Radiology-Pathology Conference

Shanna Matalon, PGY-3

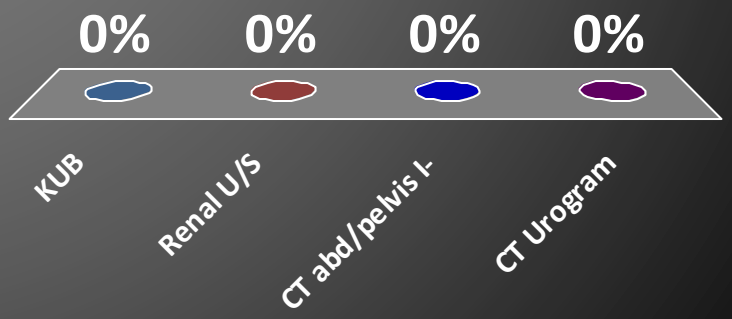
Navin Mahadevan, PGY-1

Case 1

- 84 year old male presenting with right groin pain/pressure
- U/A showed hematuria

What is the appropriate next step?

A. KUB
B. Renal U/S
C. CT abd/pelvis I-
★D. CT Urogram



ACR Appropriateness Criteria

Clinical Condition: **Acute Onset Flank Pain — Suspicion of Stone Disease**

Variant 1: **Suspicion of stone disease.**

Radiologic Procedure	Rating	Comments	RRL*
CT abdomen and pelvis without contrast	8	Reduced-dose techniques preferred.	☢☢☢☢
CT abdomen and pelvis without and with contrast	6	If CT without contrast does not explain pain or if without has abnormality that should be further assessed with contrast (ex. stone versus phleboliths).	☢☢☢☢
US kidneys and bladder retroperitoneal with Doppler and KUB	6	Preferred examination in pregnancy, in patients who are allergic to iodinated contrast, and if NCCT is not available.	☢☢
X-ray intravenous urography	4		☢☢☢
MRI abdomen and pelvis without contrast (MR urography)	4		O
MRI abdomen and pelvis without and with contrast (MR urography)	4	See statement regarding contrast in text under "Anticipated Exceptions."	O
CT abdomen and pelvis with contrast	2		☢☢☢☢
X-ray abdomen and pelvis (KUB)	1	Most useful in patients with known stone disease.	☢☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

Coursey, C.A., et al. Ultrasound Q, 2012.

Non-contrast CT and stones

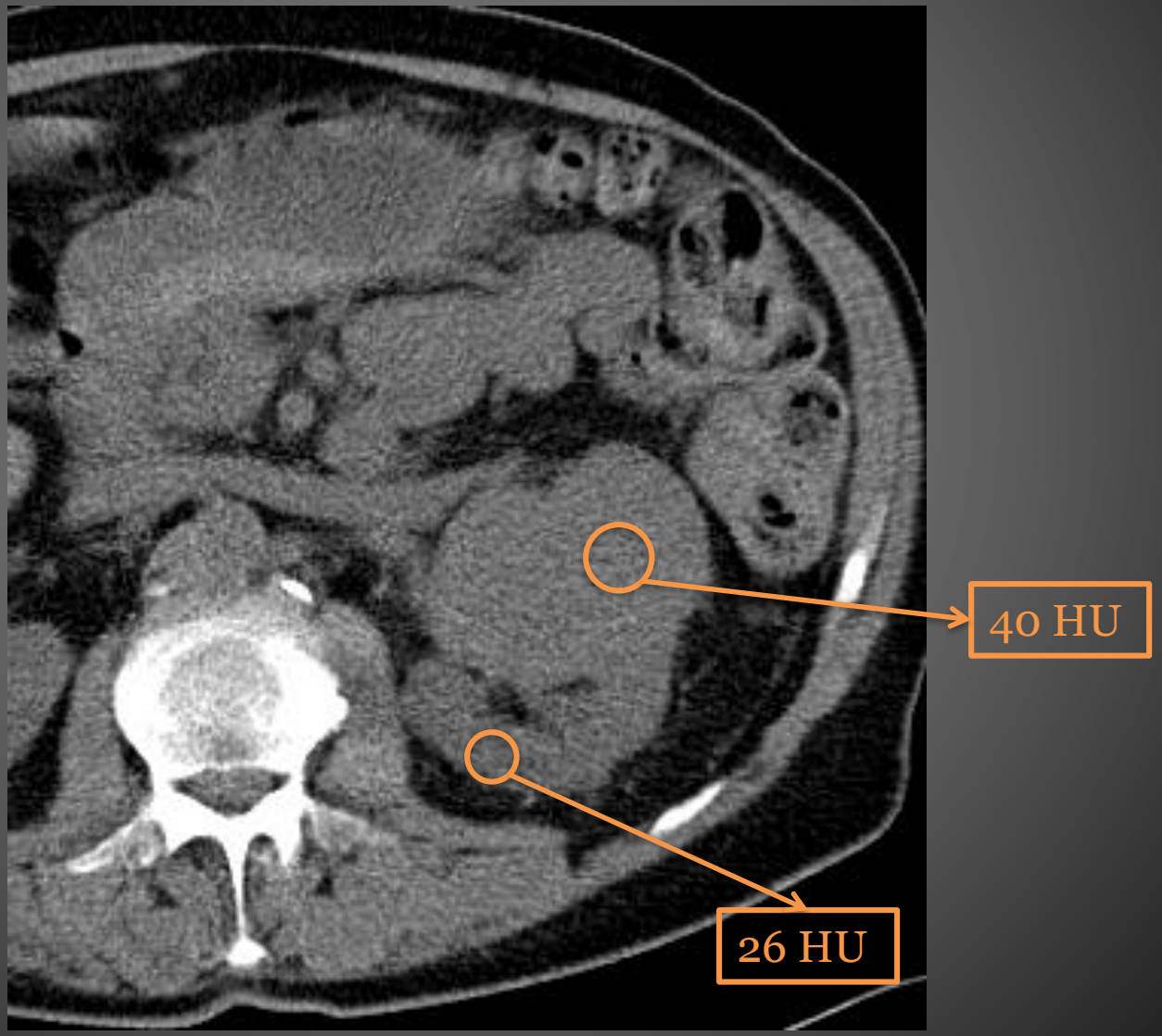
- Highest sensitivity (95-96%) and specificity (98%)
- Virtually all stones are radiopaque
- *Pregnancy

Coursey, C.A., et al. Ultrasound Q, 2012.

That's all great, but…

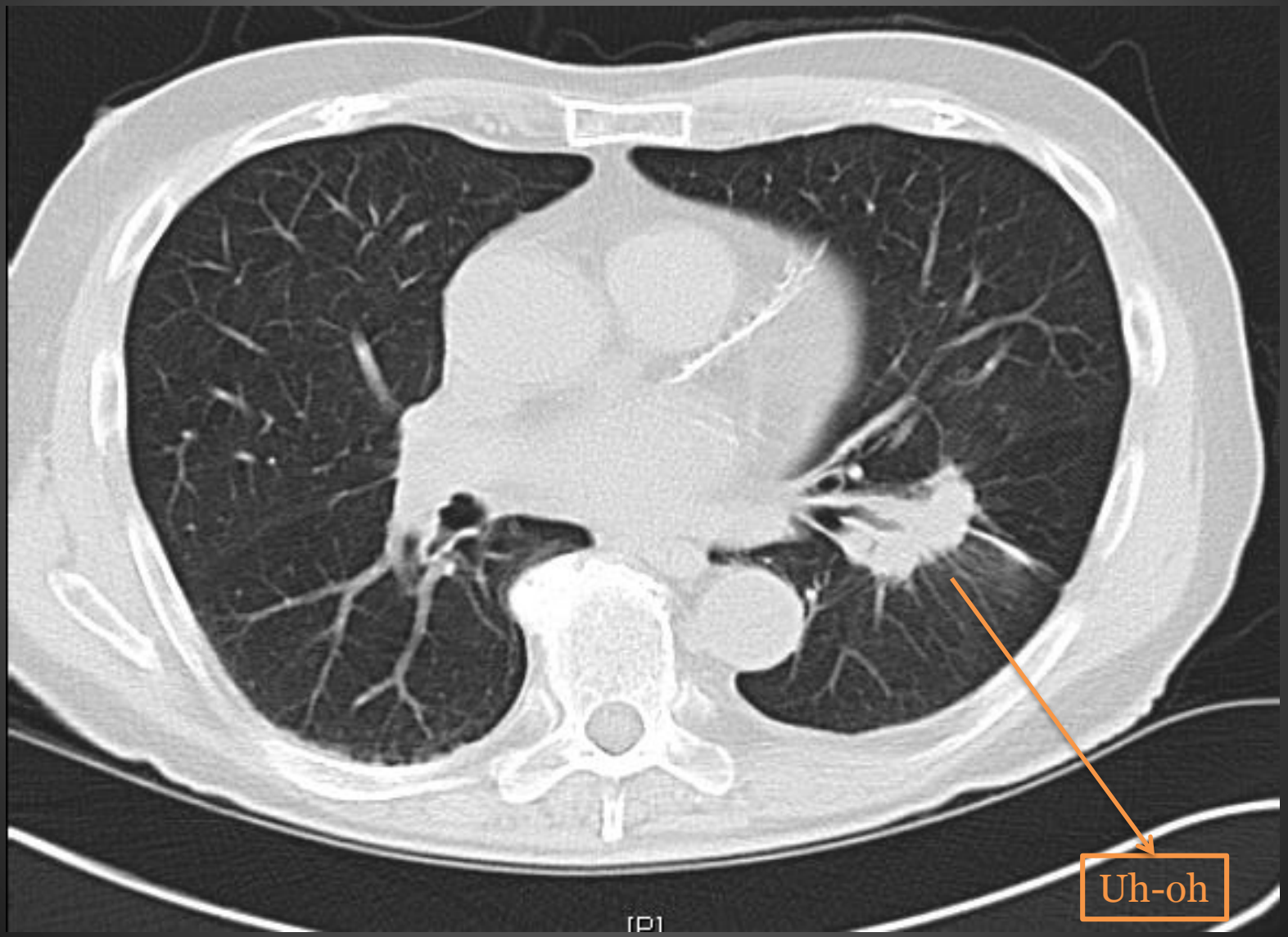
- 84 year old male with new stone?
- What else should we consider…?

