KARNATAKA RADIOLOGY EDUCATION PROGRAM

Anatomy and Applied Radiology Kidneys – 5

Nuclear imaging

Renal imaging in nuclear medicine is a method to assess the kidneys and collecting systems via multiple different radioactive tracers.

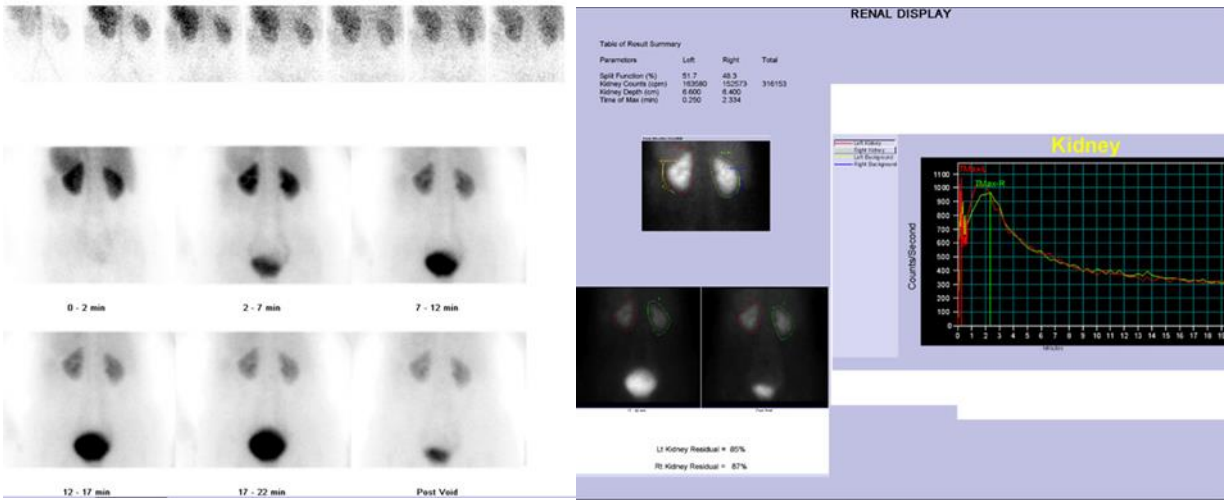
Dynamic renal imaging is performed using Tc-99m MAG3 or Tc-99m DTPA, and static renal imaging is performed with Tc-99m DMSA. In addition, Tc-99m DTPA can be used to calculate glomerular filtration rate (GFR) washout without an accompanying imaging study.

Dynamic renal scintigraphy

Dynamic renal studies are able to assess the perfusion to the kidneys, extraction of tracer from the blood and excretion of the tracer through the collecting system. Tc-99m MAG3 is secreted in the distal part of the proximal tubule by active secretion and Tc-99m DTPA is removed from the blood by the glomerulus by filtration 3. While both radiopharmaceuticals provide good images, MAG3 has higher renal extraction and chemical purity and is often the preferred agent for imaging only studies. If the patient requires concurrent GFR measurement, Tc-99m DTPA will be performed.

Indications include evaluation of mechanical renal tract obstruction (including pelviureteric and vesicoureteric junction obstruction), perfusional abnormalities, investigation of declining renal function, calculation of differential renal function and assessment of renal transplants 3. Furosemide (Lasix) is often administered to patients who are being investigated for known or suspected renal tract obstruction or those with poor urine drainage after 10 to 20 minutes 3. Renovascular hypertension or renal arterial stenosis (RAS) can be investigated with the addition of captopril to the imaging protocol 3.

Imaging protocols vary between sites, but will consist of continuous acquisition for a minimum of 25-30 minutes to demonstrate the perfusion, extraction and excretion phases. Delayed planar imaging can be performed if there is a concern for renal tract obstruction. SPECT-CT is not routinely performed as part of the study.

