSN) and 3-Tesla magnets will further improve MR imaging of prostate cancer.

The internal anatomy of the prostate gland is best demonstrated on T2-weighted images (T2WI). The normal peripheral zone demonstrates higher signal intensity than the central zone because of its high-water content and the loose acinar structure of the glands. The tumor appears as low signal on both T2WI and T1WI whereas blood appears to be of low signal on T2WI and high signal intensity on T1WI.

MR imaging is increasingly being used for staging and evaluating endometrial, cervical, and ovarian cancers, and the appearance of bladder and ureters is critical. MR imaging has proved to be superior to other techniques for staging of cervical and endometrial cancers and should be used for preoperative staging of these tumors.

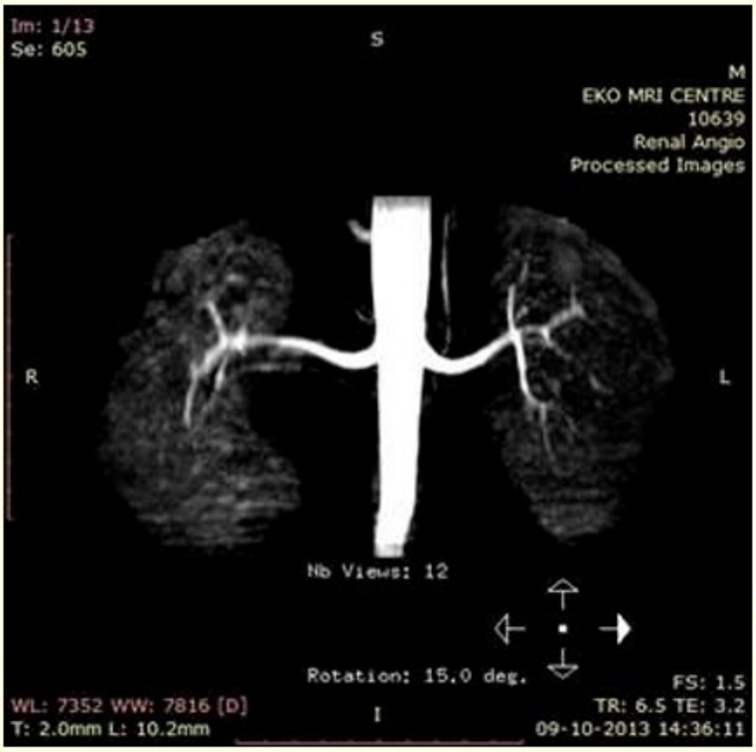
MR Urography

The unique advantage of MR Urography (MRU) is the absence of ionizing radiation. The exact clinical role of MRU has not yet been defined and remains under evaluation. There are two basic methods for modern MRU. The first technique uses unenhanced, heavily T2-weighted turbo spin-echo sequences to obtain static-water images of the urinary tract. It is used in poorly functioning hydronephrotic kidneys. The second technique is similar to conventional intravenous urography and is known as excretory MR urography. A gadolinium-containing contrast agent is given intravenously. Following renal excretion, the gadolinium-enhanced urine is visualized using fast T1- weighted gradient echo sequences. Furosemide (0.1 mmol per kg body weight) intravenously is often given to improve image quality.