Renal stone protocol CT

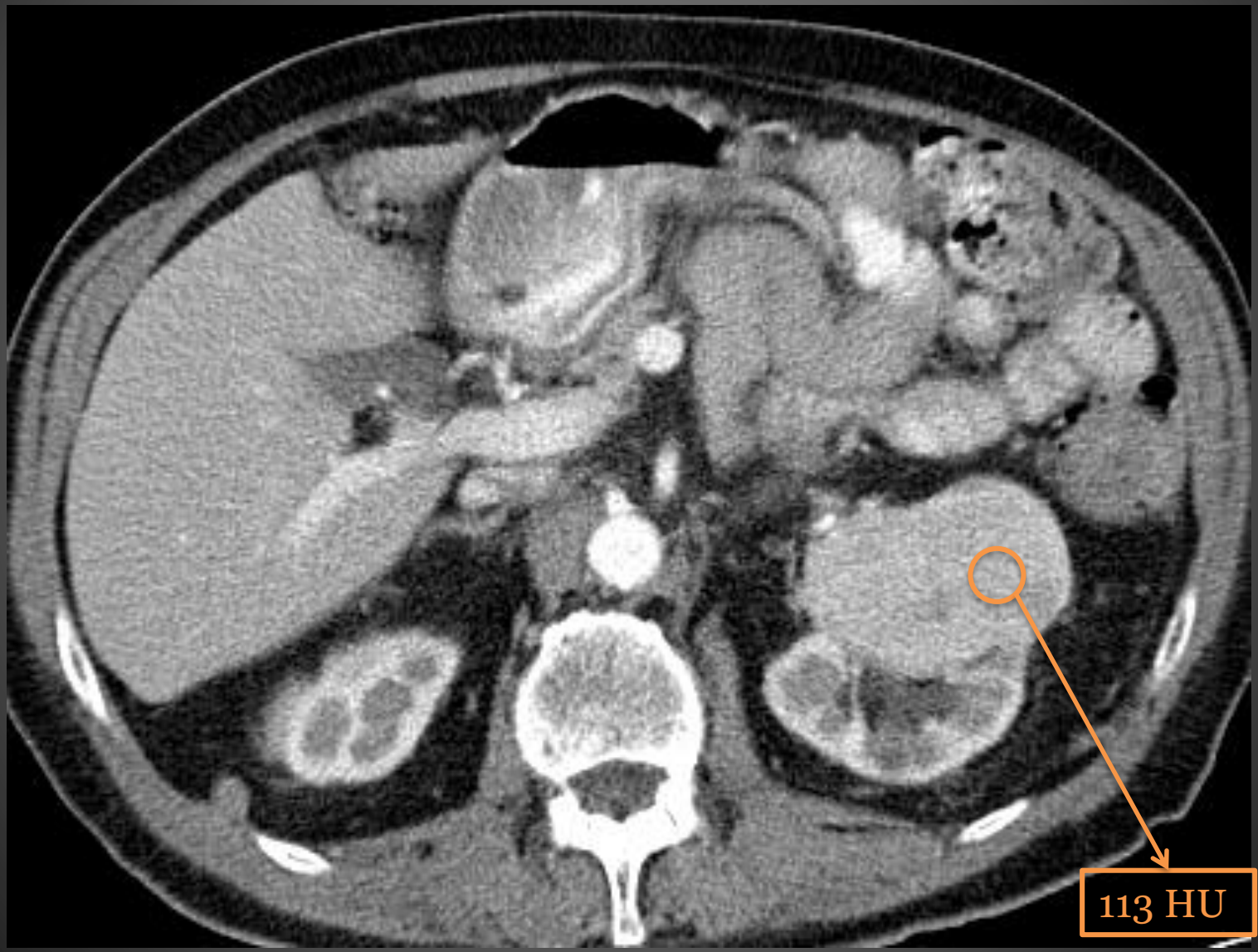


FNA of Lung Lesion → Poorly-differentiated non-small cell

First image



Further evaluation…



Differential diagnosis

- Metastatic lung cancer
- Synchronous RCC
- Oncocytoma

- Fat-poor AML

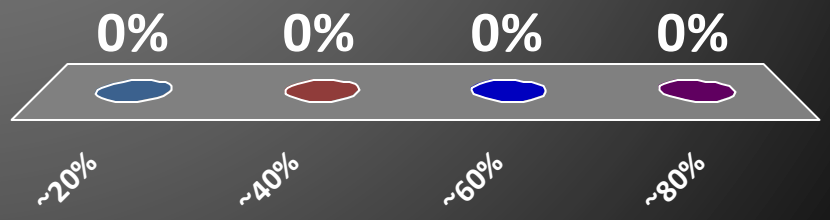
In a patient with a known primary malignancy, what percentage of renal masses represent metastasis?