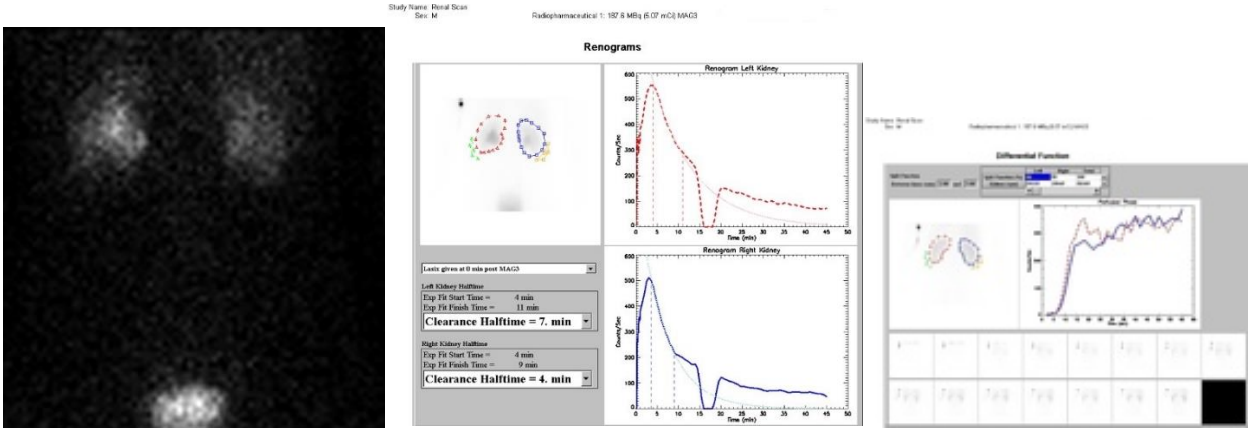


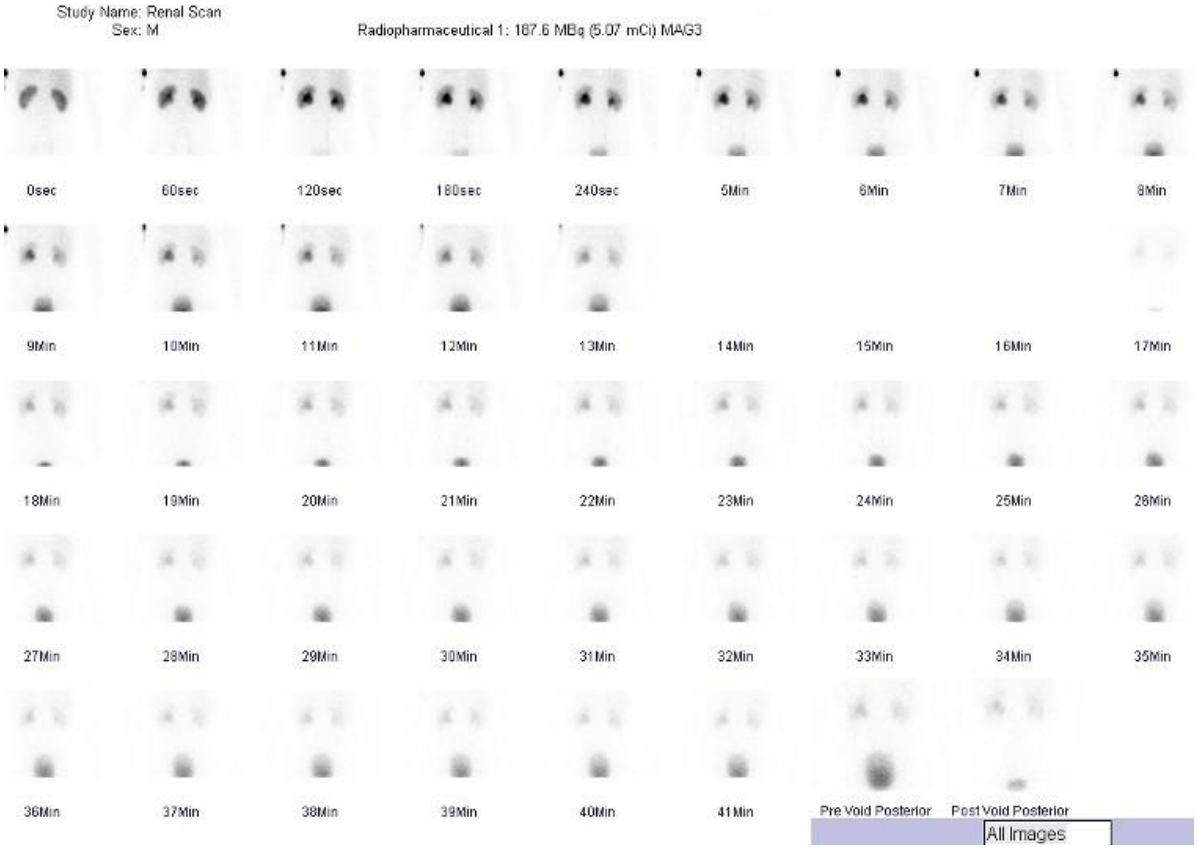
Static renal scintigraphy

Imaging of the renal cortex is achieved following administration of Tc-99m DMSA. While the mechanism of action is unclear, our ability to use it as an imaging agent is partly due to retention in renal tubular cells 3. Renal uptake of DMSA is 45 to 65% in 2 hours after intravenous injection 3.