Normal MR Urogram in a patient of right renal Bosniak IV cyst

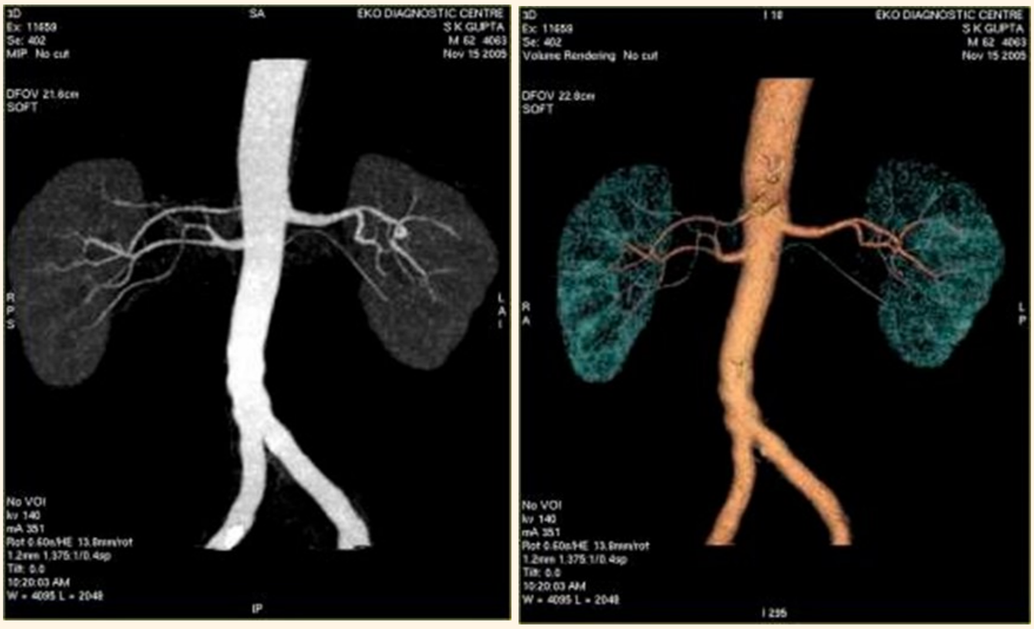
CT and MR angiography

CT angiography and Gadolinium-enhanced or non-enhanced MR angiography maybe used for assessment of vascular anatomy in renal neoplasms preoperatively.

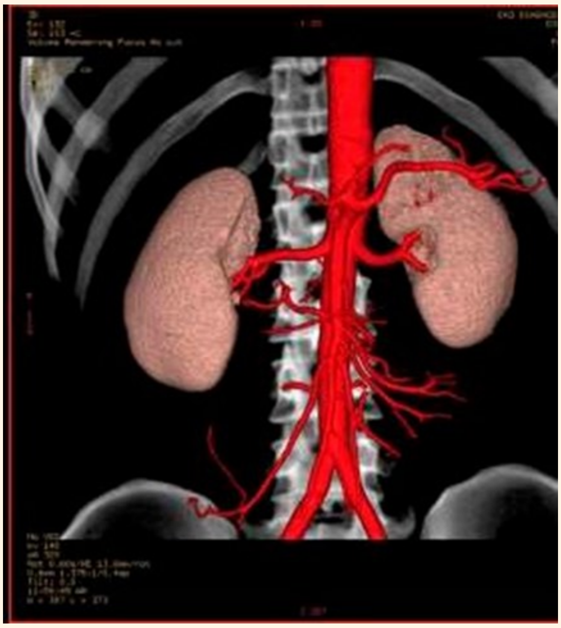


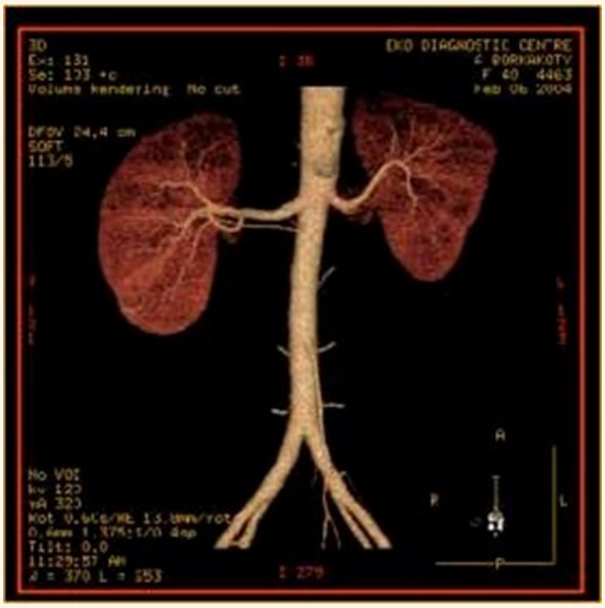
MR angiogram showing normal bilateral single renal arteries.