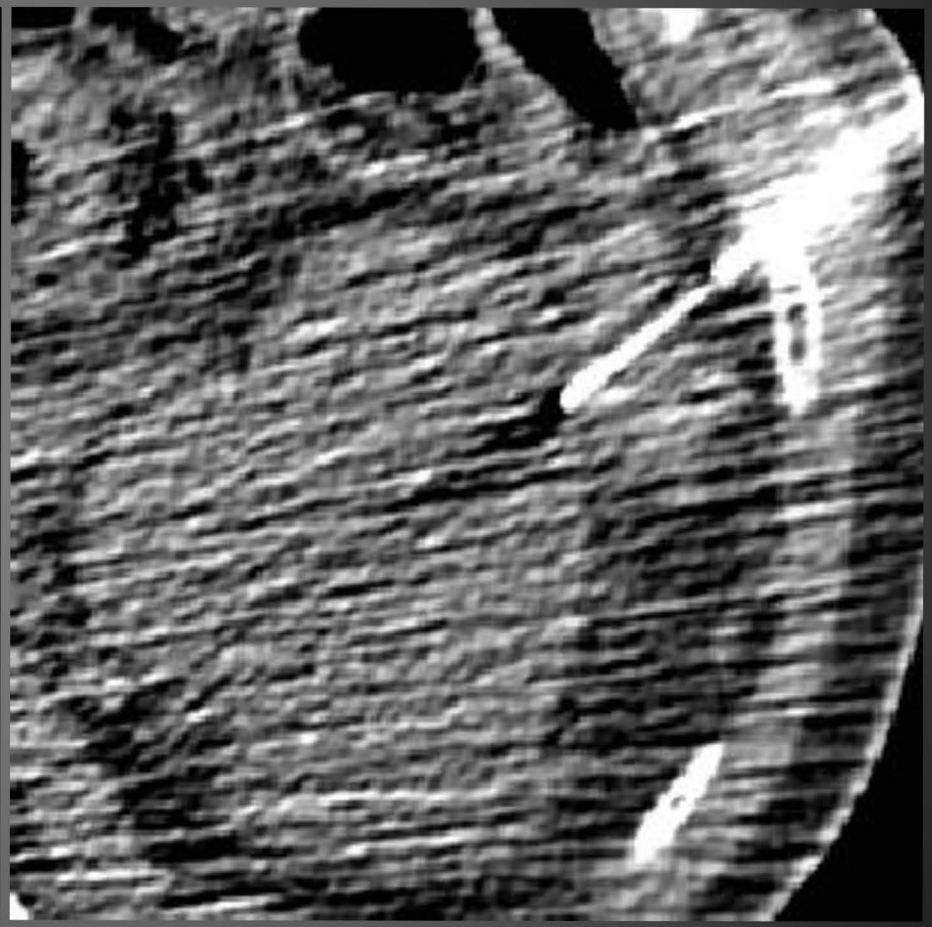
A. ~20%

★B. ~40%

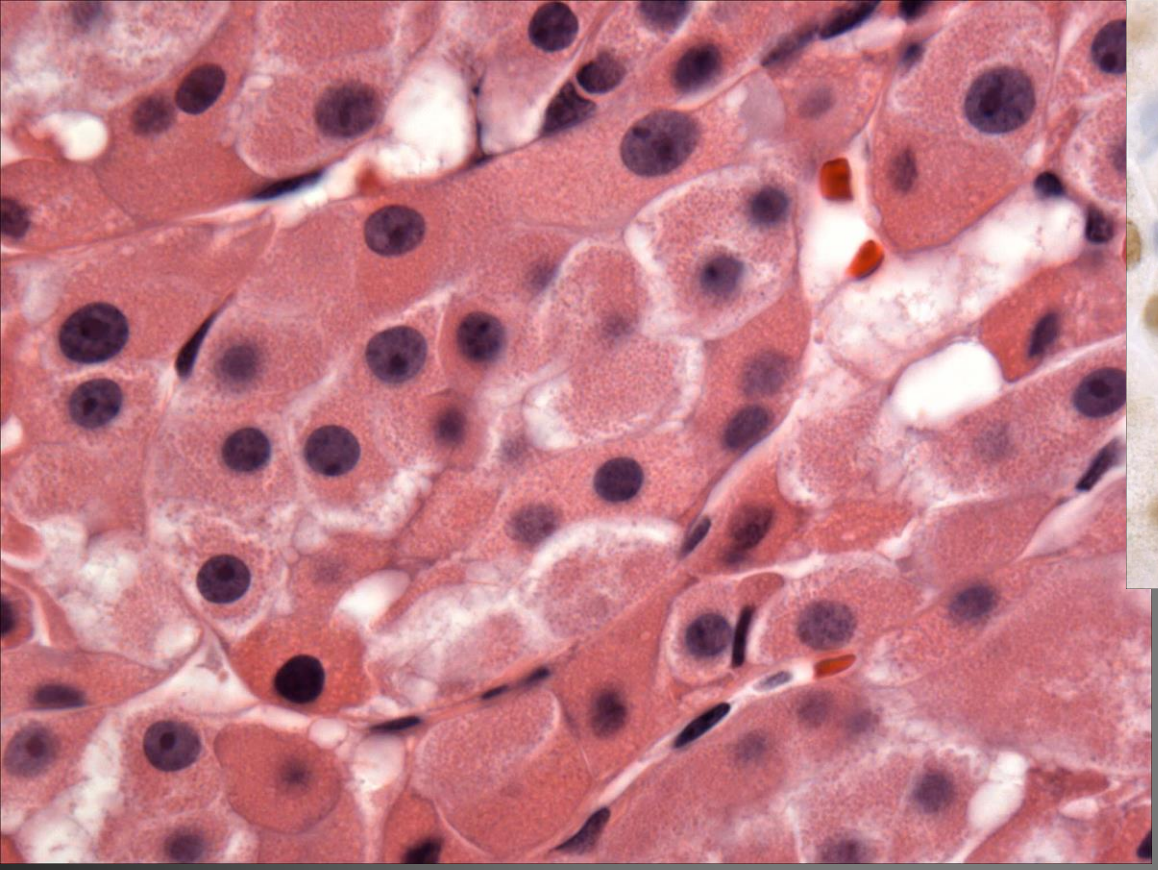
C. ~60%

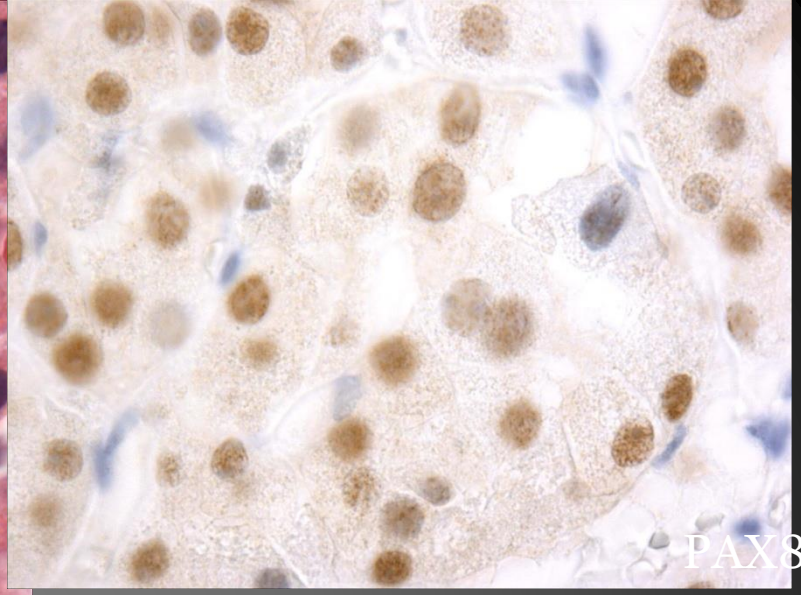
D. ~80%

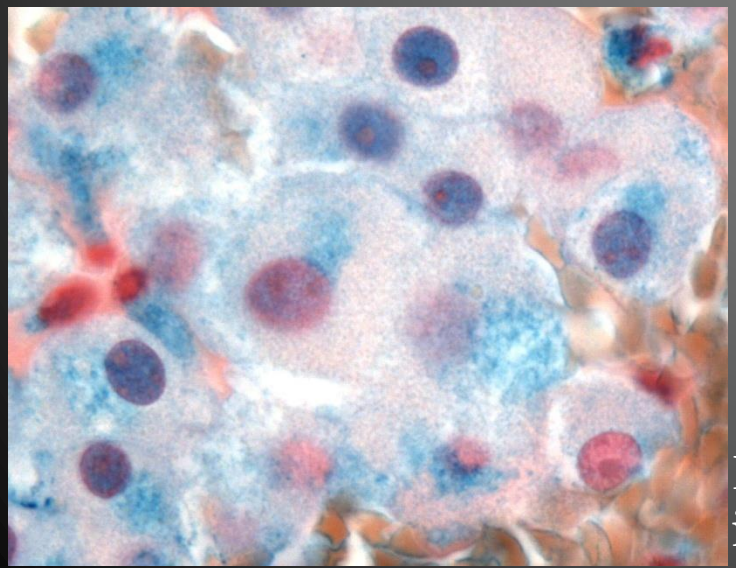




Pathology







Hales colloidal iron

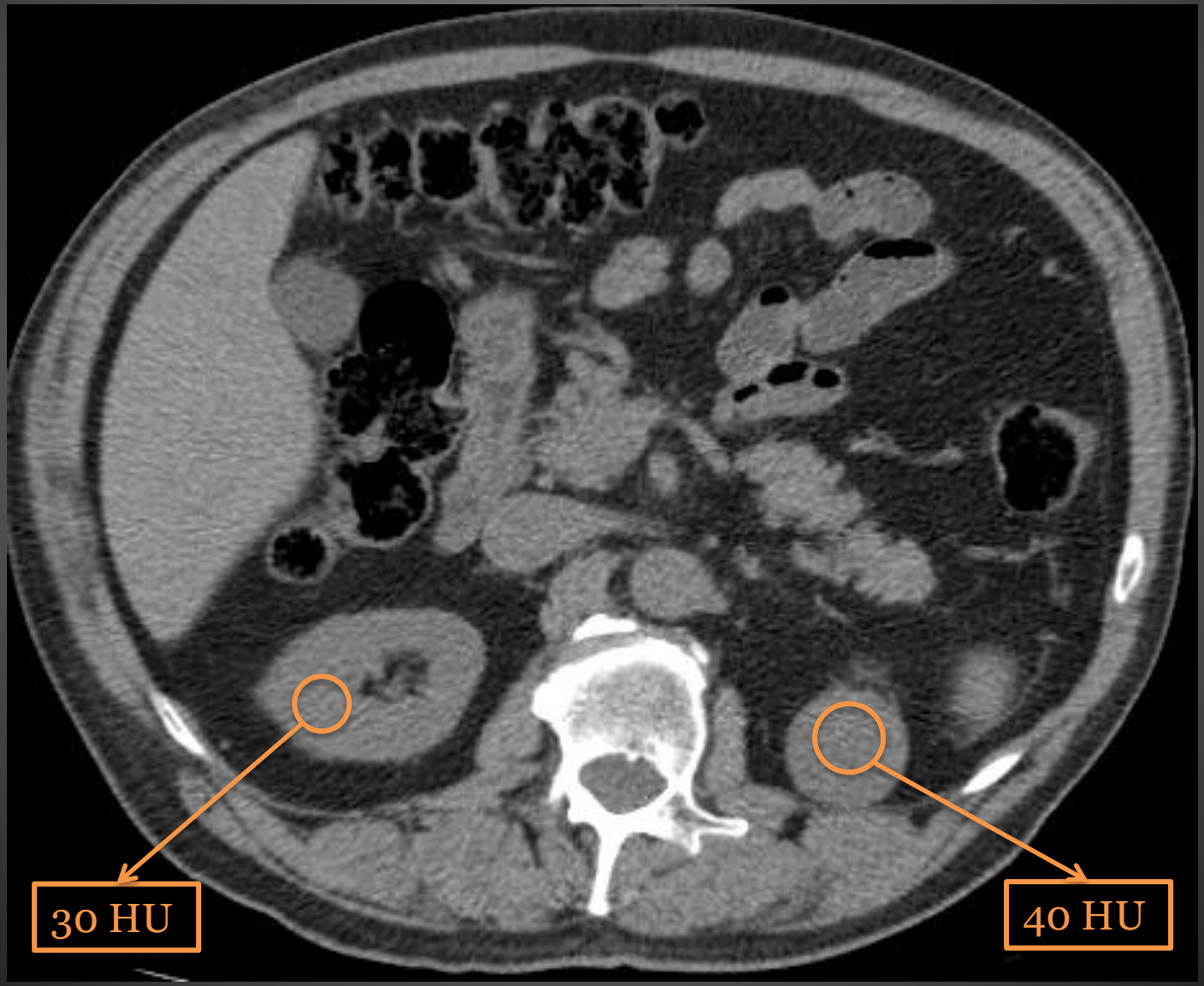
ONCOCYTOMA

Oncocytoma

Case 2

- 77 year old male with prostatitis and recurrent bothersome lower urinary tract symptoms