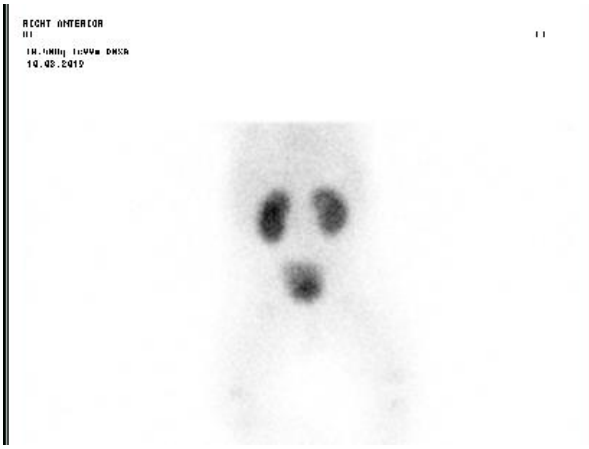
Indications include evaluation of renal scarring 3 (e.g. reflux nephropathy, prior trauma) or calculation of differential renal function.

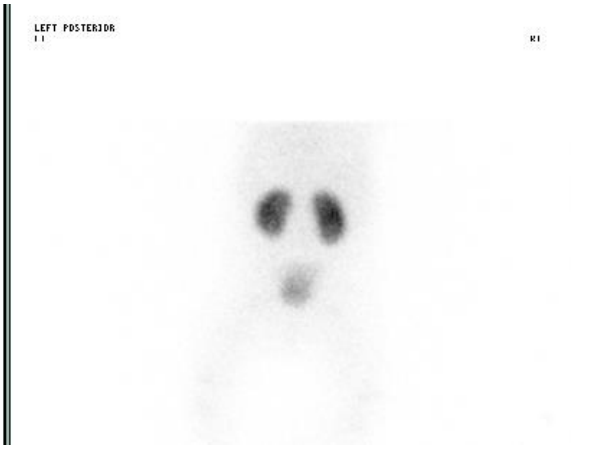
Imaging occurs at a delayed time-point, 2-4 hours after radiopharmaceutical administration. Depending on the site, image acquisition may consist of planar images only (with a pin-hole collimator) or SPEC.