MR angiogram showing normal bilateral single renal arteries



CT angiography





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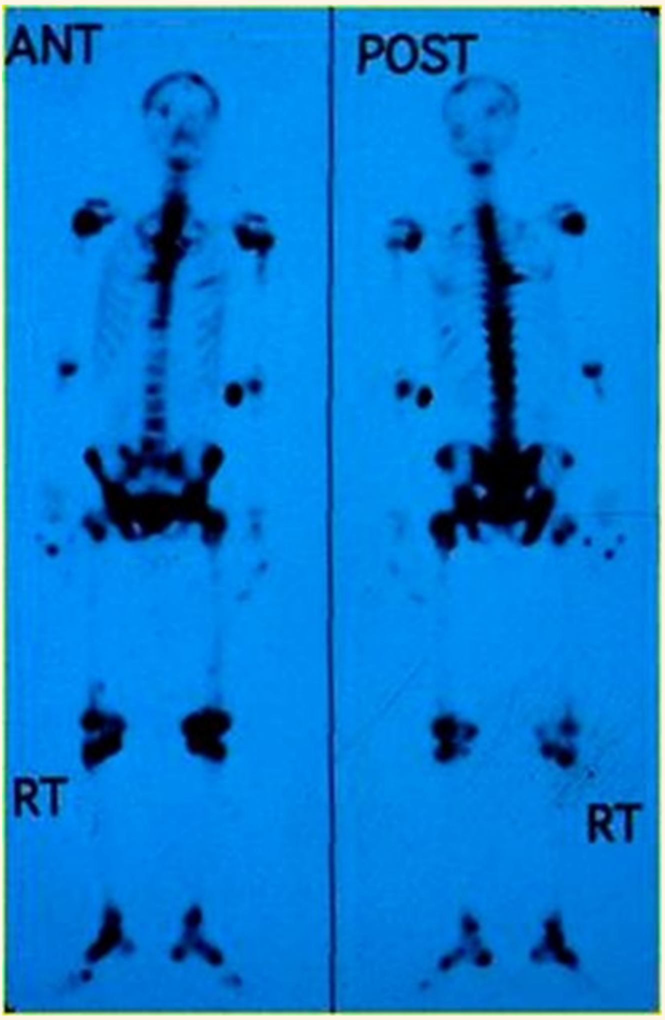
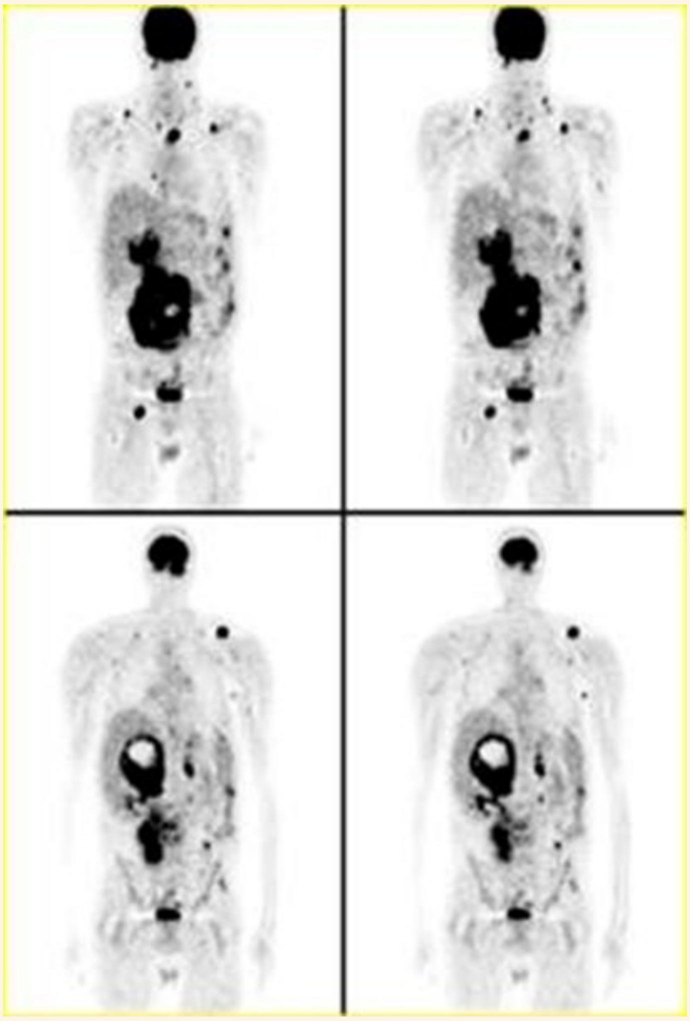


Bone Scan: Multiple metastases

PET Scan: Multiple metastases



ANTEGRADE PYELOGRAPHY

Antegrade pyelography is an accurate method of demonstrating precisely the site of an obstruction to the upper urinary tract. The IVU with delayed films may outline the obstruction, but the concentration of contrast medium may be poor, and the final diagnosis only made at 24h. Multidetector-row CT is a more rapid and accurate method of demonstrating the site (and possible cause) of obstruction.

