Ramathibodi Comprehensive Cancer Center
and Multidisciplinary Team

RCC Master Class

FROM DIAGNOSIS TO TREATMENT: THE RADIOLOGIST PERSPECTIVE

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Role of imaging in RCC

- Diagnosis
- Staging
- Follow up

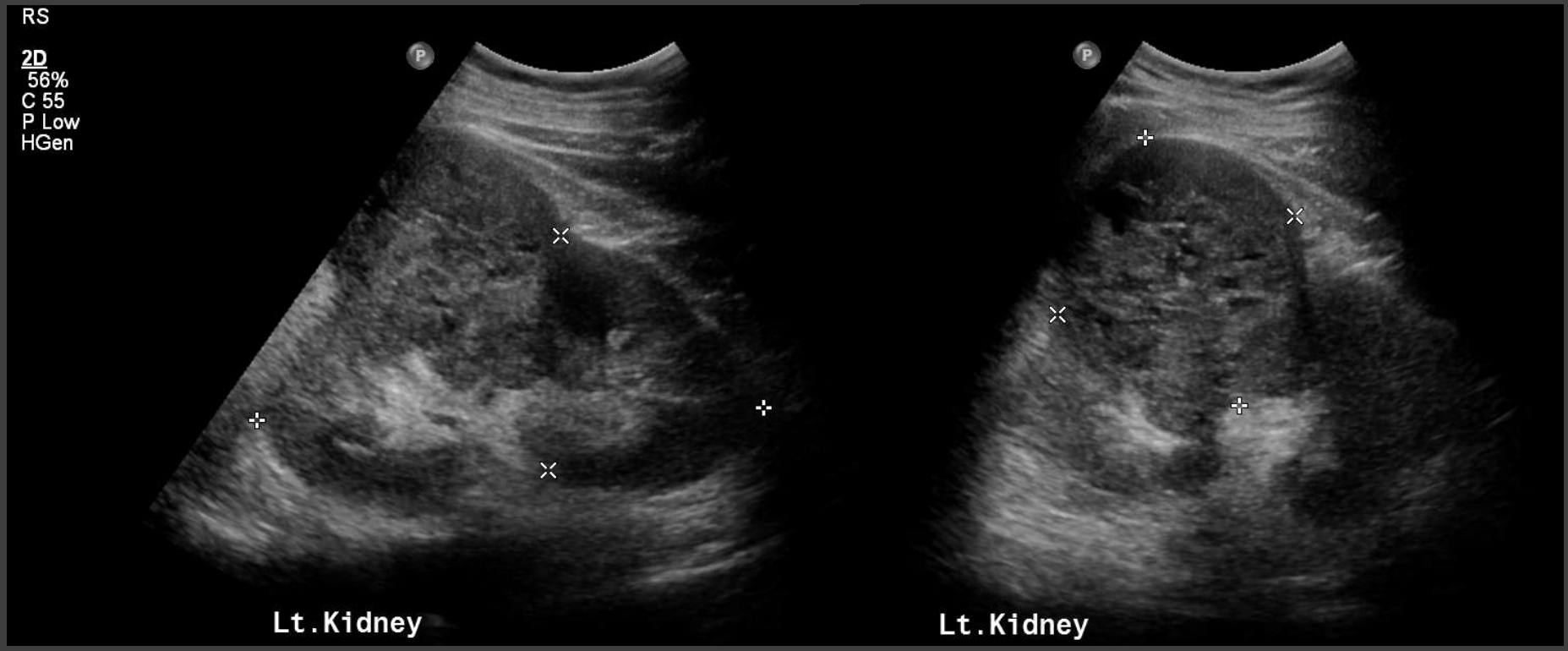
- Imaging modalities
- Limitations and pitfalls

Diagnosis

- Incidentaloma
- Differentiate benign from malignant lesion
- Early cancer detection

Ultrasonography

- Cystic or solid lesion
- Variable echogenic
  - Hyperechoic (48%)
  - Isoechoic (42%)
  - Hypoechoic(10%)



Large mass – heterogeneous echogenicity

Ultrasonography

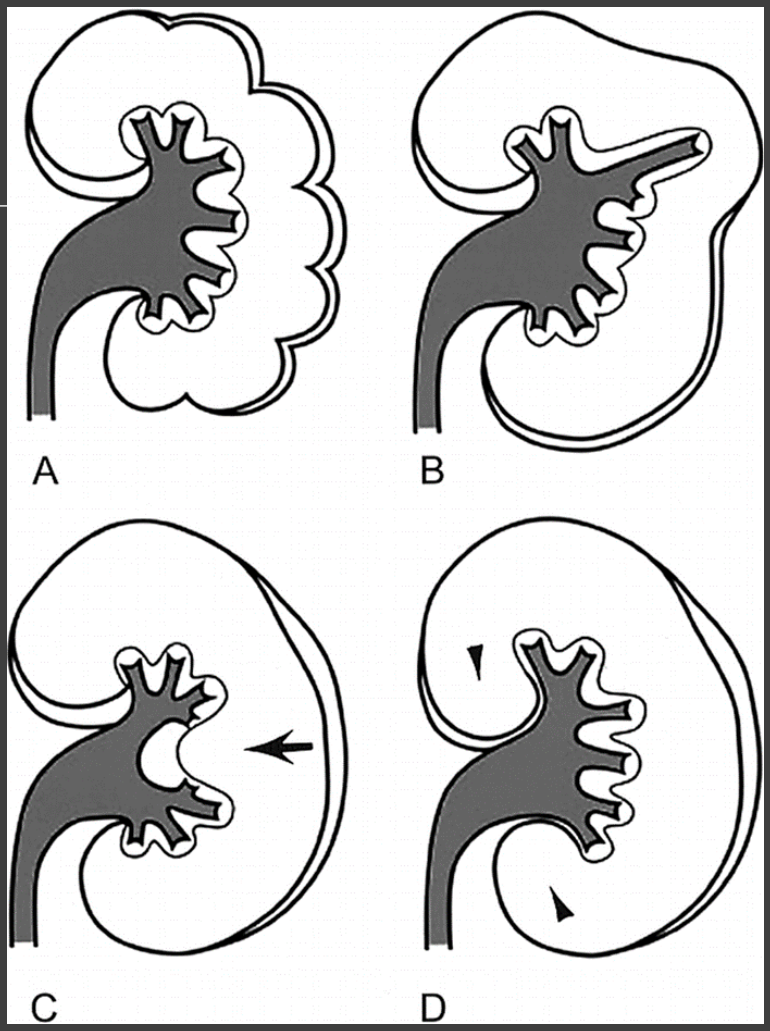
Detection depend on

- Size – 1.5 cm (sensitivity 80%)
- Location
- Echogenicity

Isreal GM et al. Urol Clin North Am 2003; 30:499-514

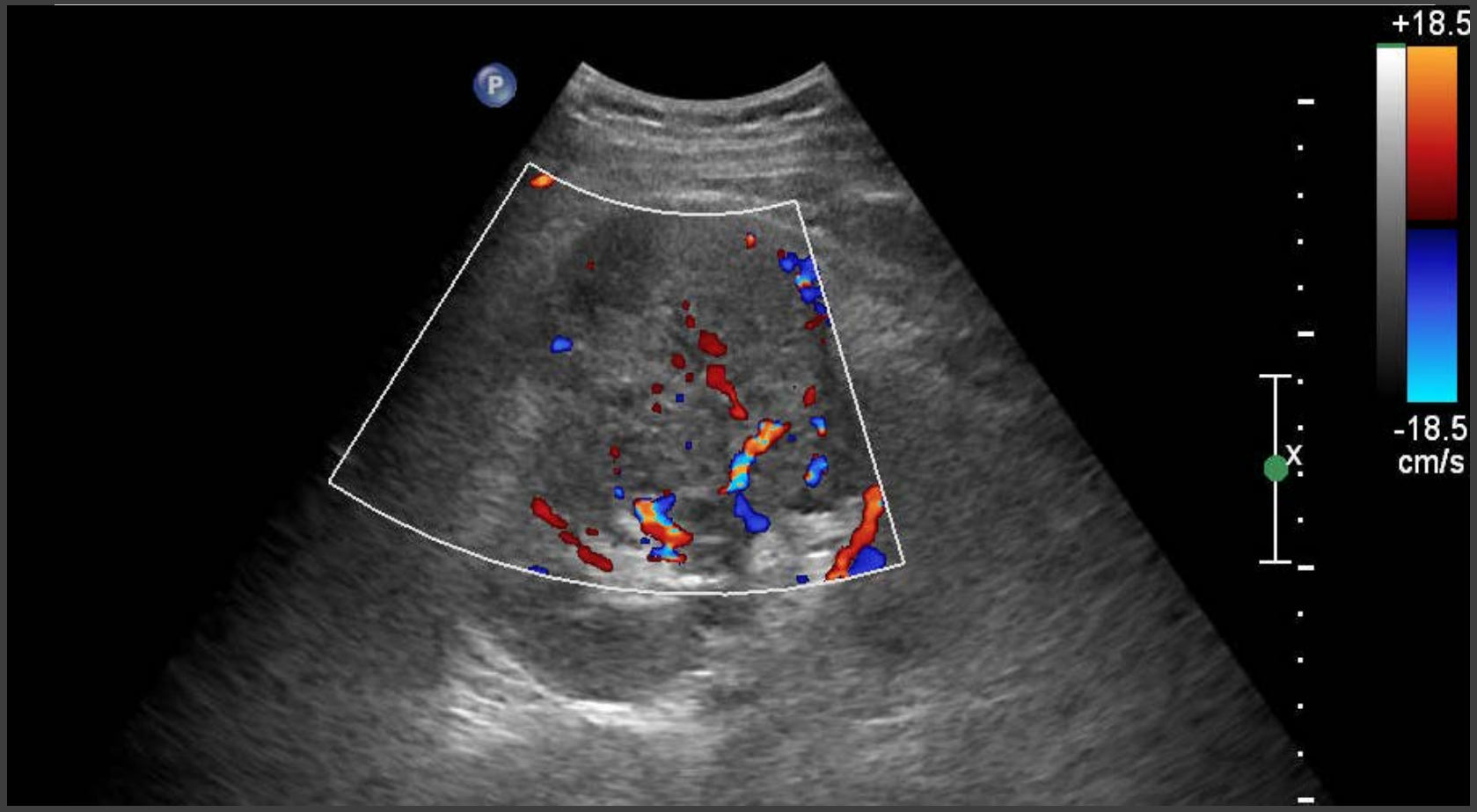
Solid lesion

- Small isoechoic can be misses
- DDx from pseudotumor
  - Prominent column of Bertin
  - Dromedary hump
  - Persistent fetal lobulation
  - Junctional parenchymal defect