Outside hospital work up



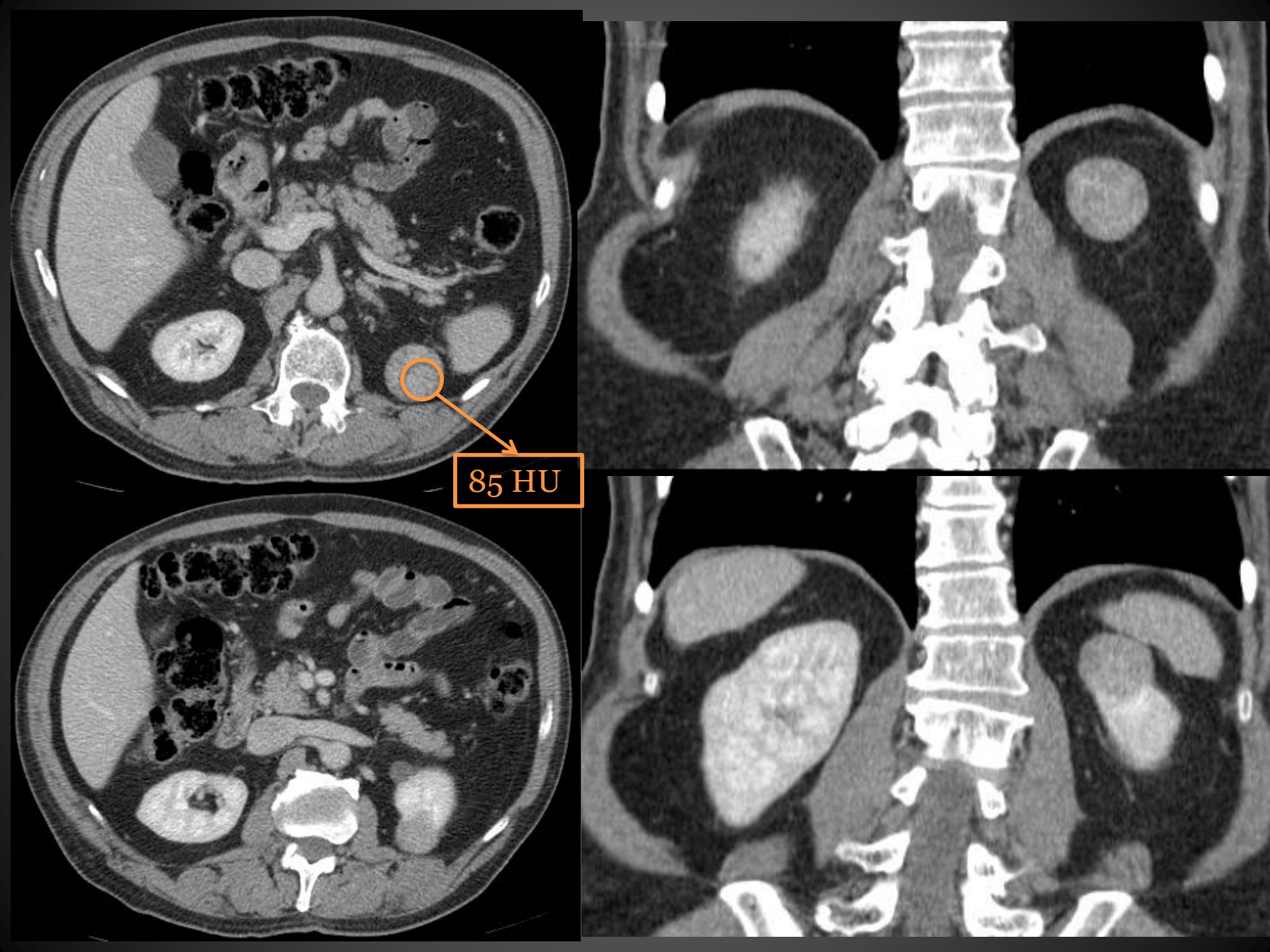
ACR Appropriateness Criteria

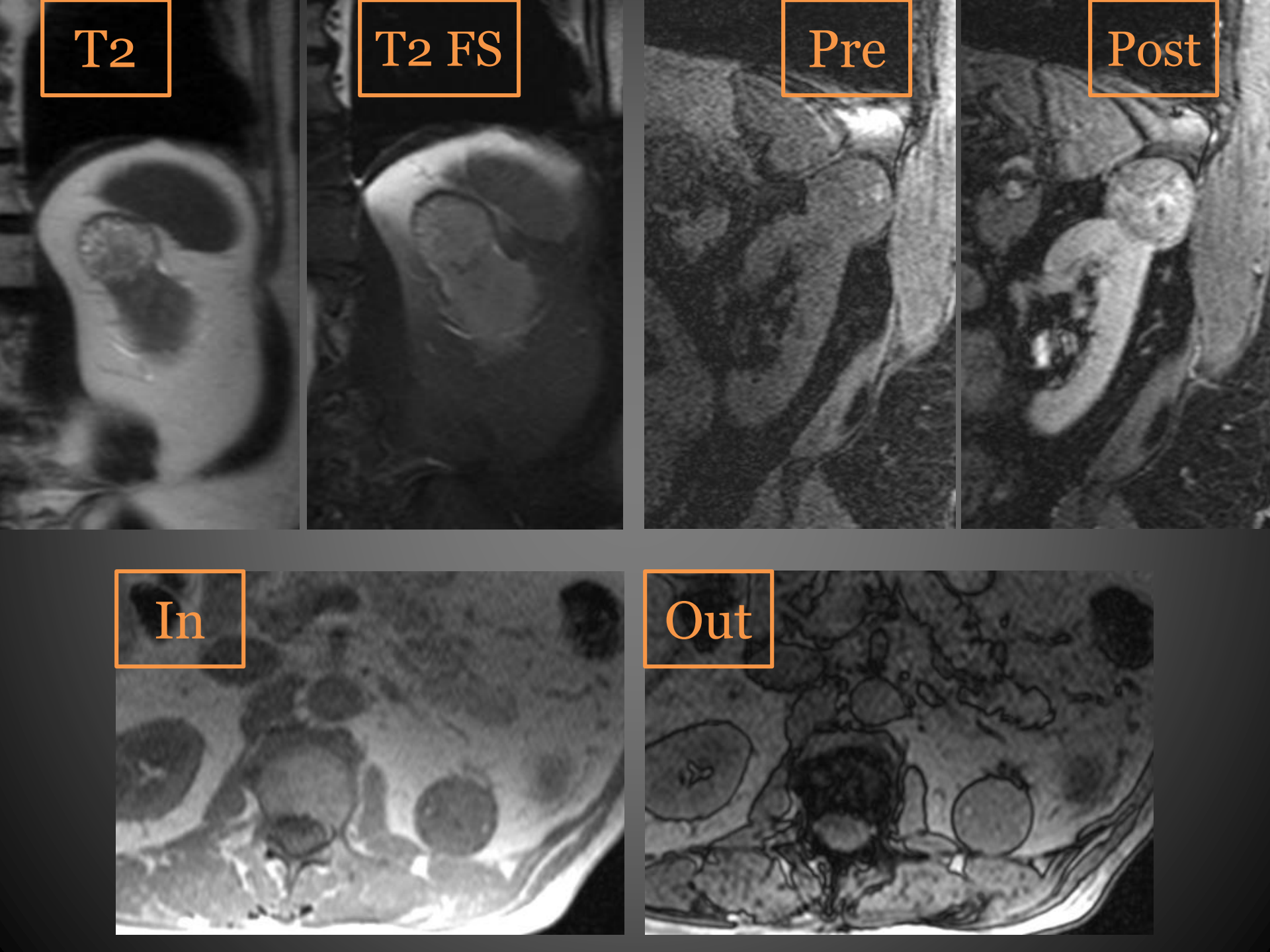
Clinical Condition: **Indeterminate Renal Mass** → 20-70 HU

Variant 1: **Patient with normal renal function.**

Radiologic Procedure	Rating	Comments	RRL*
CT abdomen without and with contrast	9	Either CT or MRI is appropriate. Use thin-section CT.	☢☢☢☢
MRI abdomen without and with contrast	8	Either CT or MRI is appropriate. See statement regarding contrast in text under "Anticipated Exceptions."	O
US kidney retroperitoneal with duplex Doppler	8		O
Biopsy renal mass	5		Varies
MRI abdomen without contrast	3	This procedure can be useful to characterize simple cysts.	O
Arteriography kidney	1		☢☢☢
X-ray intravenous urography	1		☢☢☢
CT abdomen with contrast	1		☢☢☢
CT abdomen without contrast	1		☢☢☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

Bluth, E.I., et al. Radiology, 2000.


85 HU

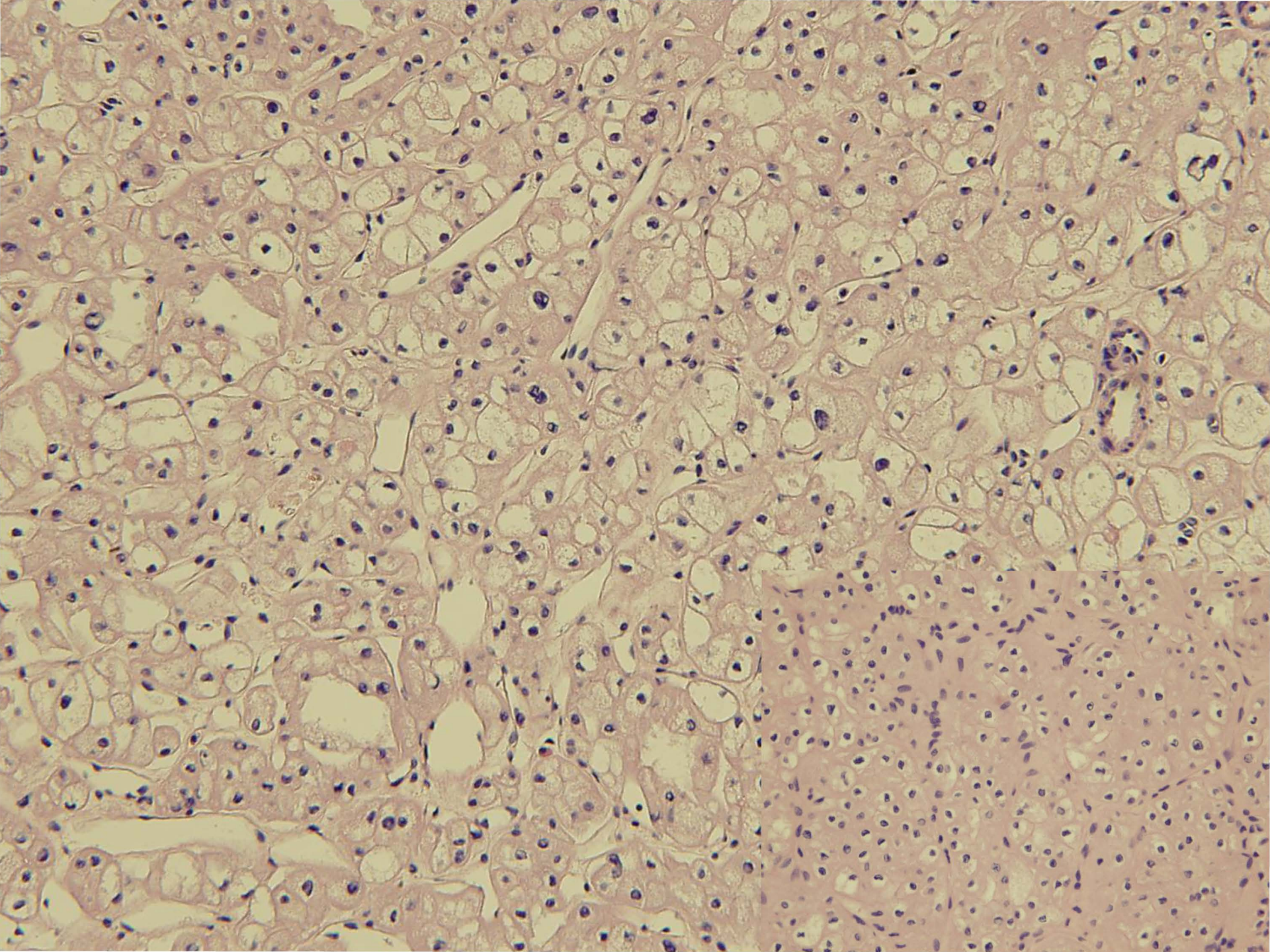

T2
T2 FS
Pre
Post
In
Out

Differential diagnosis

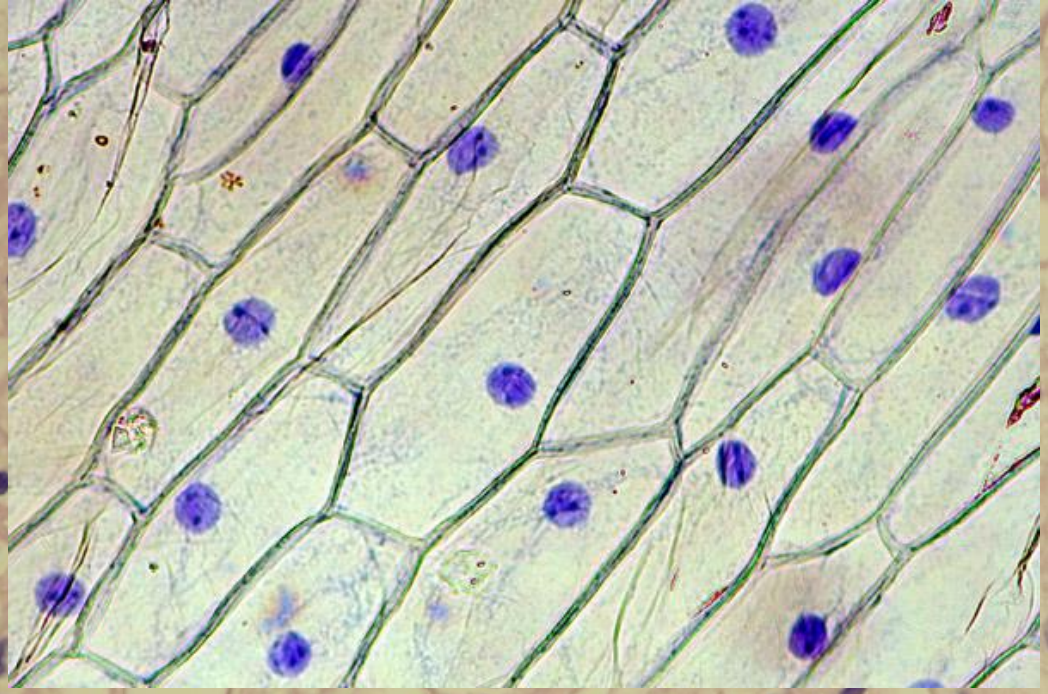
- RCC
- Oncocytoma

- Leiomyoma/sarcoma

Pathology



RCC, CHROMOPHOBE



Chromophobe RCC

Case 3

- 64 year old male presenting with newly elevated creatinine

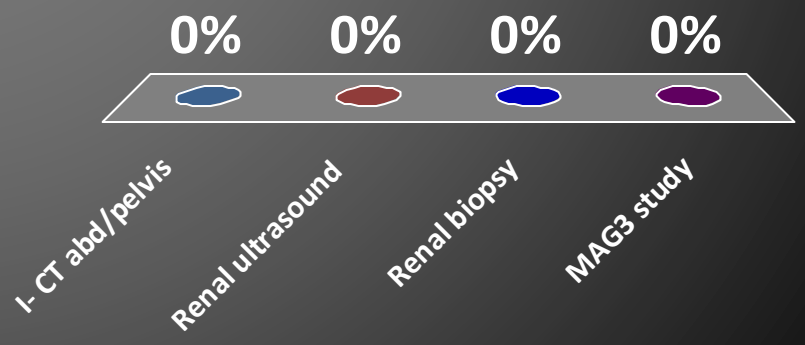
What is the appropriate next (imaging) step?