Ultrasound will rapidly confirm the presence of dilatation in the pelvicalyceal system, allowing the clinician to proceed directly to antegrade pyelography. With the patient prone, a fine 20–22-gauge Chiba needle is inserted under ultrasound guidance or fluoroscopic control beneath the twelfth rib into a lower pole calyx, under local anaesthesia. As soon as the collecting system is punctured, trapped urine will escape through the needle. This should be aspirated and sent for culture and, if a urothelial tumor is suspected, for cytology. Once some reduction of pressure has been achieved within the system, contrast medium is injected to outline the pelvis and ureter down to the level of obstruction. It may be necessary to tilt the patient into a semi-erect position to demonstrate this.

RETROGRADE PYELOGRAPHY

Retrograde ureteropyelography is indicated mainly in those patients suspected of having a urothelial tumor of the upper urinary tract and in whom excretion urography is normal or equivocal. The catheter may be placed using a flexible cystoscope under sedo-analgesia and may be left in a selective position for some hours to collect urine for cytological examination. Images of exquisite detail may be obtained. Although it is important to ensure that anterior calyces are filled with contrast medium for a complete examination, too much contrast medium may cause a tear of the calyx.

PERCUTANEOUS NEPHROSTOMY

Indications

Relief of obstruction

Collecting system and ureter access for percutaneous procedures

Palliation of ureteric leaks and fistulas anterior perforation (through-and-through puncture)

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Patient positioning

The patient is placed in the 30° prone oblique position with a pillow under the abdomen in order to decrease the lumbar lordosis.

Imaging techniques for collecting system localization

A combination of ultrasound and digital C-arm fluoroscopy currently provide the most suitable imaging combination for image-guided access. CT is usually reserved for only the most challenging of cases.

Access technique

Using real-time ultrasound for guidance, a calyx is entered using a 22 g 15 cm Chiba needle. Contrast medium is injected into the collecting system and sometimes a small amount of air to assist with visualization of posterior lying calyces. If the entry site is via the calyx, then the track is dilated over fine guidewire. Should the entry point have missed a calyx, a second puncture is made either with another 22 g Chiba needle or with a 19 g diamond-pointed sheathed needle. The selected calyx for entry is positioned at the isocentre of the C-arm. This is achieved by putting the calyx in the centre of the TV monitor with the C-arm in the AP position. The C-arm is moved 15–20° RPO (right posterior oblique). If the calyx is at the isocentre, it will remain in the centre of the screen. If it moves to the left or right of the TV screen, the calyx is not at the isocentre. Raising or lowering the table so that the calyx is returned to the centre of the screen will achieve the required isocentre. During nephrostomy placement the radiologist should have control of the table and C-arm movements for maximum accuracy and convenience and also to keep the radiation dose to a minimum.

Fixation of the catheter

Displacement of catheter position is an exceedingly frustrating complication. Secure fixation is mandatory and usually involves a skin disc loosely sutured to the skin and tightly secured around the catheter. The ideal catheter position is where the pigtail lies in the upper pole from a lower pole access.

Results

The technical success rate for nephrostomy is high (98%), even in the emergency situation.

Complications

The complication rate of percutaneous nephrostomy (PCN) is low. Major complications are septicaemia and haematuria needing transfusion. Minor complications are catheter displacement or malposition, pelvic perforation, paralytic ileus, pneumonia/atelectasis, and pleural effusion. The mortality rate of 0.2% for percutaneous nephrostomy compares favourably with the 6% reported for surgical nephrostomy. Patient death related to PCN is most commonly due to an unanticipated cardiovascular event or rare cases of overwhelming sepsis or massive haemorrhage.

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Haemorrhage

In PCN, serious arterial injuries requiring embolization or surgery are rare (1–2%). However, clinically silent subcapsular or extrarenal haematomas are much more common and were found in 13% of cases following PCN as detected by CT 1–2 days after the procedure. A transparenchymal needle puncture directed immediately into a calyx will avoid the interlobar arteries and veins that traverse the renal medulla. Approaches that are too medial may miss the renal parenchyma completely and may even injure the main renal artery or vein.

Puncture of adjacent structures

Accidental puncture of neighbouring organs may follow PCN placement if due care and attention are not given to the relevant anatomy. Inadvertent puncture of the colon, liver, or spleen has been reported. Ultrasound immediately before PCN placement will help avoid these wayward punctures. If the kidney is located in an anomalous position (e.g., horseshoe kidney) or the patient has significant physical deformities (e.g., scoliosis), it may be helpful to localize the kidney using CT and hence map out a safe approach.