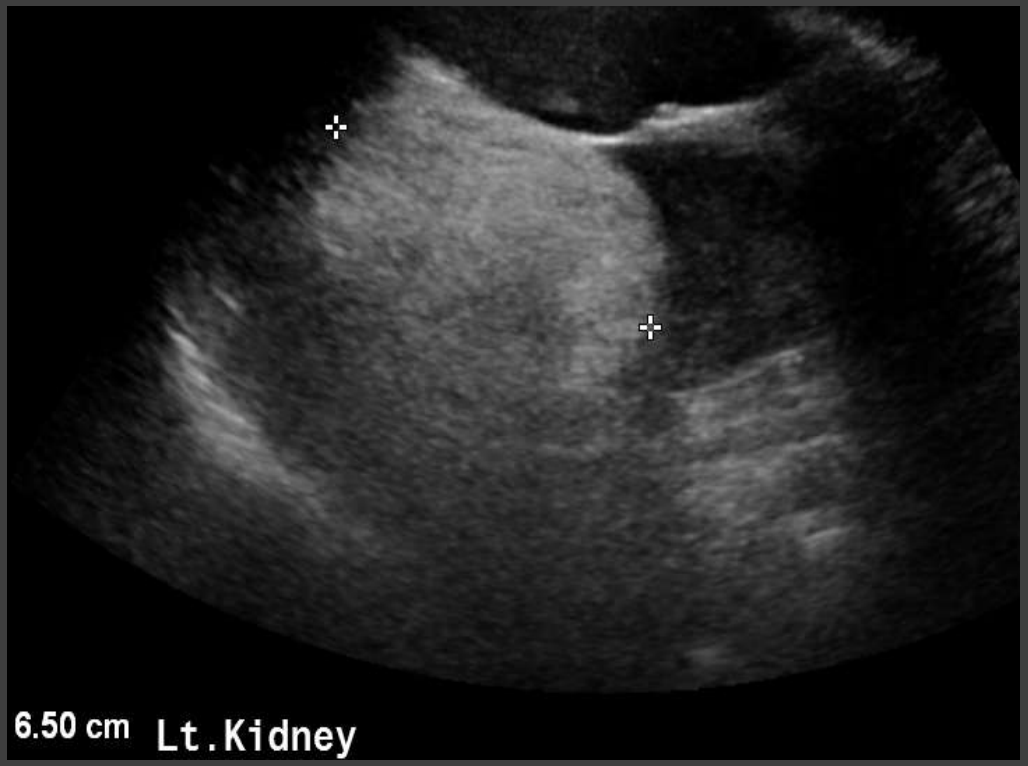
Dyer R B et al. Radiographics 2004;24:S247-S280

Color Doppler US



Solid RCC

- Small solid hyperechoic lesion
  - Hypoechoic/anechoic rim/pseudocapsule and intratumoral cystic changes - **RCC**
  - Posterior acoustic shadow - **AML**

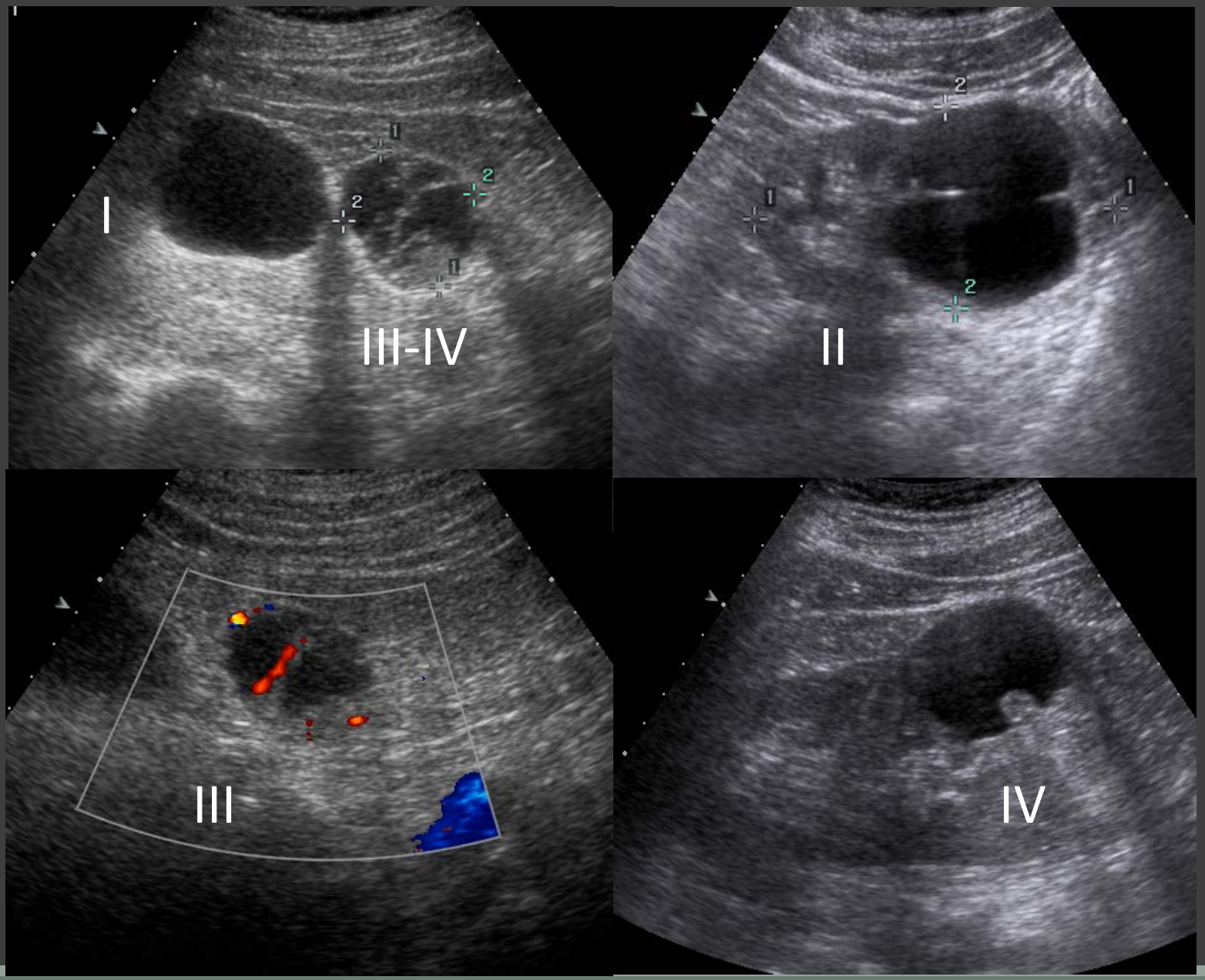

6.50 cm
Lt.Kidney

Cystic lesion

- Do not fulfill criteria of simple cyst - possibility of cystic renal carcinoma.
- US and CT, MR complement each other in characterization of renal lesions

Cystic lesion

- Features concerning malignant cyst lesion
  - Thickened wall
  - Multiple septations, thickened or nodular septations
  - Irregular or central calcifications
  - Presence of flow in septations or cystic wall on Doppler imaging
  - Solid mural nodule


I
III-IV
II
III
IV

Bosniak Classification of Renal Cysts

Lesion Type	Morphology	Calcification	Septations	Cyst Wall	Management
Bosniak I	Simple cyst with fluid attenuation (0–20 HU)	None	None	Thin and smooth	Benign; no follow-up needed
Bosniak II	Minimally complex cyst or a well-marginated, uniformly hyperattenuating cyst; diameter ≤3 cm; partially outside the kidney	Fine or minimally thick calcifications in wall or septa*	A few hairline-thin septa without measurable enhancement*	Thin and smooth	Benign; no follow-up needed
Bosniak IIF	More complex elements than a Bosniak II cyst but fewer than a Bosniak III cyst, or a uniformly hyperattenuating cyst that does not meet Bosniak II criteria	May contain a few small nodular calcifications*	Multiple thin internal septations without measurable enhancement*	May be mildly thickened, without measurable enhancement	Follow-up CT or MR imaging to assess for increasing complexity, which may indicate malignancy
Bosniak III	Complex cyst with enhancing septations or wall	Variable	May be thick or irregular, with measurable enhancement	May be thick or irregular, with measurable enhancement	30%–100% chance of malignancy; resection recommended
Bosniak IV	Cystic mass with enhancing soft-tissue components	Variable	Clearly enhancing nodule in septa	Clearly enhancing nodule in wall	Malignant until proven otherwise; resection recommended

Note.—MR = magnetic resonance.
*Hyperattenuating Bosniak II and IIF cysts do not have septations or calcifications.