A. I- CT abd/pelvis

★B. Renal ultrasound

C. Renal biopsy

D. MAG3 study



ACR Appropriateness Criteria

Clinical Condition: **Renal Failure**

Variant 1: **Acute kidney injury (AKI), unspecified.**

Radiologic Procedure	Rating	Comments	RRL*
US kidneys and bladder	9	Assess renal size and echogenicity. Exclude bilateral obstruction in high-risk groups. Doppler may be used to assess renal perfusion.	O
Percutaneous US-guided renal biopsy	6	Especially useful in acute inflammatory conditions such as nephritis. Perform a follow-up after US examination, if needed.	O
Tc-99m MAG3 scan kidney	4	This procedure may be useful if the creatinine level is high. Perform a follow-up after US examination, if needed.	☢☢☢
CT abdomen without contrast	3	Potentially helpful in trauma evaluation. Noncontrast helical CT is more sensitive than KUB for calculi. Evaluation of ureteral obstruction due to retroperitoneal diseases, masses, and tumors (hydronephrosis on US but an undetectable cause).	☢☢☢

Rating Scale: **1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate** | ***Relative Radiation Level**

Remer, E.M., et al. Am J Med, 2014.


TRV RT KID DECUB
LOWER _
14fps


TRV RT KID DECUB
LOWER _
8fps

ACR Appropriateness Criteria

Clinical Condition: **Indeterminate Renal Mass**

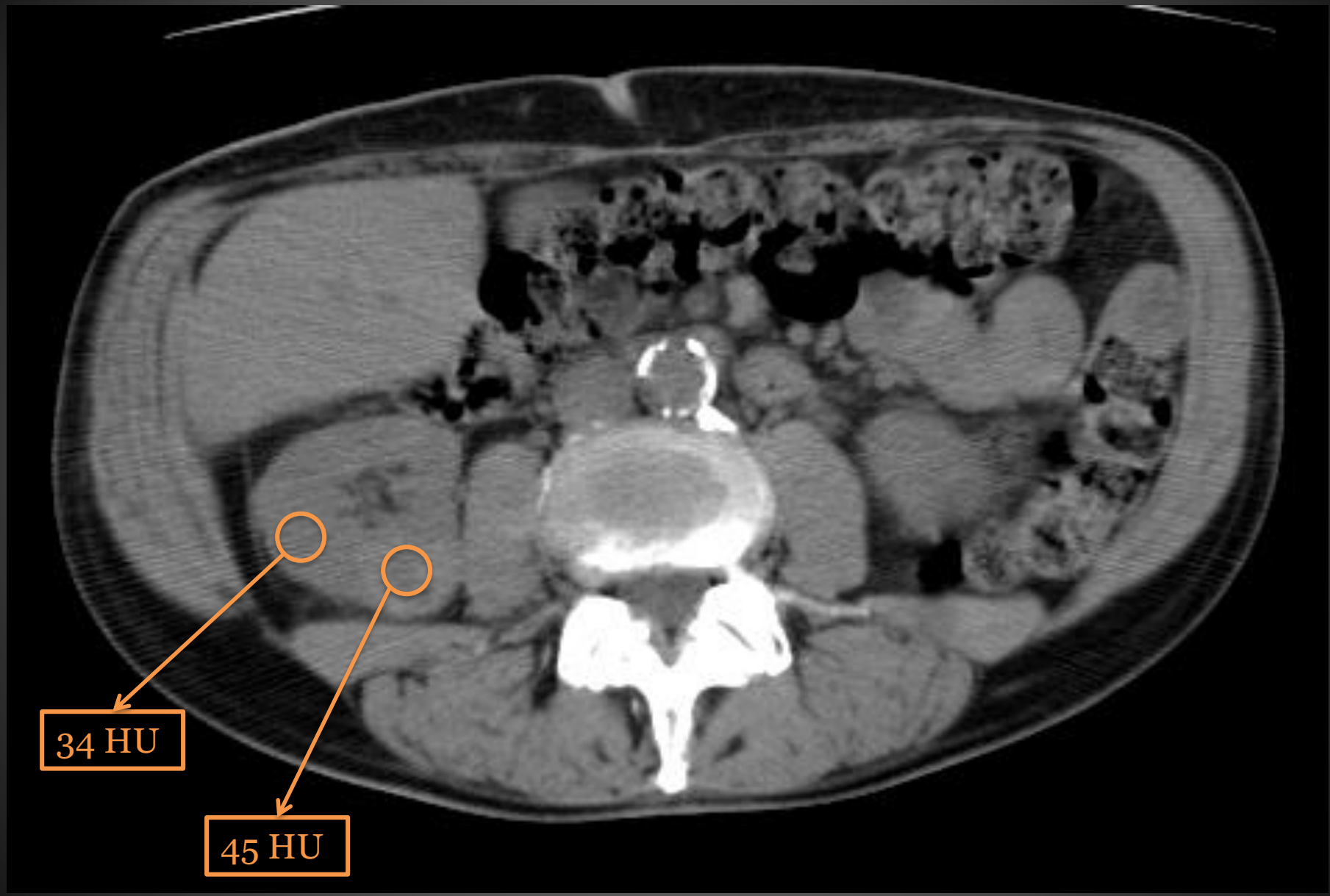
Variant 2: **Patient with renal insufficiency (contraindication to intravenous contrast).**

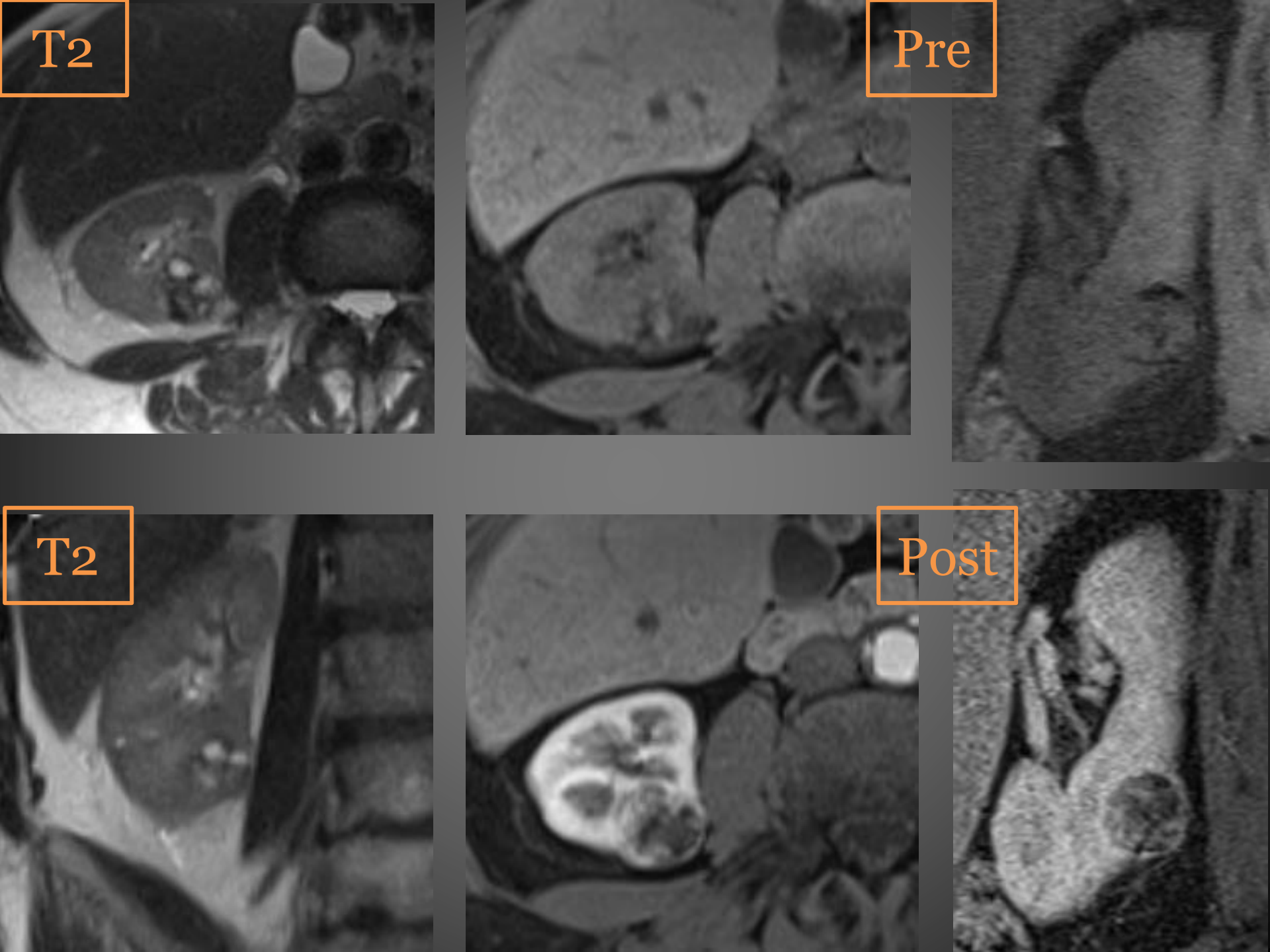
Radiologic Procedure	Rating	Comments	RRL*
✓ US kidney retroperitoneal with duplex Doppler	8		O
MRI abdomen without contrast	7		O
Biopsy renal mass	6		Varies
CT abdomen without contrast	5	This procedure may be useful to detect fat in AMLs or attenuation value in cysts.	☢☢☢
MRI abdomen without and with contrast	3	This procedure is rated higher than CT because the incidence of NSF is less than the incidence of CIN.	O
CT abdomen without and with contrast	2	This procedure is rated lower than MRI because the incidence of CIN is greater than the incidence of NSF.	☢☢☢☢
CT abdomen with contrast	1		☢☢☢
X-ray intravenous urography	1		☢☢☢
Arteriography kidney	1		☢☢☢

Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate

*Relative Radiation Level

Bluth, E.I., et al. Radiology, 2000.