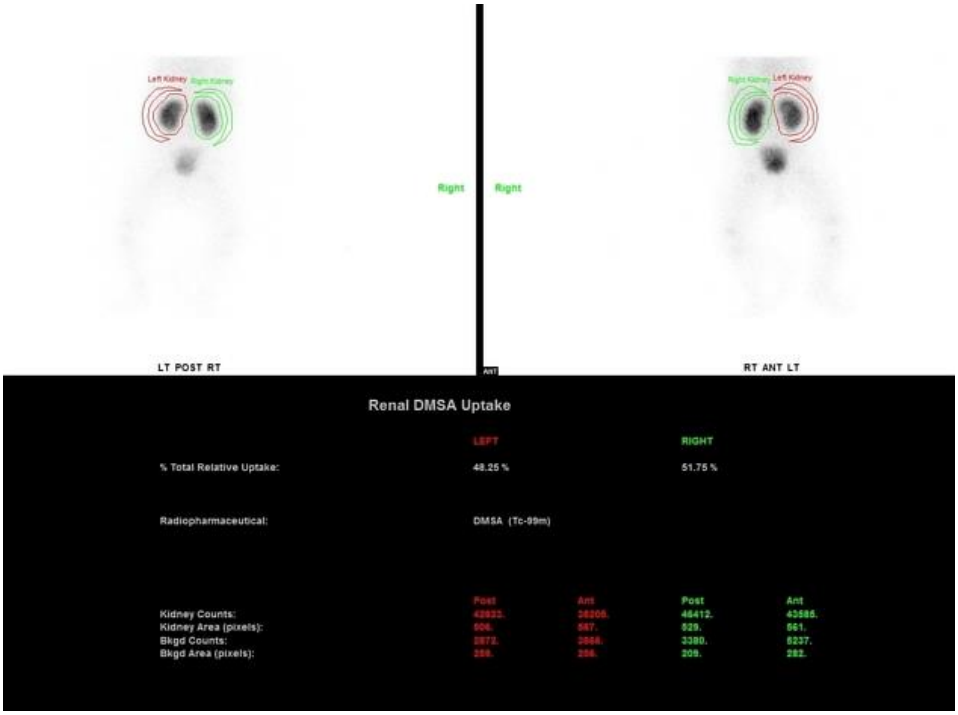




Normal renal MAG 3 nuclear study






Left Kidney
Right Kidney
Right
Right
Right Kidney
Left Kidney
LT POST RT
ANT
RT ANT LT
Renal DMSA Uptake
LEFT
RIGHT
% Total Relative Uptake:
48.25 %
51.75 %
Radiopharmaceutical:
DMSA (Tc-99m)
Post
Ant
Post
Ant
Kidney Counts:
42833.
38205.
46412.
42586.
Kidney Area (pixels):
606.
547.
529.
561.
Bkgd Counts:
2872.
2864.
3380.
8237.
Bkgd Area (pixels):
258.
256.
209.
282.

NORMAL DMSA

Percutaneous Biopsy

Percutaneous renal biopsy, utilizing either ultrasound or CT, allows for an accurate, reliable method of acquiring renal tissue for histopathological assessment.

The biopsy may be of a native or transplant kidney. It is divided into two types:

1. **non-focal or non-targeted 2. focal or targeted (i.e. directed at a lesion)**

Either type may be performed as a CT-guided biopsy or as an ultrasound-guided biopsy 1. A description has been given of the use of 3D cone beam CT in assisting the biopsy of particularly challenging focal lesions .

This depends on both patient and operator factors, such as patient body habitus, ability to cooperate and operator experience. Transplant renal biopsy is usually undertaken with ultrasound guidance given its more superficial location in the pelvis.

An alternative option for percutaneous CT/US guidance is the transjugular renal biopsy.