Wood et al, CT and MR Imaging for Evaluation of Cystic Renal Lesions and Diseases, Radiographics 2015.

CT scan

- MC appearance:
  - Solid lesion
  - Attenuation value > 20 HU on NCCT
  - Enhance significantly: enhancement value > 20 HU
- CECT - detection typical RCC size 1 cm
  - Sensitivity 100%, specificity 88-95%

Tann M et al. Eur Radiol 2001; 11:1435-8

CT scan

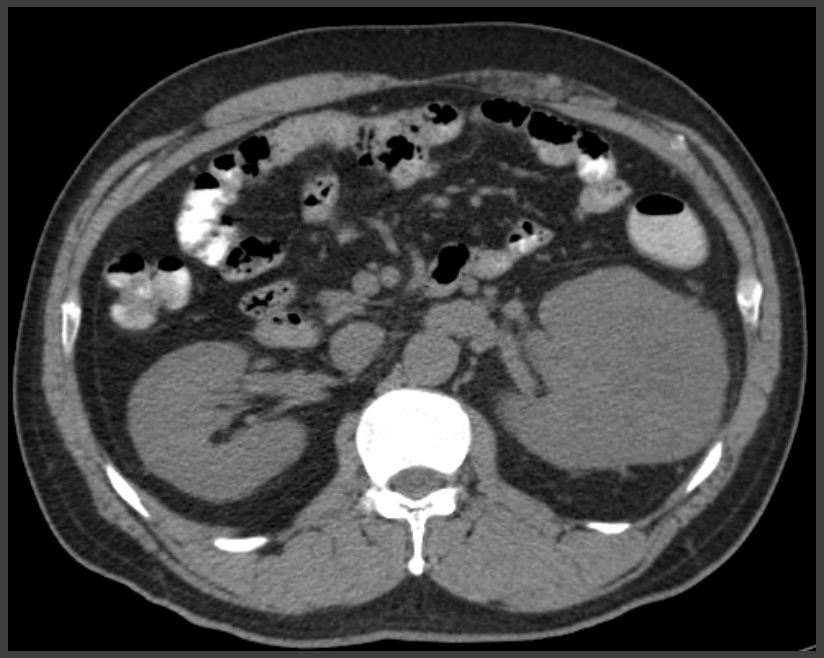
One common pitfall in characterizing renal lesions by CT is pseudoenhancement in renal cysts - volume averaging and beam hardening effects

- Degree of pseudoenhancement is greater in smaller cyst.
- Solid portion - enhances > 15-20 HU almost always pathologic process although not always malignant
- Ultrasound or MR may helpful.

Imaging protocols of MDCT of kidney

Non-contrast

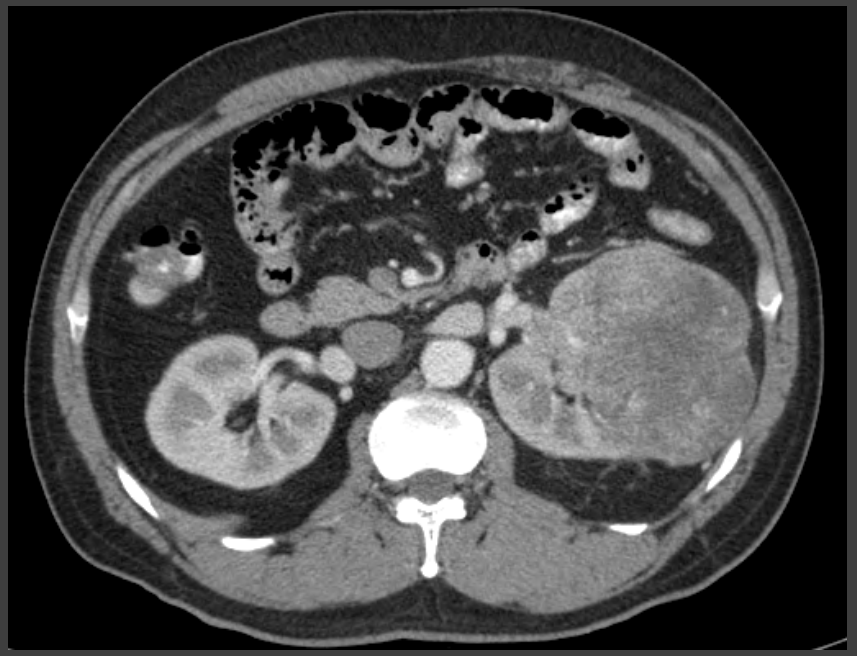
- Urolithiasis
- Acute hematoma
- Baseline density



Imaging protocols of MDCT of kidney

Arterial phase or coriticomedullary phase

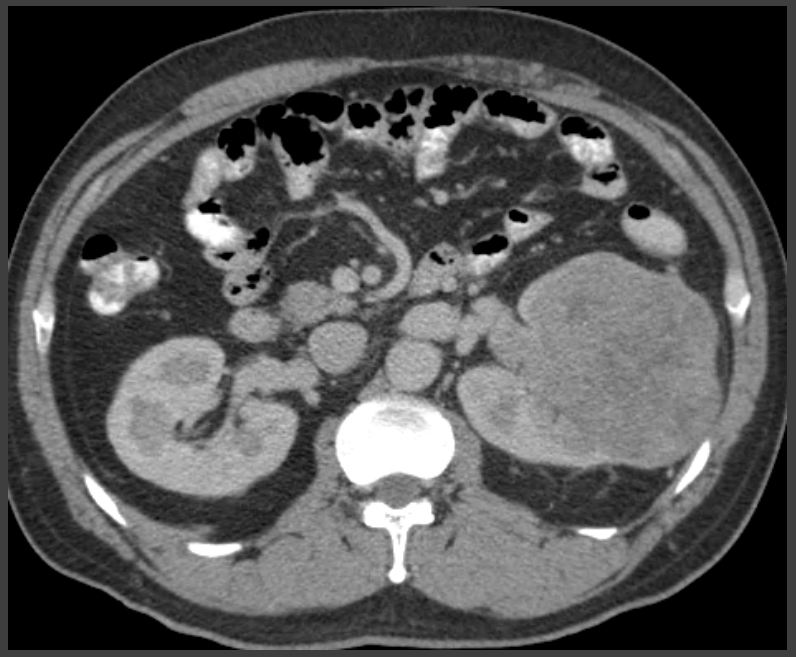
- 15-25 sec
- Arterial anatomy
- Hypervascularity
- Limitation of small RCC
  - enhance same degree as cortex
- Metastasis



Imaging protocols of MDCT of kidney

Nephrographic phase

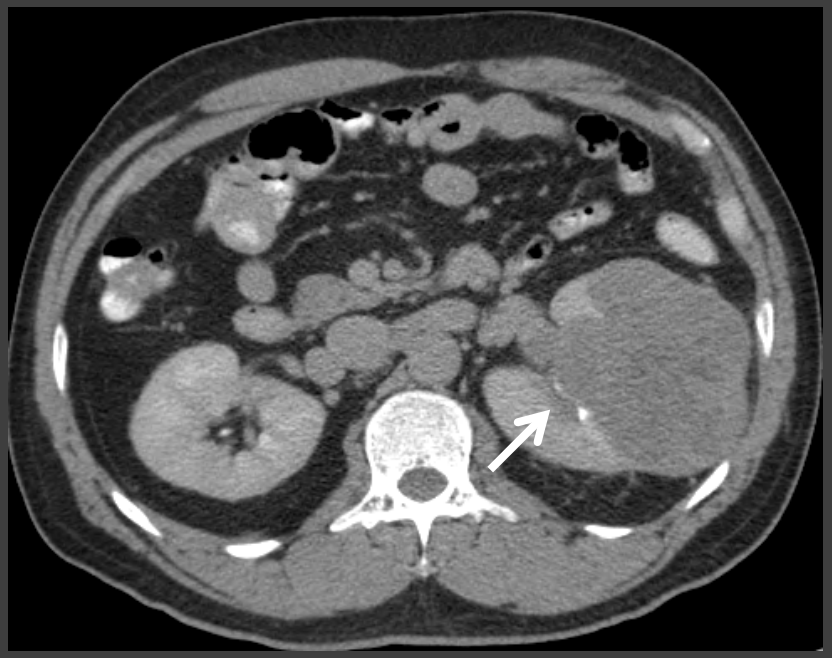
- 80-180 sec
- Renal parenchyma enhanced homogeneously.
- Most valuable for detecting renal masses



Imaging protocols of MDCT of kidney

Delayed/excretory/ urographic phase

- 180 sec
- Contrast excreted into collecting system - evaluate involvement calices and pelvis.
- Papillary subtype
  - Less intense enhance
  - accumulate contrast more slowly - delayed images may be helpful in confirming enhancement



CT scan

MDCT with multiplanar reformations (MPR)

helps delineate location of mass and its relationship to collecting system and vessels.