34 HU
45 HU

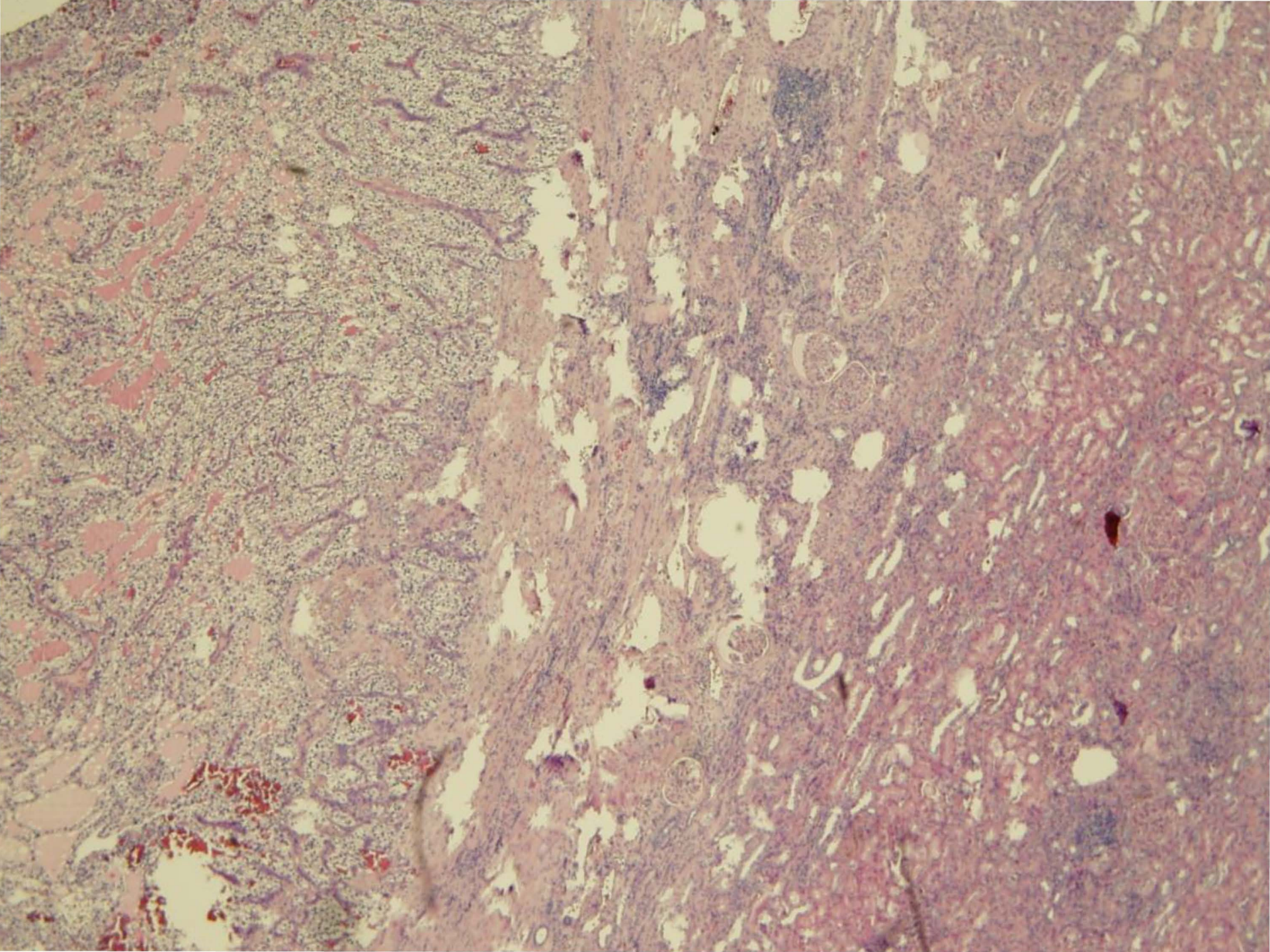

T2
Pre
T2
Post

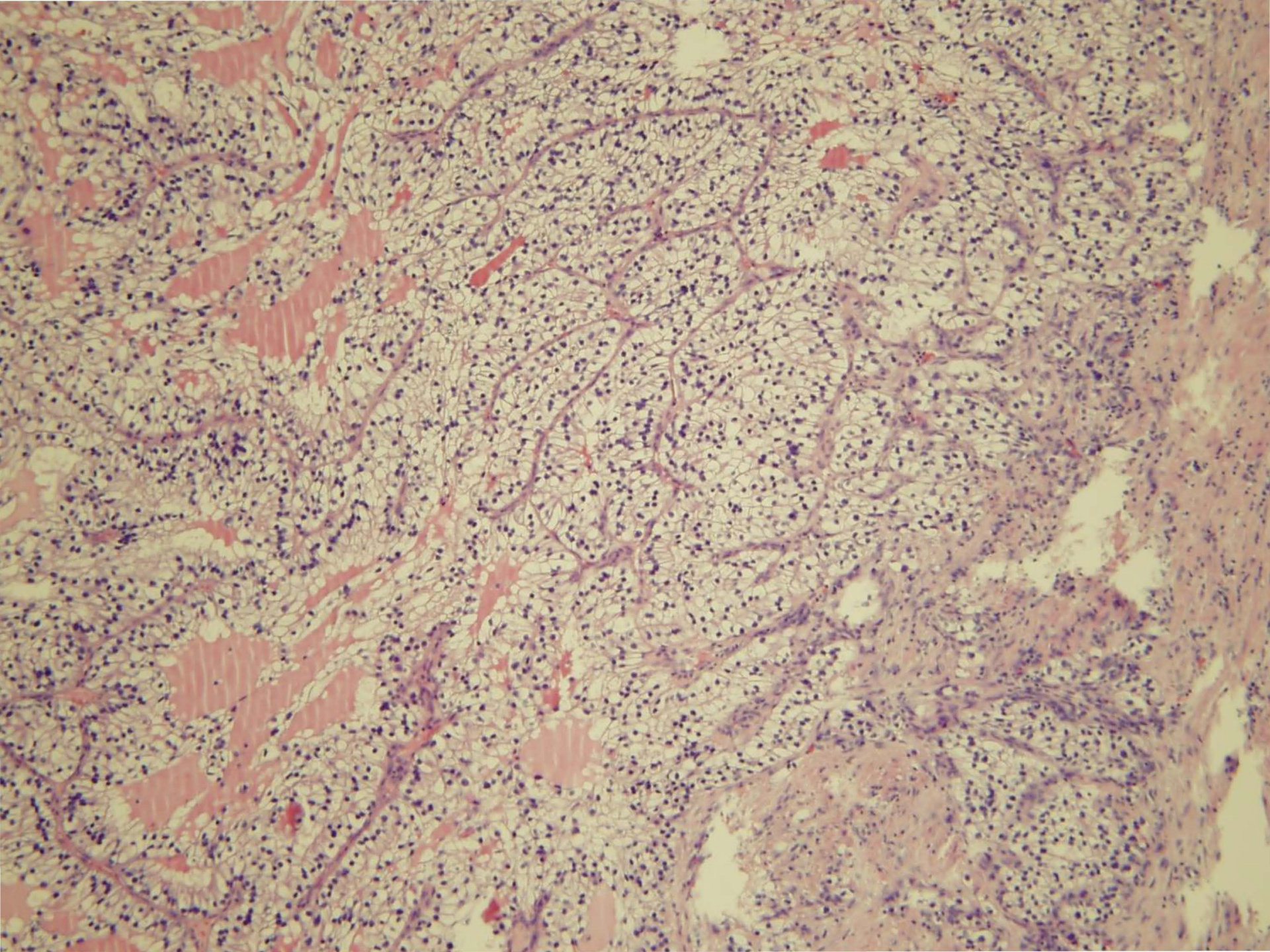
Differential

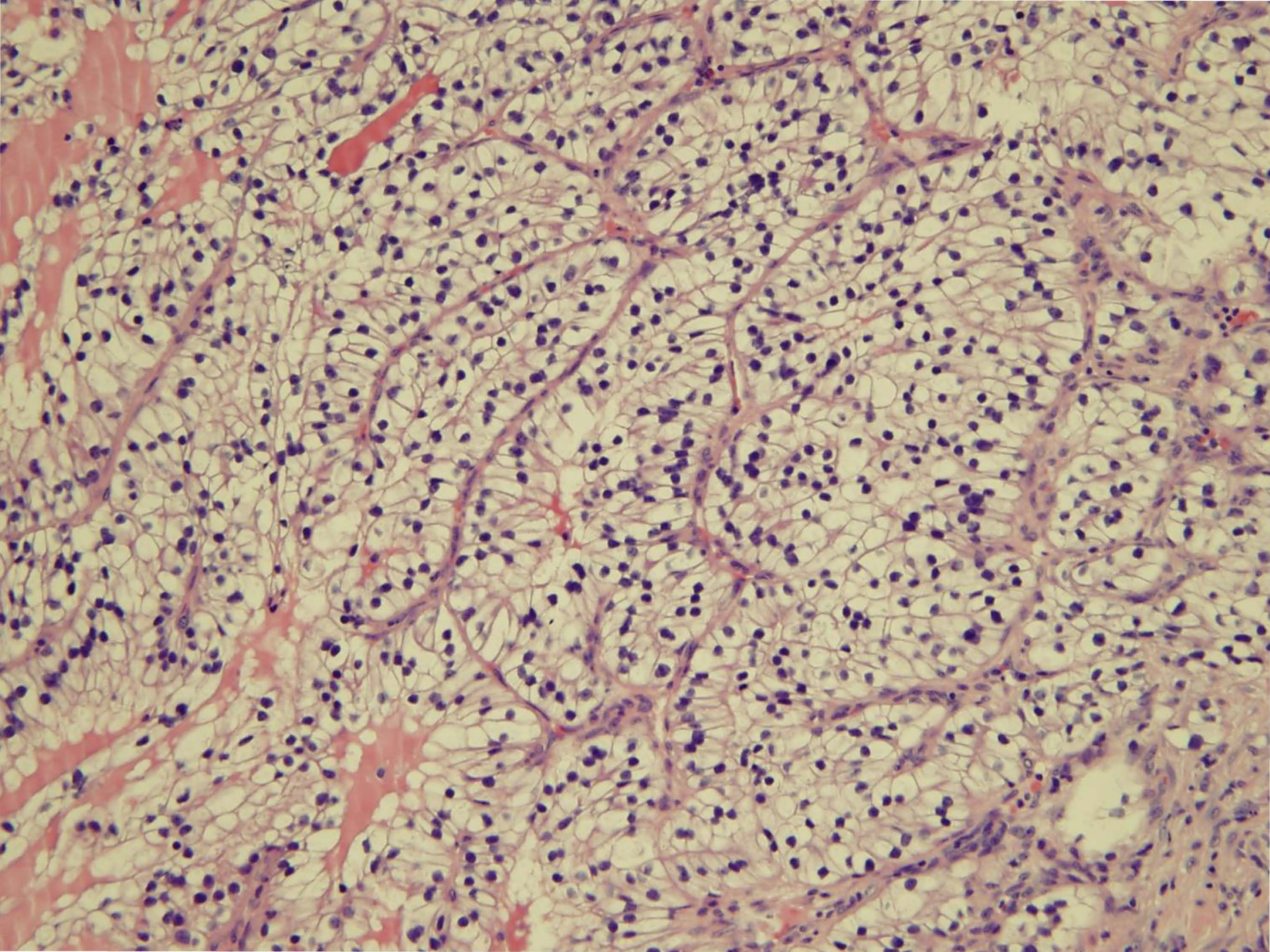
- RCC
- Oncocytoma

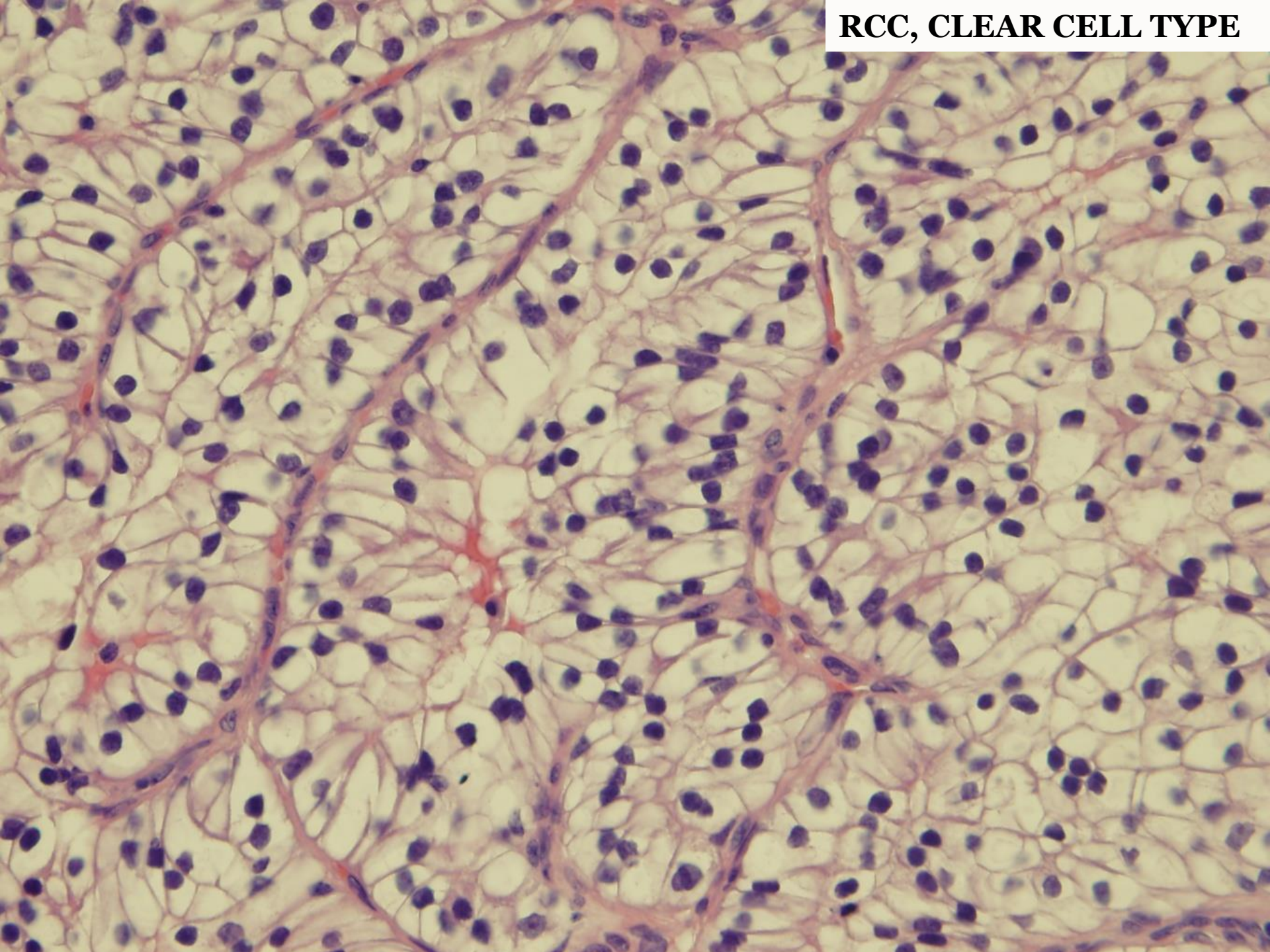
- Metastasis from unknown primary
- Leiomyosarcoma

Pathology







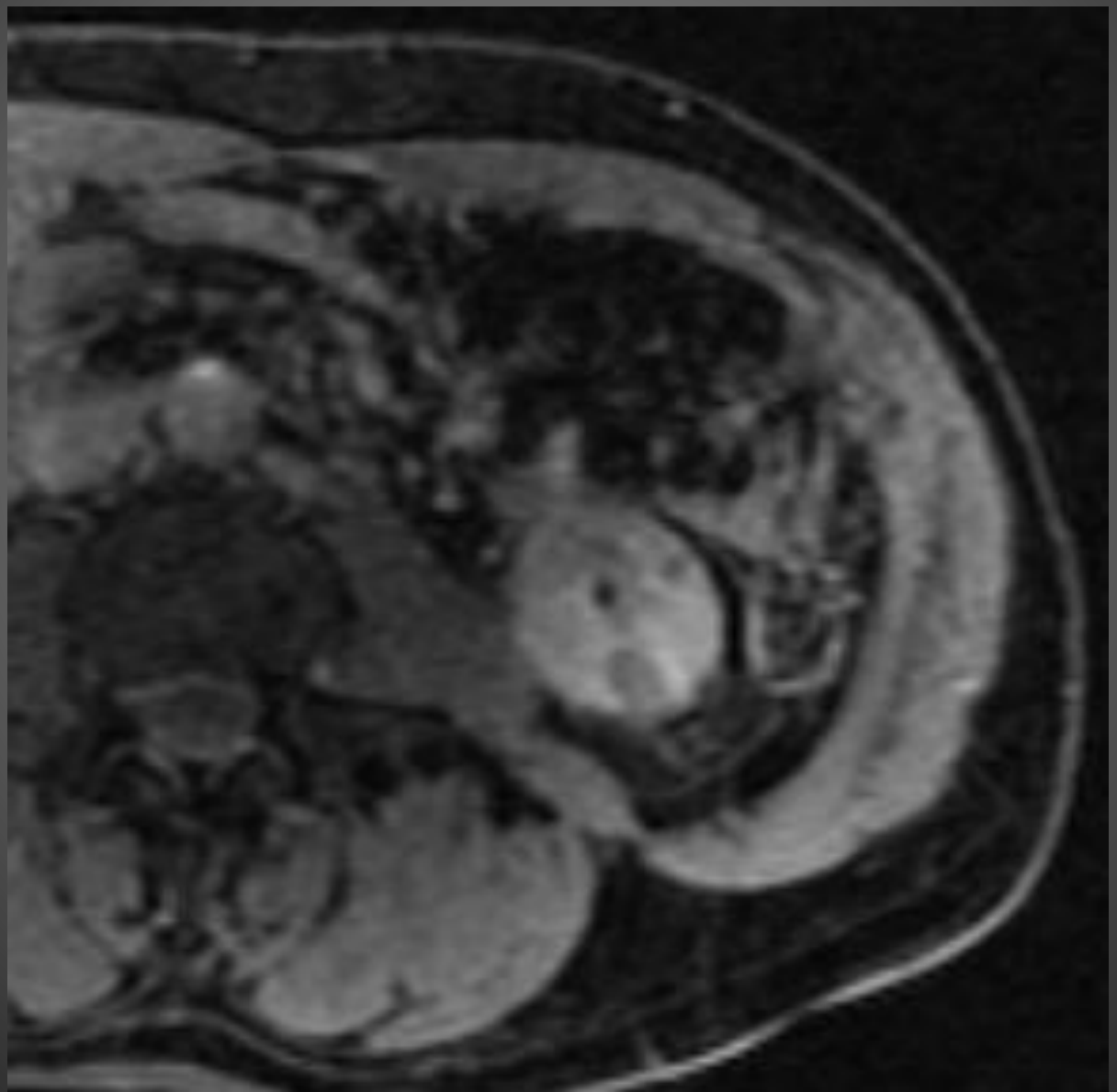

RCC, CLEAR CELL TYPE