Infection

Special care should be taken when puncturing an infected system. All patients should be placed on the appropriate antibiotics before PCN is started. Intraoperative manipulation should be kept to a minimum. Overdistension of the renal pelvis should be avoided and a diagnostic nephrostogram should be deferred until the patient is afebrile. Aspirated urine should be sent for culture and sensitivity testing.

URETERIC STENT PLACEMENT

Indications for ureteric stent placement

Ureteric obstruction—stone, tumors, and strictures
Ureteric fistula
Before or after ESWL
Post-ureteric surgery/dilatation

Contraindications to ureteric stent placement

Distal obstruction (e.g., bladder outflow obstruction)
Irritable or intolerant bladder
Untreated urinary tract infections
Non-functioning bladder (noncompliant)
Bladder fistula
Small volume bladder (e.g., secondary to radiotherapy)

Approach: antegrade or retrograde?

The two principal routes used for ureteric stent placement are the antegrade (percutaneous) approach and the retrograde (transurethral) approach. The choice is influenced by several clinical factors as well as operator preference. Often one approach is successful when the other has failed. Both approaches may be reliably performed in the interventional radiology suite under light sedation and intravenous analgesia. Use of the retrograde approach means that stent placement can be carried out as a one-stage procedure and the patient is spared the

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the inconvenience of the multiple procedures usually required by the antegrade approach as well as the potential complications of nephrostomy. Theoretically, the retrograde approach should be attempted in nearly all cases before considering the antegrade route. It should be regarded as mandatory to attempt the retrograde approach first in all cases of solitary kidney. In patients with acute renal failure and tumor involving the ureteric orifices, it may be pertinent to go straight to nephrostomy to reliably establish renal drainage.

Antegrade ureteric stent placement Basic technique

Crossing the stricture, the patient is prepared and draped in the supine oblique position and the nephrostomy catheter cut 3 cm above the skin surface. A nephrostogram is performed using dilute contrast to permit visualization of guidewires and catheters in the collecting system and ureter. The nephrostomy catheter is exchanged over a suitable guidewire (Bentson or Amplatz) for a special intrarenal manipulation catheter and a straight hydrophilic guidewire. A nephrostogram of the distal ureter is performed, the ureteric stricture is crossed with the straight hydrophilic wire and the catheter is passed into the bladder. Contrast medium is injected into the bladder together with a small quantity of local anaesthetic. If the patient has an indwelling catheter, it should now be clamped.

Measuring the length of the ureter Ureteric length is measured by positioning the tip of the guidewire at the ureterovesical junction (UVJ) and placing a clip on the guidewire at the skin surface. The same guidewire is then withdrawn to the PUJ, and a second clip applied, again at the skin surface. The length of the ureter may be determined by measuring the distance between the two towel clips using a sterile ruler.

Placing the stent An Amplatz super-stiff guidewire is placed into the bladder and the track dilated to 10F. A 9F 45 cm peel-away sheath is placed over the guidewire. Over the Amplatz guidewire and through the peel-away sheath, an 8F double pigtail stent is placed. When the radio-opaque marker on the stent pusher is located within the renal pelvis above the PUJ, the inner stiffener and the Amplatz guidewire are completely withdrawn. The sheath is gradually withdrawn and peeled-away while maintaining the position of the proximal pigtail above the PUJ, but still within the renal pelvis, by a combination of tension on the drawstrings and pressure on the pusher until the stent is delivered into the renal pelvis. The stent may be finally positioned by pulling the strings while maintaining the position of the sheath. The strings are then cut and removed.

Following stent placement

A covering nephrostomy catheter is placed through the peel-away sheath into the kidney and left in place for 24–48 h until the draining urine turns clear and any residual debris or clot is passed. Patency of the stent should be confirmed by a nephrostogram before nephrostomy removal. An appointment should be given to the patient to attend for routine retrograde replacement in 6 months and the patient entered in the stent registry or database.

Antegrade ureteric stent placement is often technically challenging, requiring modifications of the basic technique.

Suboptimal percutaneous access

Much has been made of selecting an upper or middle calyx for access before stent placement but invariably a lower posterior calyx will suffice if stiff guidewires and sheaths are subsequently used for stent delivery. This is important as it means the easiest calyx for nephrostomy access should always be selected for renal drainage in the emergency situation.