MR imaging

- High soft tissue contrast
- Availability of non-nephrotoxic contrast agent
- Identification macro and microscopic fat

MR imaging

- Macroscopic fat : AML
- Microscopic fat : AML, clear cell RCC
  - Lipid-poor AML (5.5%) may mimic RCC.
  - MR: Lipid-poor AML drop SI of 42%
    Clear cell RCC drop SI < 20%

RCC containing fat mimic AML

Malignant should be suspected on following criteria

↓

Intratumoral calcification

Large, irregular tumor invading perirenal fat

Large necrotic tumor with small foci of fat

Associated non-fatty lymph node

Venous extension

MR imaging

- Differentiation of cystic and solid renal lesions
- May depict additional septa, thickening wall or enhancement
- Evaluation of small renal masses with pseudoenhancement on CT

MR imaging

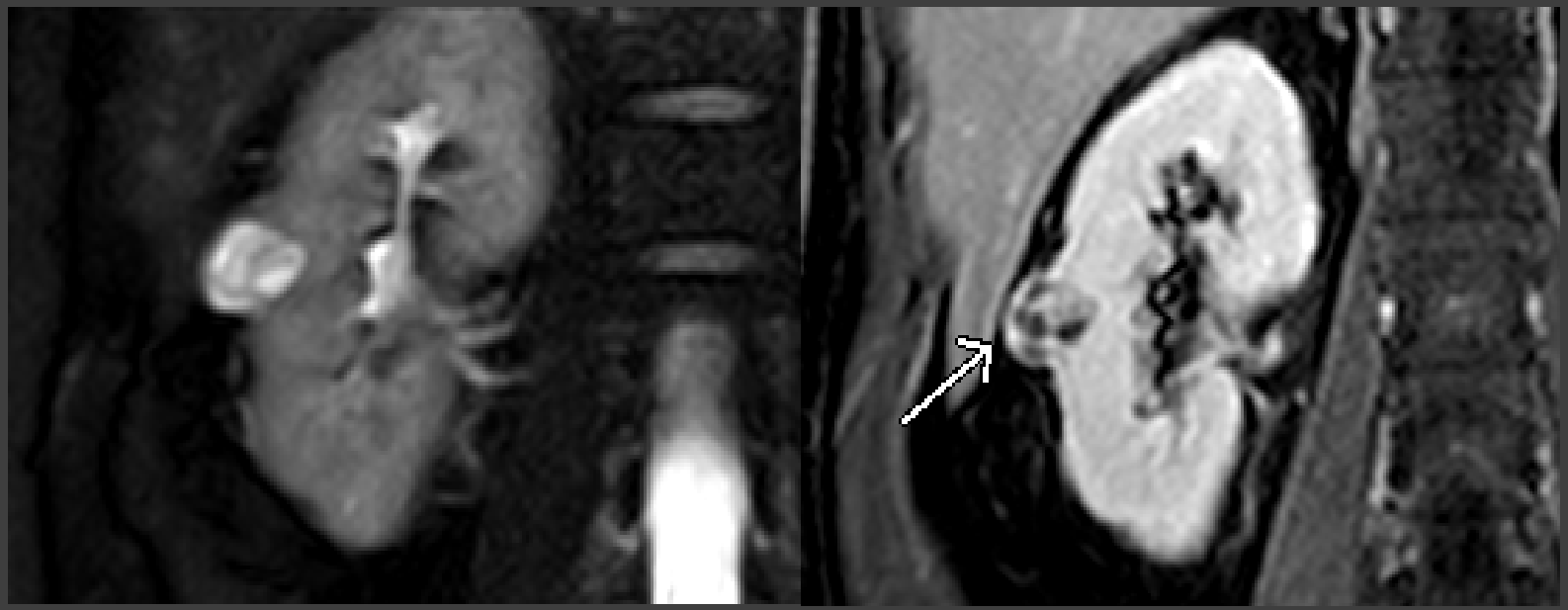
- RCC typically isointense or hypointense on T1W
  - may contain hemorrhage and show T1W hyperintensity
- Mildly hyperintense on T2W
  - Cystic RCC – marked hyperintense

RCC subtypes

Clear cell RCC

Clear cell RCC

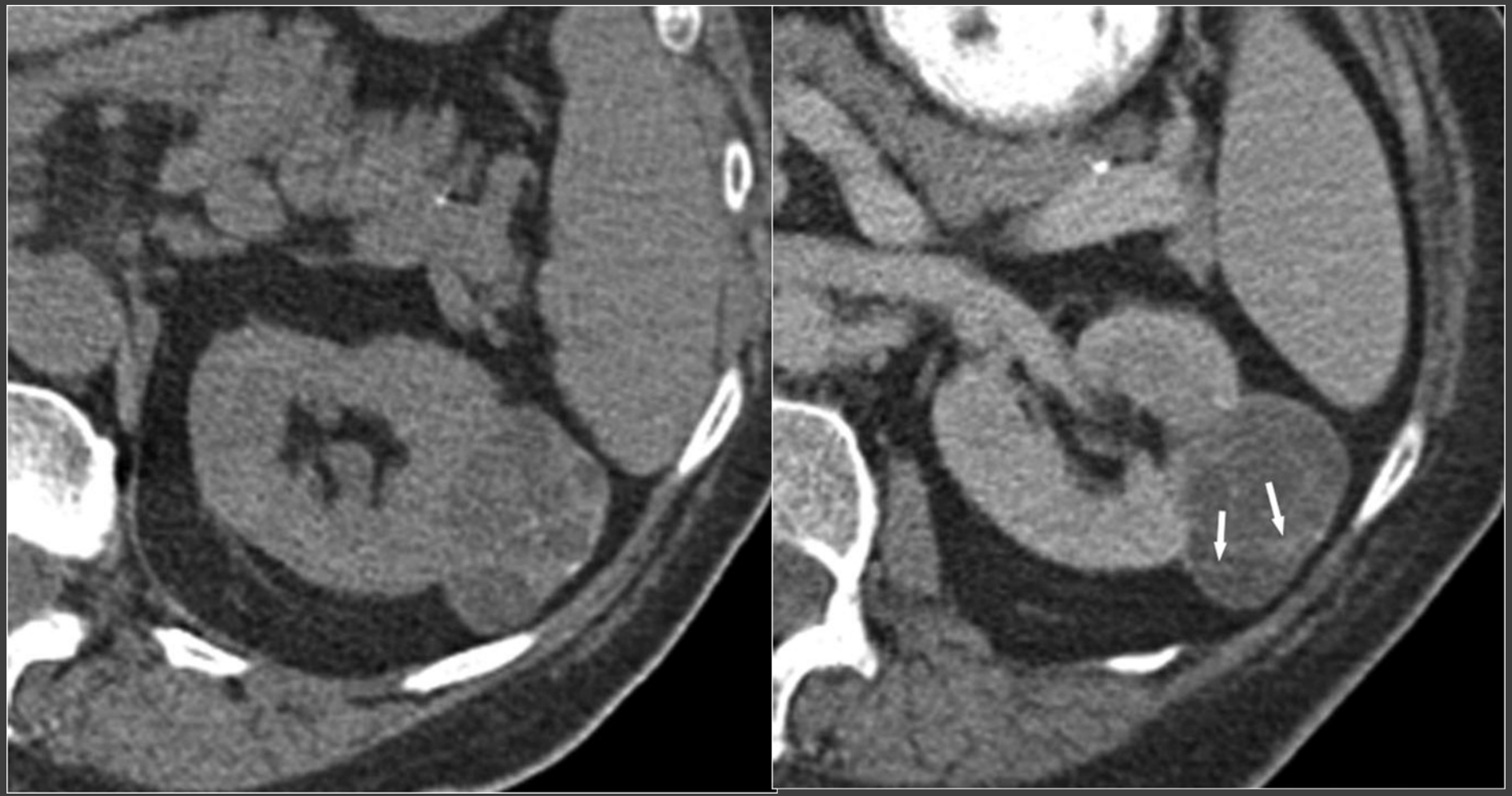
- ccRCC was predicted by signal intensity on T2W (high vs low, OR: 3.2, 95%CI 1.4-7.1) and contrast avidity (avid vs. low, OR: 4.5, 95%CI 1.8-10.8)