Indications

- **focal lesion non-characterized on diagnostic imaging**
- **renal failure with unknown cause (typically a nephropathy)**
- **deteriorating renal function in a transplant patient**

For focal mass lesions, the established indications include:

- **known extra-renal malignancy**
- **suspected renal lymphoma**
- **prior to ablation therapy**
- **multiple or bilateral renal masses**
- **diagnostic dilemma of infection/malignant mass**
-

Contraindications

The contraindications must be considered individually in each case. Overall, the most important contraindications are:

- **uncooperative patient**
- **uncorrectable bleeding diathesis (abnormal coagulation indices)**

Procedure
Laboratory parameters for a safe procedure
Interventional procedures like renal biopsy require special attention to coagulation indices. There are widely divergent opinions about the safe values of these indices for percutaneous

biopsies. The values suggested below were considered based on literature review, whose references are cited below:

- **complete (full) blood count:**
  - **platelet > 50000/mm3 (some institutions determine other values between 50000-100000/mm^3) [3]**
- **coagulation profile:**
  - **some studies showed that having a normal INR or prothrombin time is no reassurance that the patient will not bleed after the procedure:**
    - **international normalized ratio (INR) ≤ 1.5 [3]**
    - **normal prothrombin time (PT)/partial thromboplastin time (PTT)**

Pre-procedure preparation

- **written informed consent**
- **assessment of patient's cooperation for the procedure**

Equipment

- **single or co-axial needle set: usually an 18 G core biopsy needle**
- **1% lidocaine/lignocaine**
- **midazolam (for sedation): select cases only; assess on a case-by-case basis**
- **histopathology department pots**

Technique

Focal biopsies usually require only a single core. Non-focal biopsies typically require two cores. This influences technique as the latter requires a co-axial needle set.

For native or transplant non-focal kidney biopsies, the core is usually taken from the lower pole.

Both ultrasound and CT biopsies are normally performed with the patient prone or on occasion on the ipsilateral side up position in CT. Transplant biopsies are performed supine due to the superficial position in the pelvis.

CT guidance is preferred for those of larger body habitus. Operator preference plays a part too.

After the procedure, a brief assessment for perinephric or intraparenchymal hemorrhage is advised.

Post-procedure care

Bed-rest is advised as well as regular observations for 4 hours (pulse, blood pressure, SpO_2) and active questioning of the patient of any pain or hematuria.

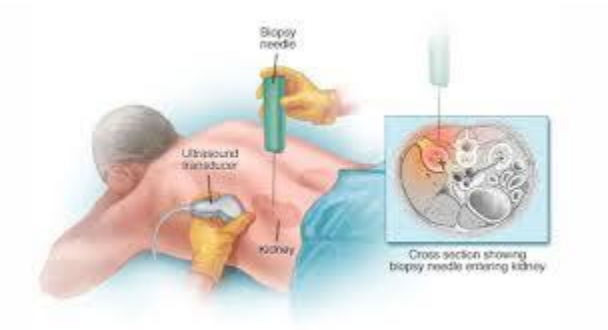
The observation period should allow an ample opportunity to identify and treat a potential complication in a timely manner to prevent a serious or catastrophic outcome, this varies with each institution's protocol. One large experience review major complications were identified in >90% of cases by 24 hours .

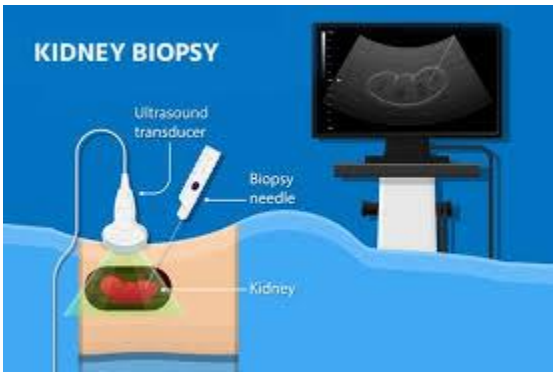
Complications

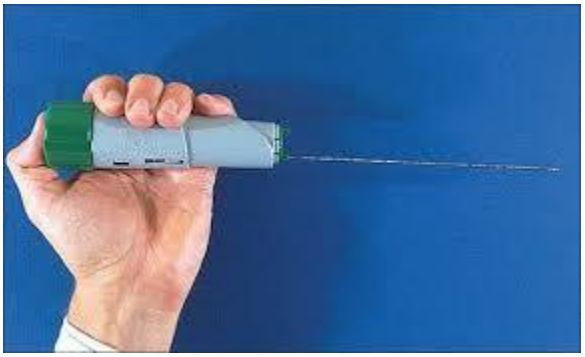
Percutaneous renal biopsy remains a safe procedure, but the risk of complication is higher in patients with advanced renal insufficiency [4]. Some studies have also shown that hypertension and amyloidosis has a significant influence on the complications [5]. These patients may benefit from a longer observation period.