Ureteric S-bends

Inability to negotiate an S-bend in the obstructed ureter may lead to failure of stent placement. Rarely, the passage of the guidewire and catheter through the ureteric S-bend leads to formation of a complete loop, rendering stent placement impossible. Rotation of the ureteric catheter at its hub in one direction causes the loop to unfold, whereas the other direction causes it to tighten. Once untwisted, the path for stent placement becomes straightforward.

Stricture dilatation

Dilatation of a ureteric stricture may allow the passage of a stent. A 5 mm diameter, 4 cm long angioplasty balloon is usually effective.

Difficult strictures

Difficult strictures may be crossed using a 6F/4F coaxial catheter system passed over a straight hydrophilic guidewire. If the 6F supporting catheter is placed close to the site of the stricture, the stricture may be crossed with the guidewire and immediately followed by the 4F inner catheter.

Impassable strictures

A number of methods for making new channels have been reported. The simplest involves reversing the straight hydrophilic guidewire and pushing firmly along the line of the stricture, aiming for the bladder. More developed methods involve the use of electrocautery or a Nd: YAG laser [52].

Complications of ureteric stent placement

Unfortunately, there is no such thing as the perfect stent. Complications may be divided into immediate and delayed. Immediate complications relate to the technique of stent placement, whereas delayed complications are related to the presence of a foreign body in the urinary tract.

Infection, especially when combined with low urine output, predisposes to stent encrustation. Infection may be treatable with antibiotics; however, if marked encrustation has occurred, stent replacement may be required. It is important that infection should be well treated before ureteric manipulation. Pre-procedural antibiotics are recommended even if there is no pre-existing infection.

Some patients tolerate stents poorly. In these cases, replacement with a shorter or softer stent may relieve symptoms. Complications of stent placement are listed below.

Immediate complications

Upper pigtail left outside the kidney in the perinephric space, Upper pigtail placed too low in the upper ureter, Perforation of the renal pelvis or ureter, Extraureteric stent placement

Buckling—obstruction

Delayed complications

Bladder irritation, Stent occlusion, Stent migration, Stent breakage, Infection, Stone formation, Ureteric erosion, Ineffective drainage, reflux pain.

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A Platform For Radiology Education & Interaction

Calcutta Academy of Radiology was formed on international day of Radiology in 2019, that is on 8th. November, 2019 to promote Radiology education, keeping in mind Residents as well practicing Radiologists.

Since then we are on WhatsApp and Telegram, where thousands of cases have been discussed by members from all over the world and in the process we are sharing our experiences and helping each other. These social media platforms have turned out to be great learning tools.

We had organized a half day CME also on GI Radiology in February, 2020. We have plans to organize more such CME programmes in future when world recovers from this ongoing pandemic.

We are on YouTube also where we regularly post teaching videos and in the process try to propagate Radiology as much as possible.

We are on WhatsApp and Telegram

Next issue will be published in April 2023

We will be bringing out such Newsletters with a frequency of one issue every two months. So, next issue will be published in April 2023.

We are hereby inviting good interesting cases and original work from our fellow Radiologists, which will be published on merit basis.

So, I request all of you to contribute to this Newsletter. Please send your material in Word format with good quality images. Please send your photograph and details of your place of work with email address also.

Your material should reach us by 15th. Of March 2023. You can send the word file to our abovementioned email address or you can WhatsApp it to above-mentioned three phone numbers.

On our YouTube channel, we are presenting a new case every week and there is good response to such teaching videos. I hereby request all Radiologists to share their teaching videos with us and if they contain good teaching material, we will surely publish it on our channel. So friends, during this trying time , stay away from depression by engaging yourself in academic activities.

Our Telegram group is lagging behind in academic activities as compared to two WhatsApp groups, so I request all of you to join our Telegram group. Since, WhatsApp restricts the number of members to 256 only, whatever activity going on there is not helping the whole Radiology community. Telegram can add up to whopping 200,000 members. So, if we post our study material there; it will reach to and benefit huge number of members.

So friends, take care and be safe.

So, see you all in next issue of CAR newsletter.

So long,

Anup Sadhu, Bijon Kundu and Viral Parekh.

We are thankful to all the contributors for sharing their experiences and literature with us and in the process helping the Radiological fraternity.