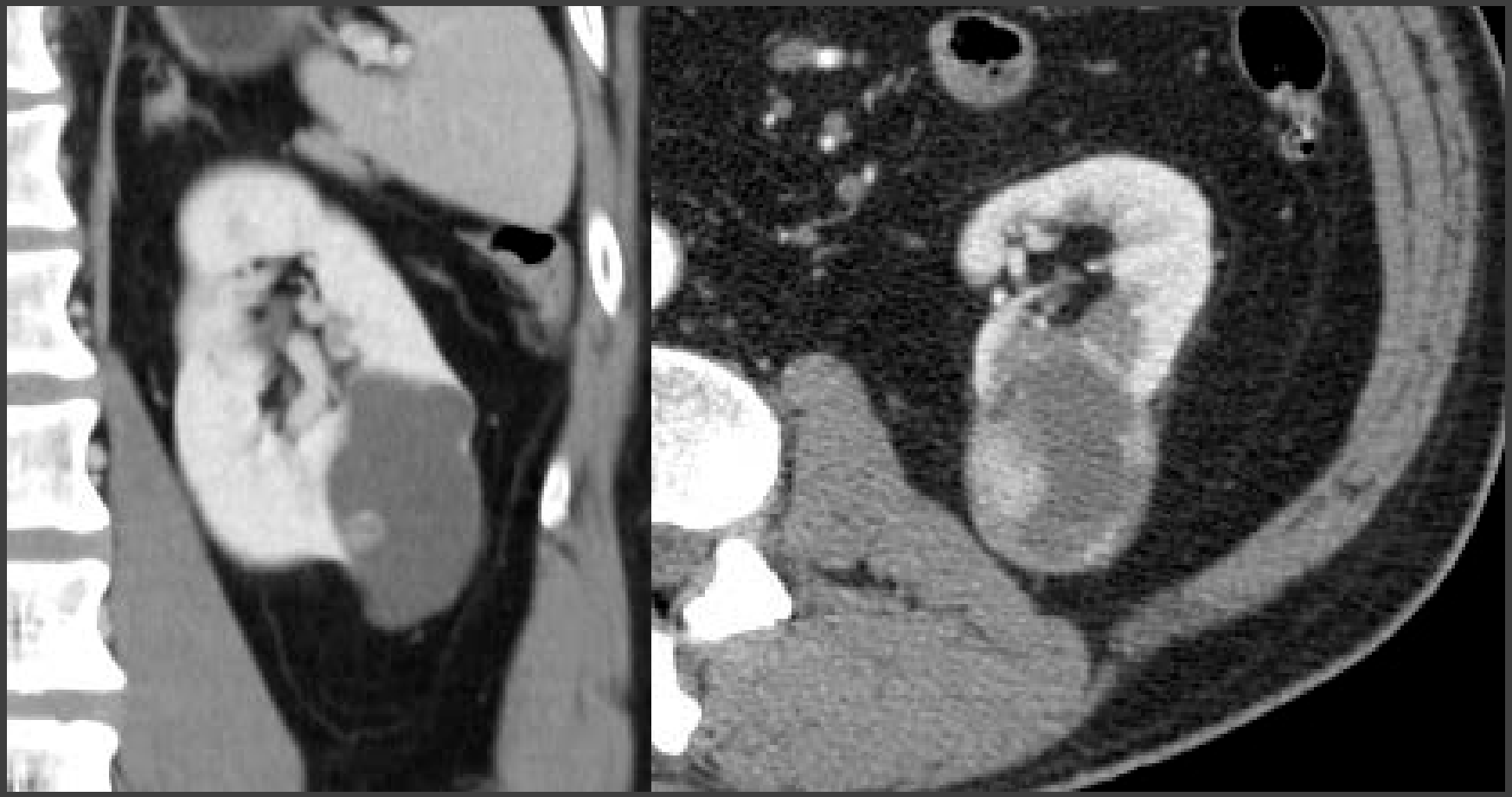
Cystic RCC

- Unilocular cystic RCC : extensive necrosis of previously solid RCC
- Multilocular cystic RCC : intrinsic multilocular growth, impossible to distinguish from multilocular cystic nephroma
- Mural nodule in cystic RCC : tumor arising in wall of preexisting cyst