Clear cell RCC

Case 4

- 67 year old male with prostate adenocarcinoma with incidental renal lesions detected on prostate/pelvic MR

Large FOV axial post-contrast image



ACR Appropriateness Criteria

Clinical Condition: **Indeterminate Renal Mass**

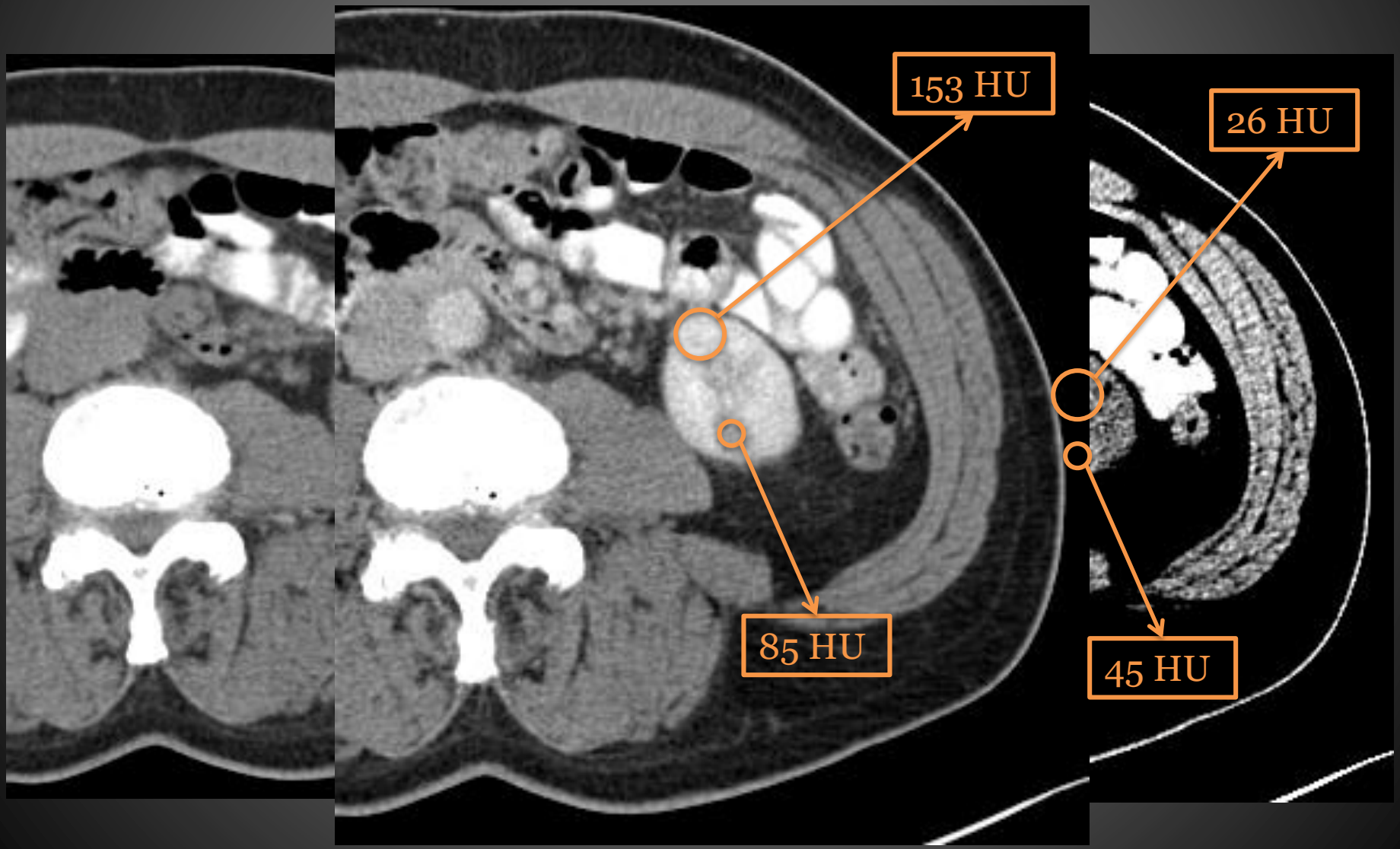
Variant 1: **Patient with normal renal function.**