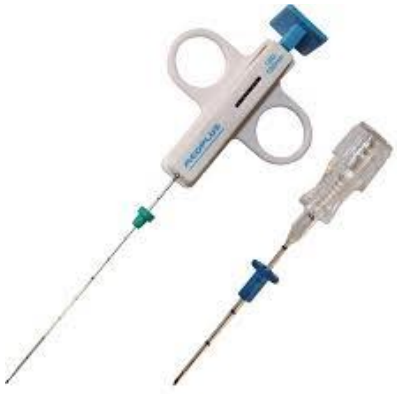
Complications include:

- **perinephric (retroperitoneal) or intra-renal hematoma**
- **hematuria**
- **arteriovenous fistula or pseudoaneurysm**
- **colonic injury (very rare with image guidance)**
- **pneumothorax (very rare with image guidance)**









Histopathological analysis

Core 1

Fixed in paraffin then used for the following staining procedures for light microscopy:

A: Routine stains:

- **Hematoxylin and eosin (H&E)**
- **Periodic acid-Schiff's (PAS)**
- **Fibrous tissue stain (e.g.elastic van Gieson etc)**
- **Silver stain**

B: Optional stains:

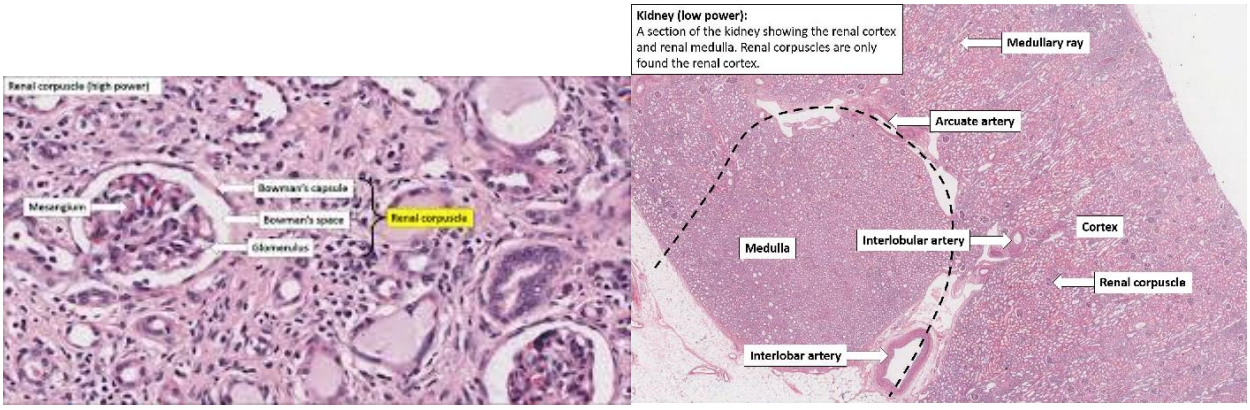
- **Kossa stain (calcifications)**
- **Congo red stain (amyloid)**

C: Immunohistochemistry: IgG, IgA, IgM, C3, C1q

Core 2

Used for immunofluorescence studies (frozen sections), electron microscopy (fixed in glutaraldehyde) and additional tests.

Not every biopsy requires electron microscopy. Some conditions (e.g. Alport's disease; immunotactoid disease; minimal change nephropathy) require electron microscopy for a definite diagnosis.



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