Category III



Category IV



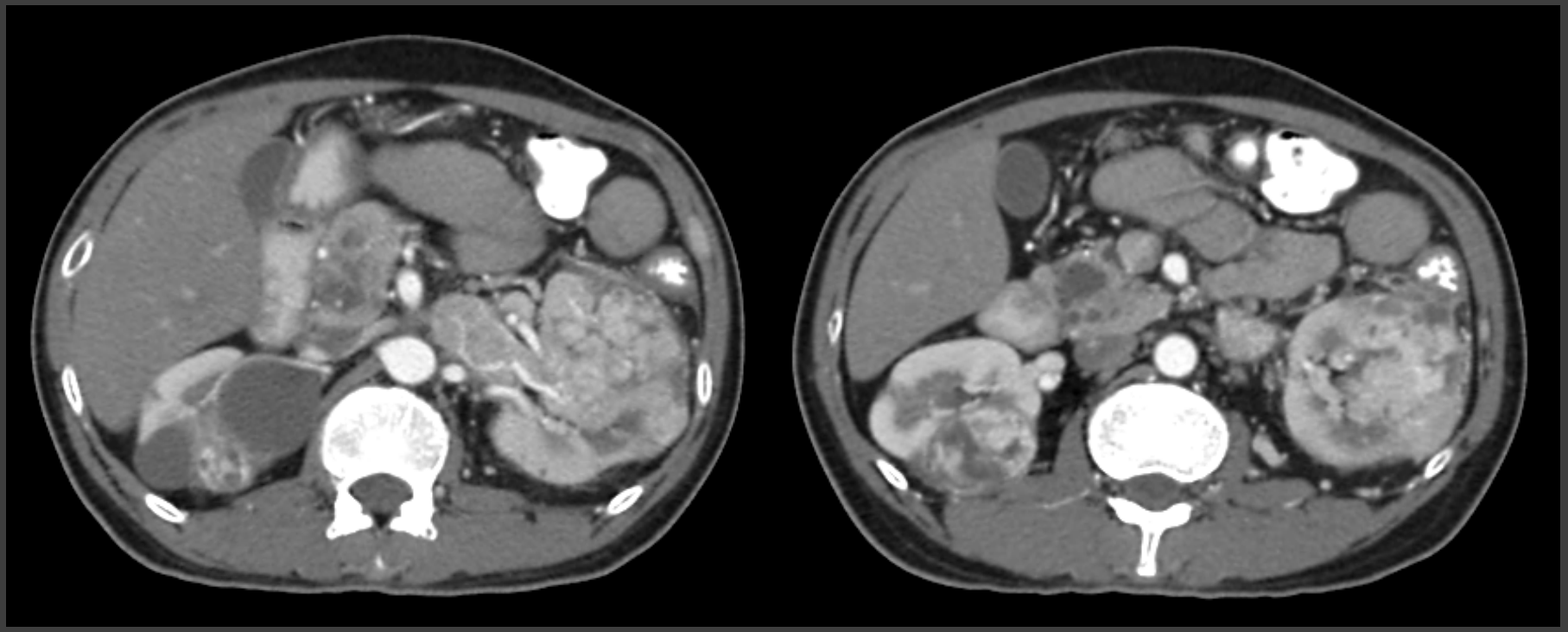
Papillary RCC

Less intense enhance

Chromophobe RCC

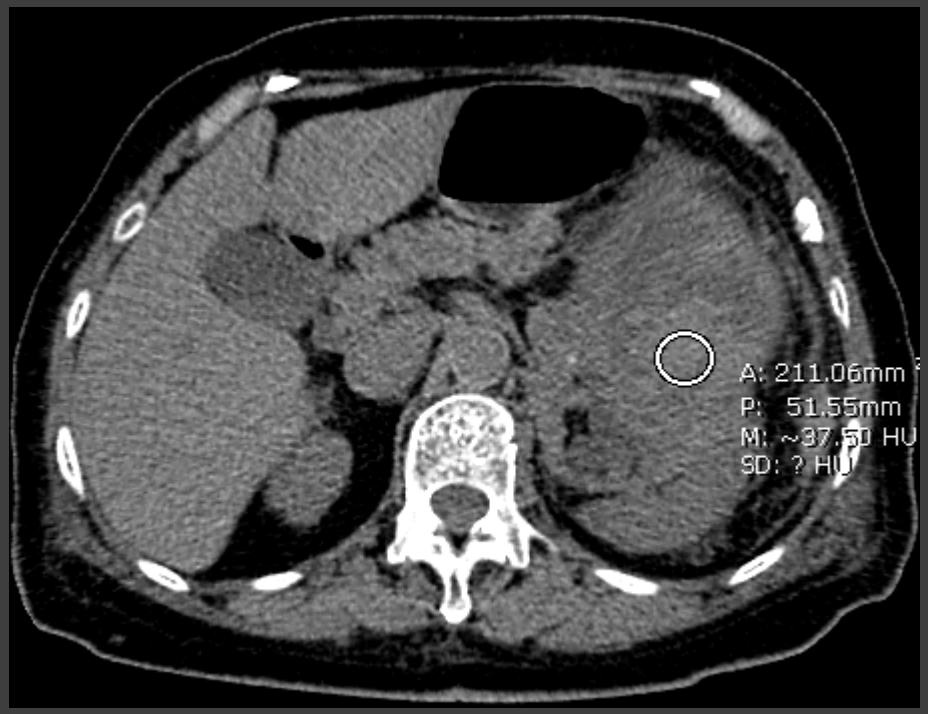
Synchronous multifocal RCCs

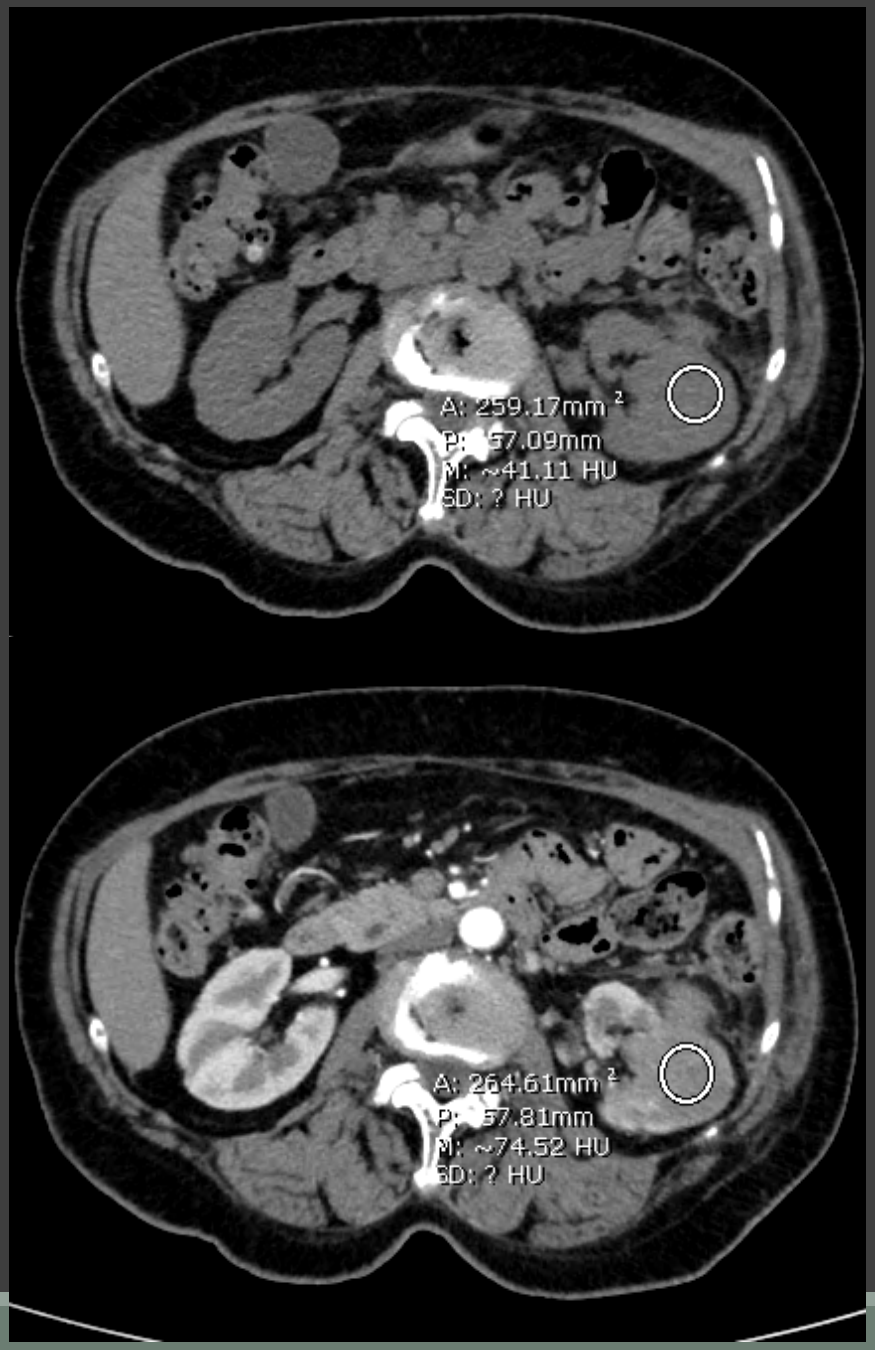
- Hereditary form :
  - Von Hippel-Lindau : clear cell RCC
  - Hereditary papillary RCC : papillary RCC
  - Birt-Hogg-Dube : chromophobe RCC
- Sporadic form : < 5%.



Spontaneous perirenal hematoma

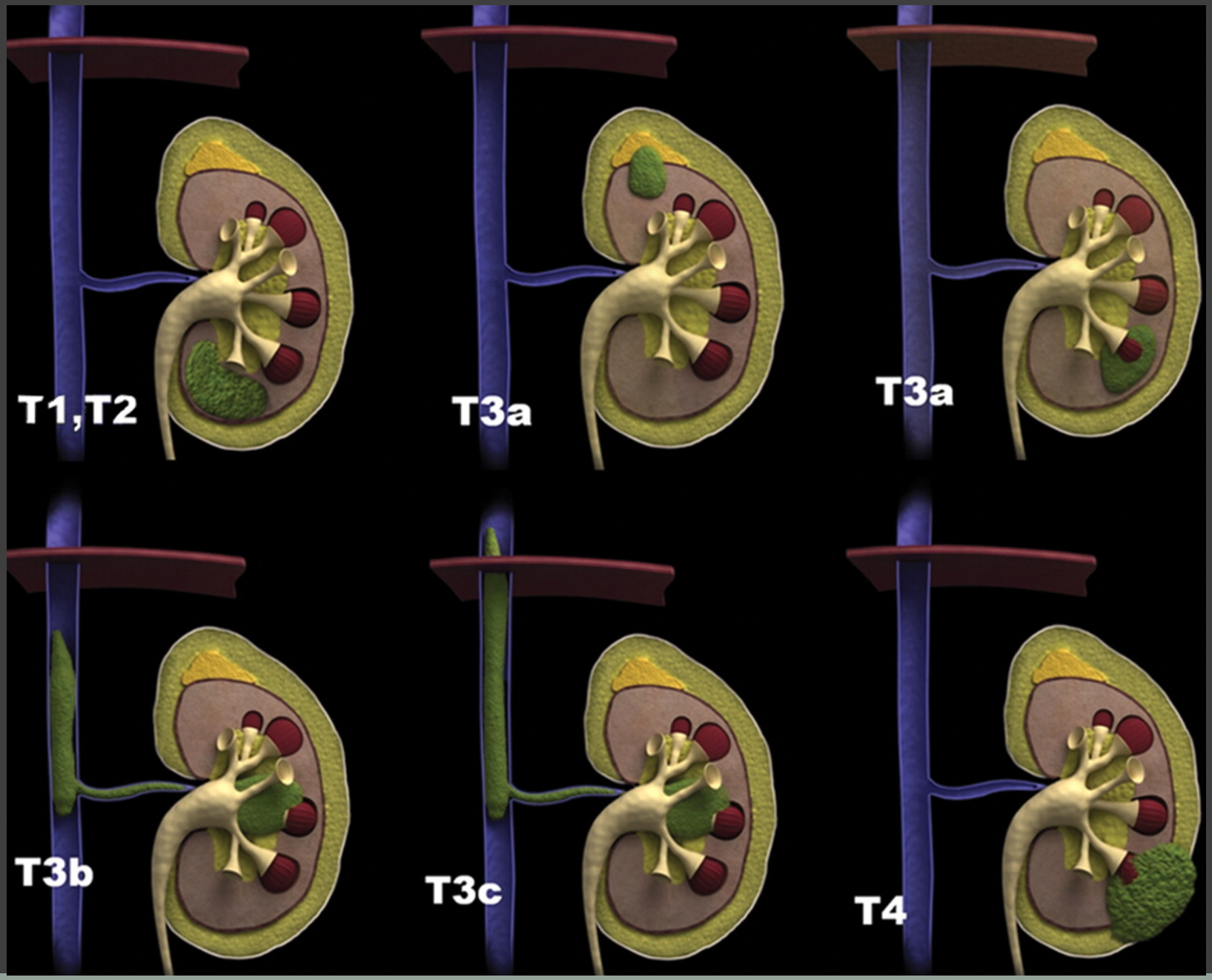
- MC cause of spontaneous unilateral perirenal hemaorrhage are benign or malignant neoplasms
  - AML is the MC
  - Followed closely by RCC
- When initial imaging does not demonstrate the cause of renal hemorrhage, repeat imaging resolution is essential.


A: 211.06mm ²
P: 51.55mm
M: ~37.50 HU
SD: ? HU


A: 259.17mm ²
M: ~41.11 HU
SD: ? HU
A: 264.61mm ²
M: ~74.52 HU
SD: ? HU

Staging RCC

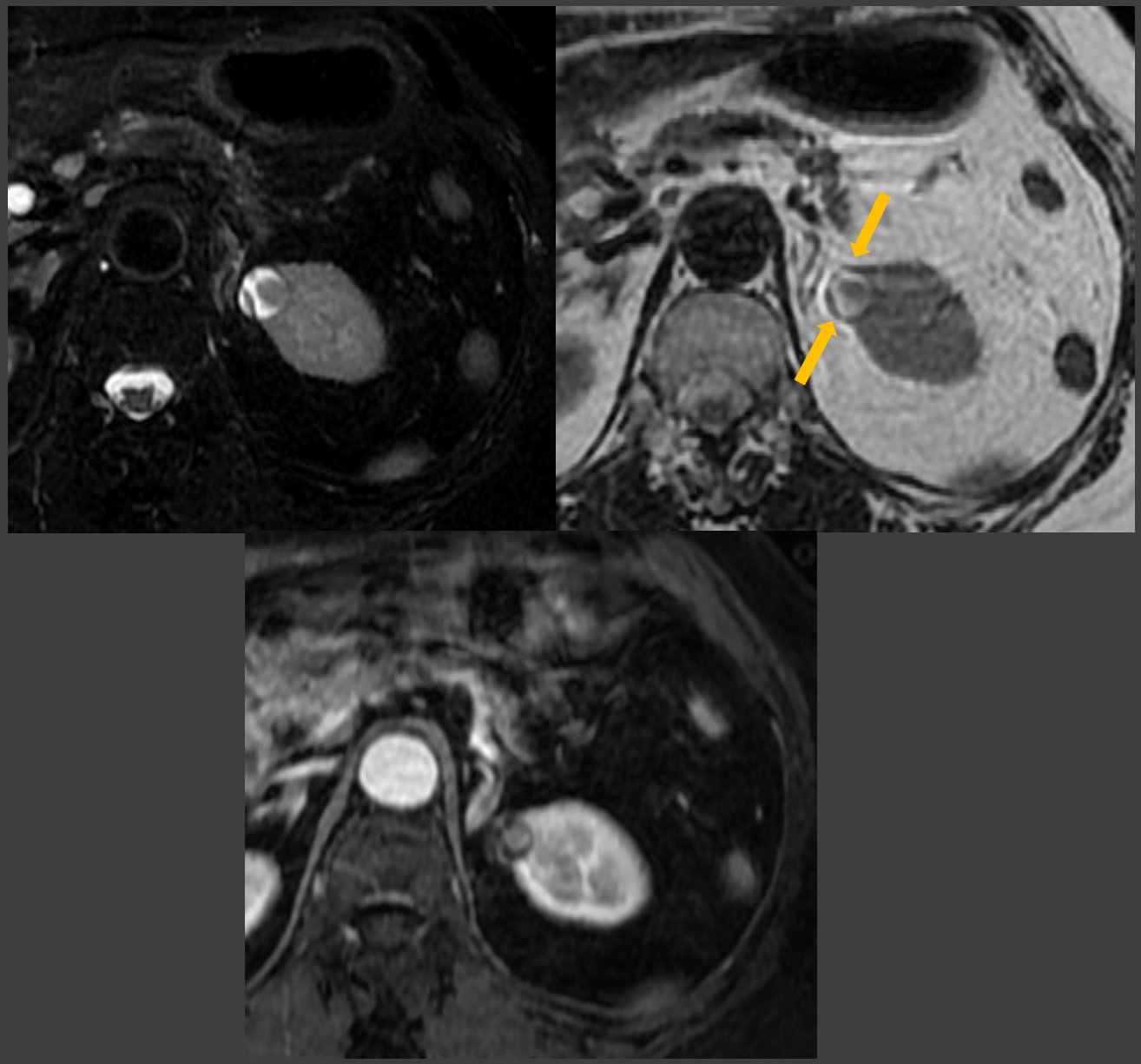
TNM staging system of the American Joint Committee on Cancer (AJCC)

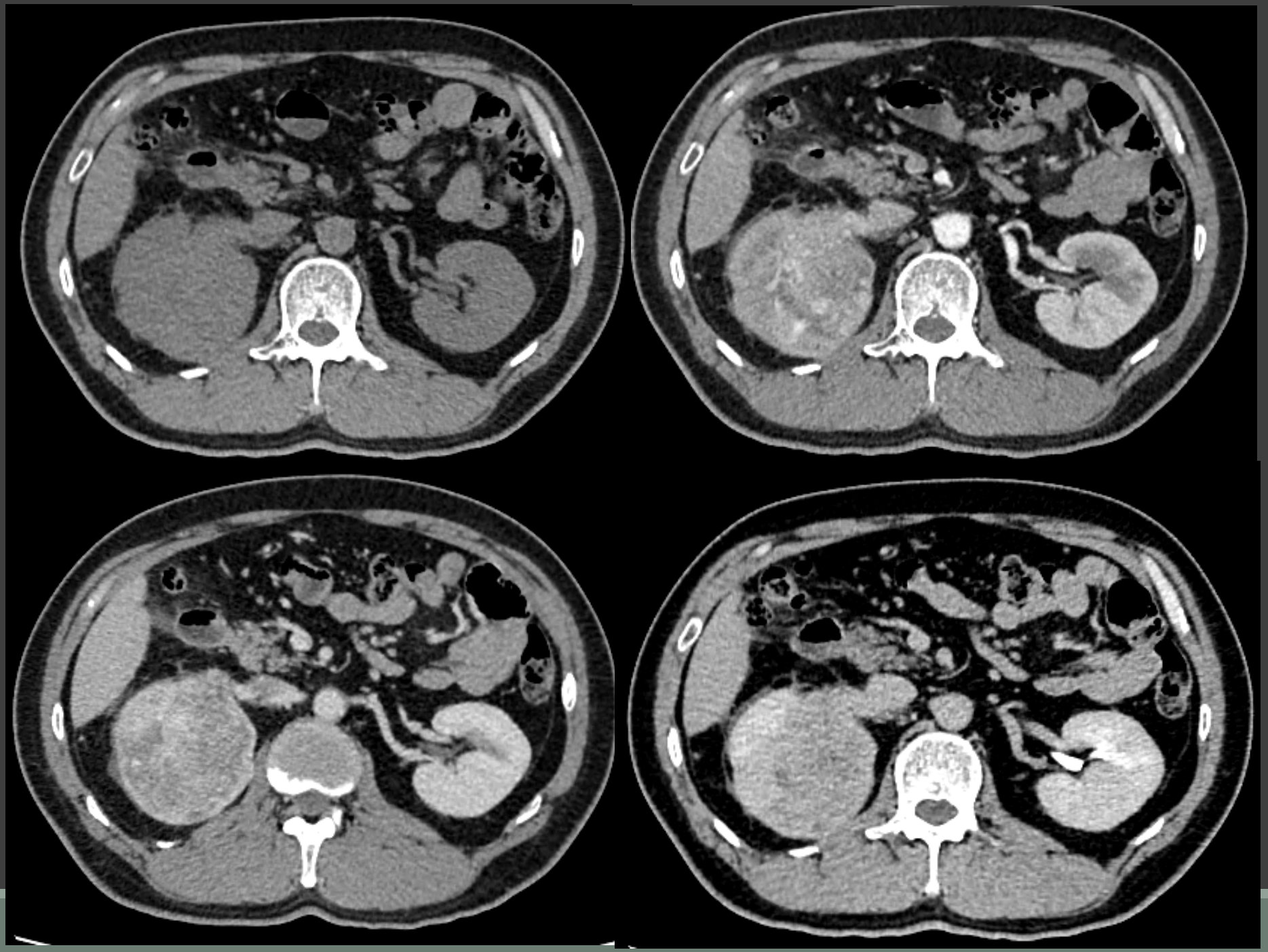


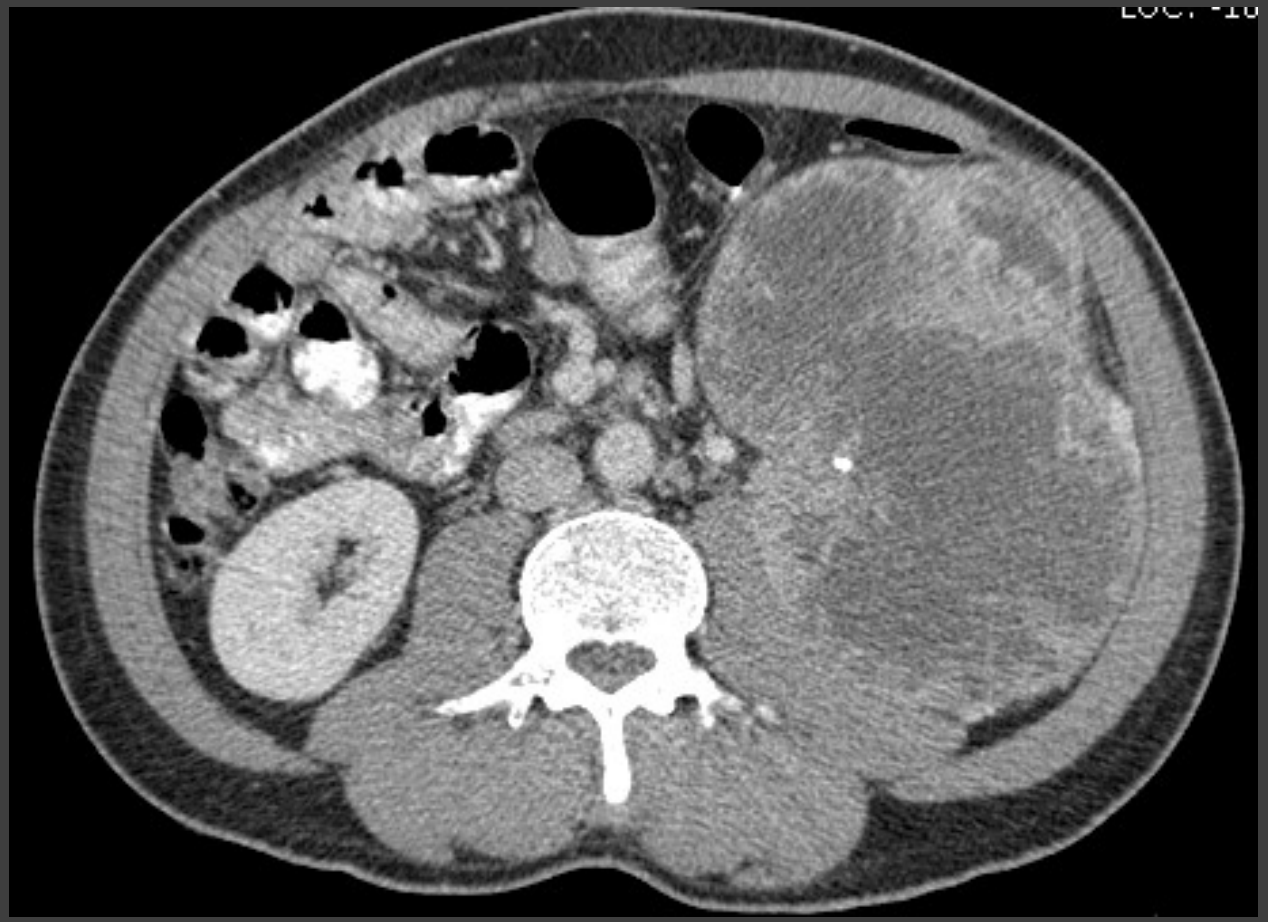
Vikram R et al. Radiographics 2009;29:741-754

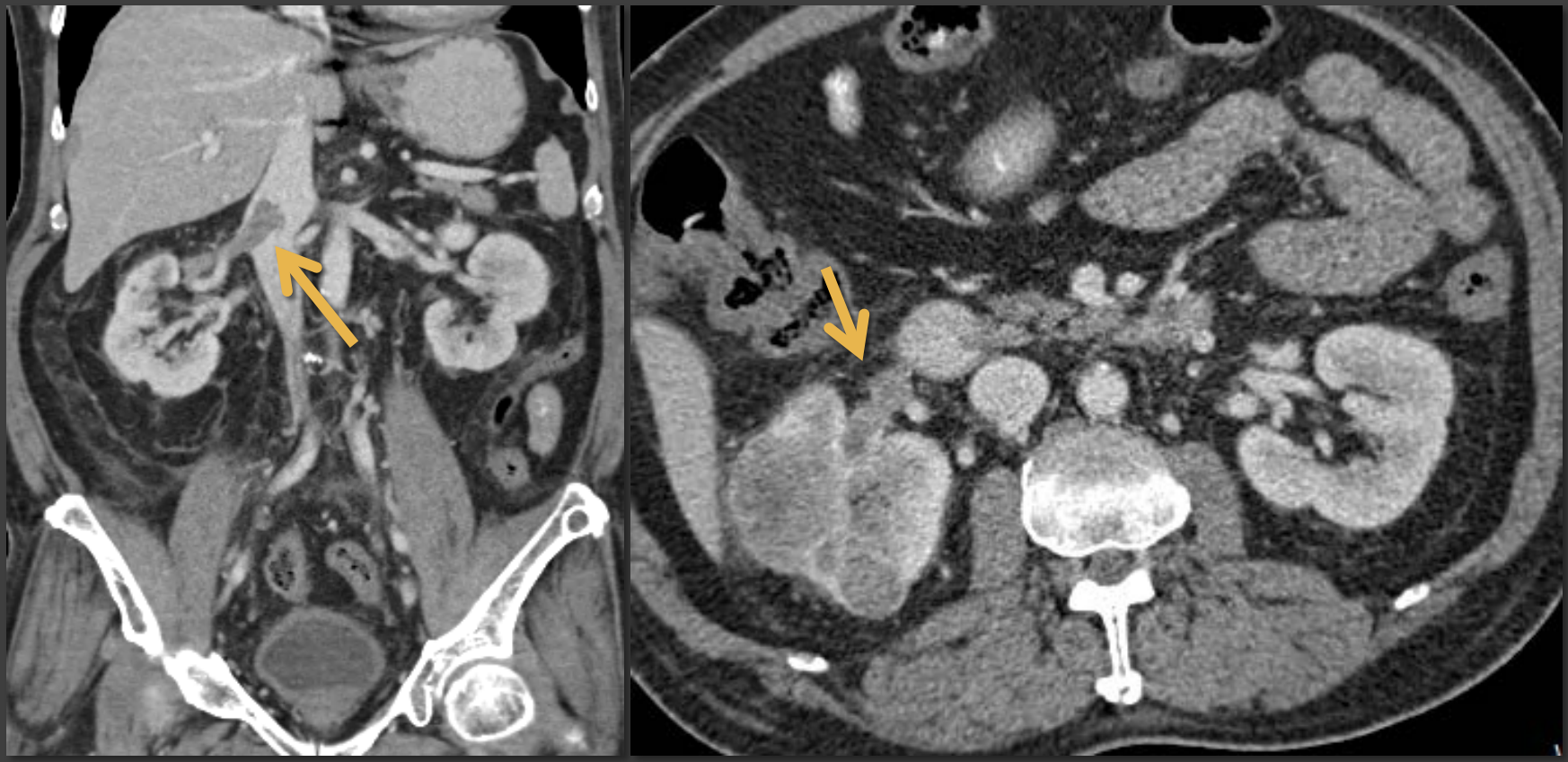
Staging RCC

- MRI is useful in delineating the parenchymal-tumor interface
- The most staging errors - perinephric extension
  - Intact pseudocapsule - best detected by T2W suggests lack of perinephric fat invasion







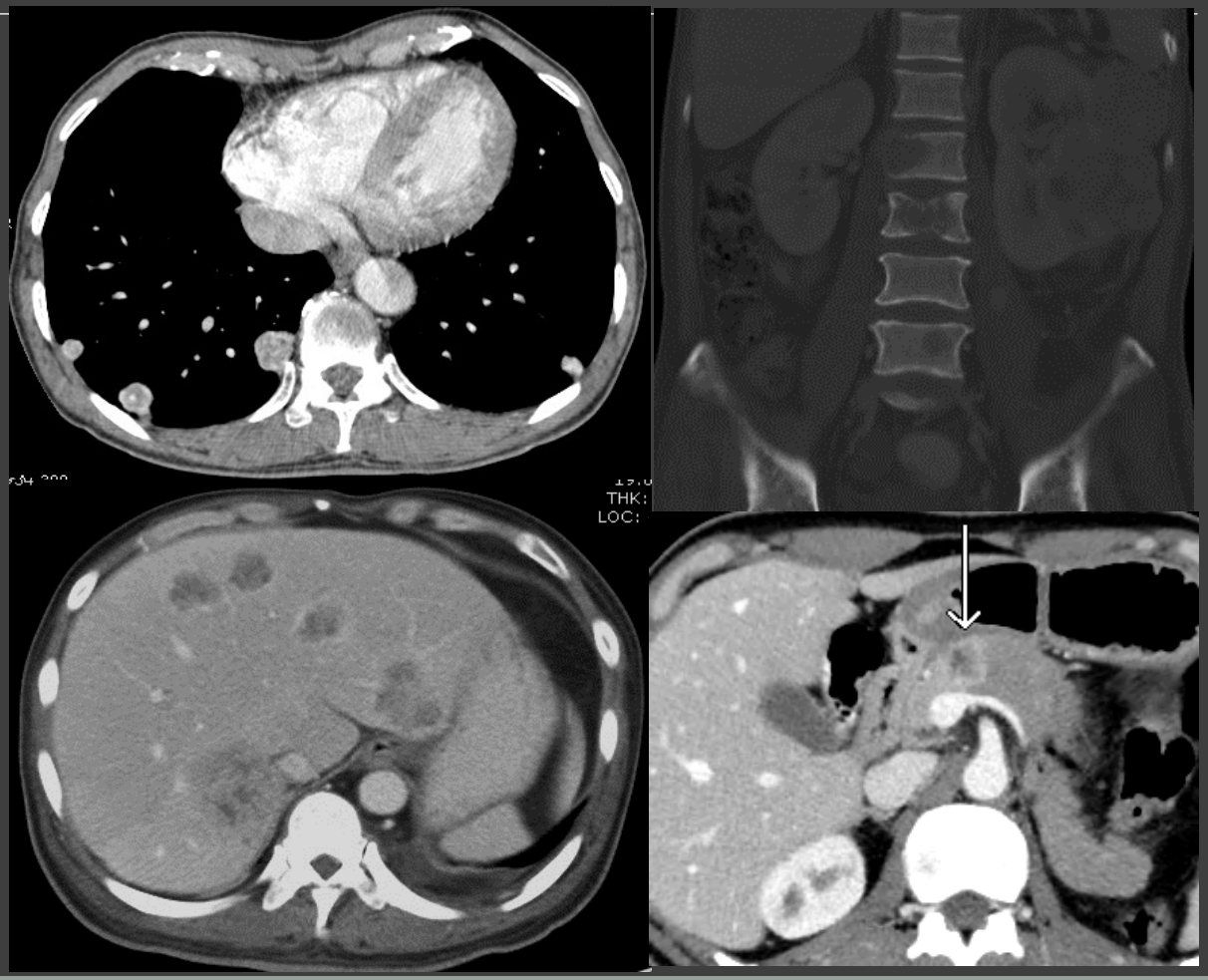


Nodal metastasis

- Size ≥10 mm in short axis
- Central low density – necrosis
- Heterogeneous SI on MRI

Distant metastasis

- Lung
- Bone
- Brain
- Liver
- Pancreas



Imaging follow up

- Size - quantitative imaging tumor response
  - RECIST
- Immune checkpoint inhibitors
  - "pseudoprogression"
  - tumor growth with immunotherapy that regresses with time

Imaging follow up

- CT attenuation - degree of necrosis
- Contrast-enhanced CT – absolute or percentage change
  - Limitations : contrast injection and several patient factors

Imaging follow up

- Local tumor relapse - nephrectomy site
- Distant metastasis
  - Lung – CXR (low risk), CT (high risk)
  - Others – LN, bone, brain, liver
- CT is modality of choice for detection local recurrence and distant metastasis.

Imaging follow up

- FDG PET
  - Evaluation of distant metastasis
  - DDx of recurrence or post-treatment change.
- Negative result cannot reliably rule out metastatic disease
  - Small lesion

THANK YOU