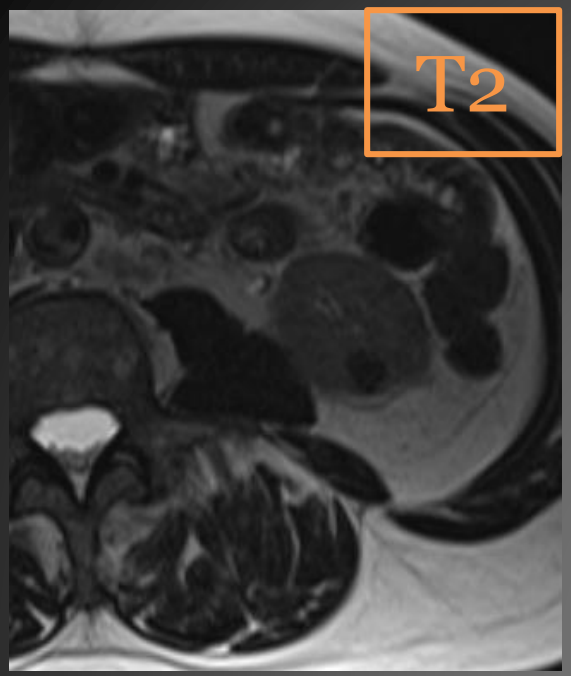
Radiologic Procedure	Rating	Comments	RRL*
CT abdomen without and with contrast	9	Either CT or MRI is appropriate. Use thin-section CT.	☢☢☢☢
MRI abdomen without and with contrast	8	Either CT or MRI is appropriate. See statement regarding contrast in text under "Anticipated Exceptions."	O
US kidney retroperitoneal with duplex Doppler	8		O
Biopsy renal mass	5		Varies
MRI abdomen without contrast	3	This procedure can be useful to characterize simple cysts.	O
Arteriography kidney	1		☢☢☢
X-ray intravenous urography	1		☢☢☢
CT abdomen with contrast	1		☢☢☢
CT abdomen without contrast	1		☢☢☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

Bluth, E.I., et al. Radiology, 2000.

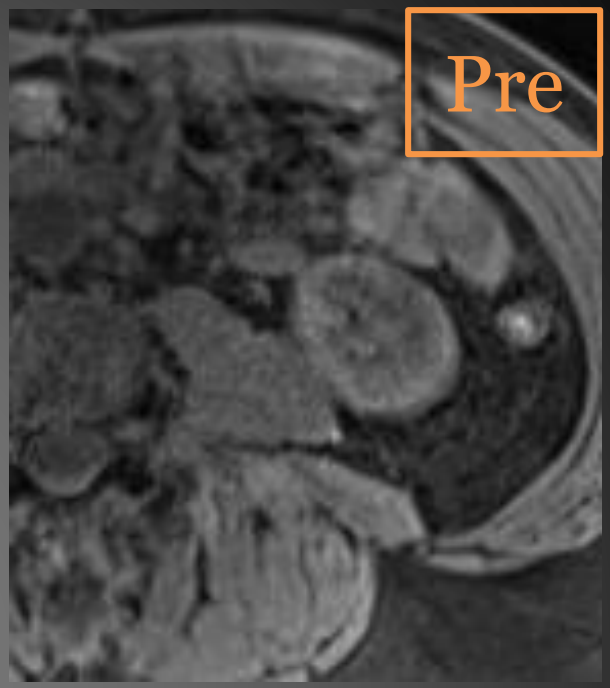
Renal mass protocol

Renal mass protocol



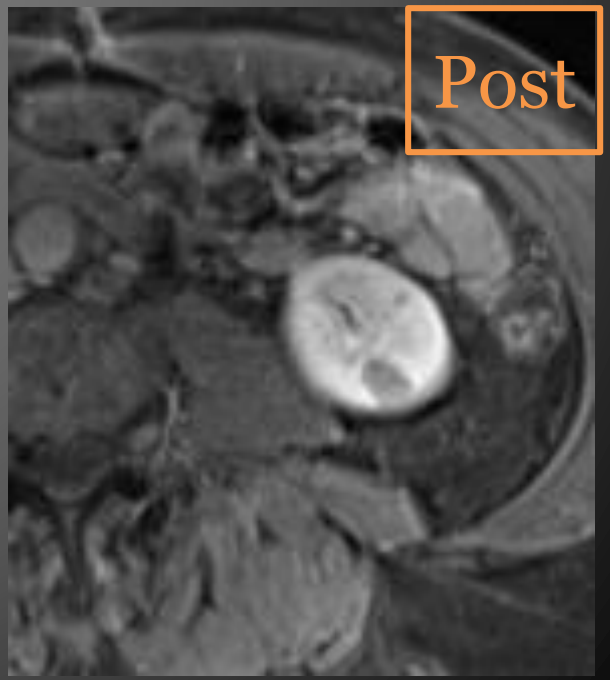

T2


Out


Pre

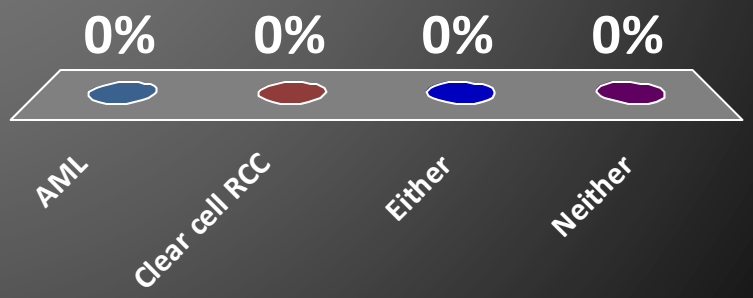

T2 FS


In


Post

If chemical shift imaging (in/out of phase) demonstrated signal drop-out, diagnosis would be:

A. AML
B. Clear cell RCC
★C. Either
D. Neither



Differential

- Fat poor AML
- Papillary RCC
- Prostate metastasis
- Lymphoma
- Oncocytoma

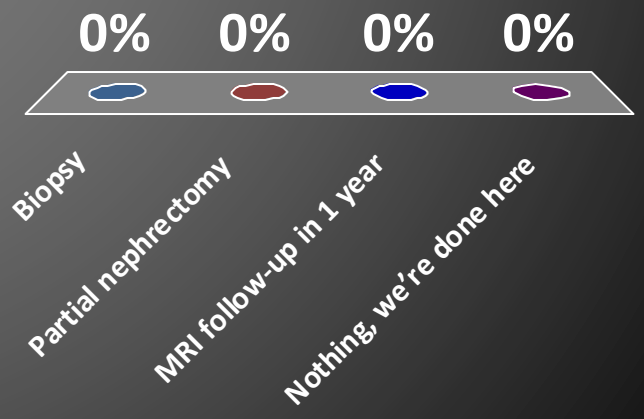
What is the best next step?

★A. Biopsy

B. Partial nephrectomy

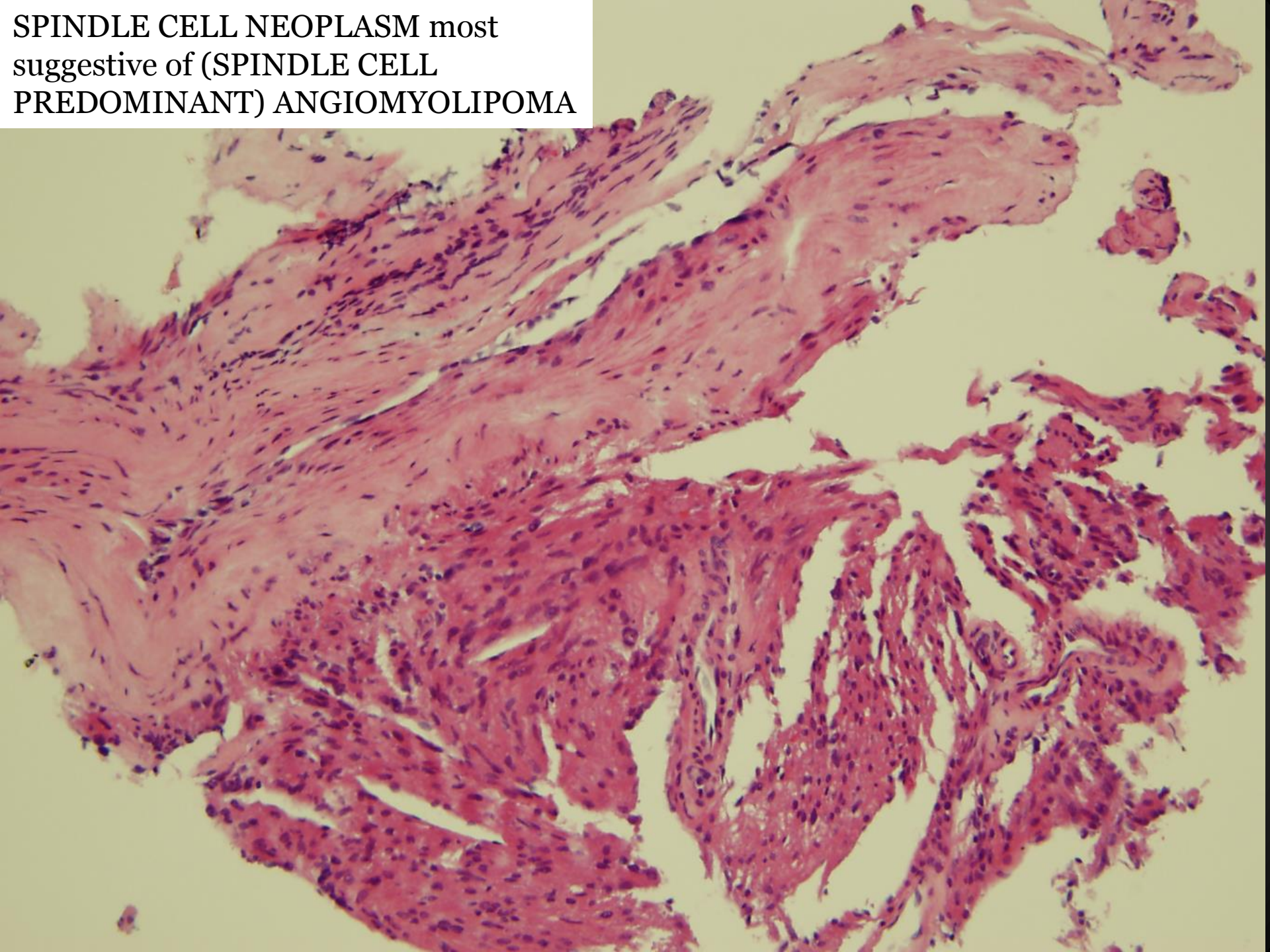
C. MRI follow-up in 1 year

D. Nothing, we're done here



Pathology

SPINDLE CELL NEOPLASM most suggestive of (SPINDLE CELL PREDOMINANT) ANGIOMYOLIPOMA



Fat poor (spindle predominant) AML

End of cases!

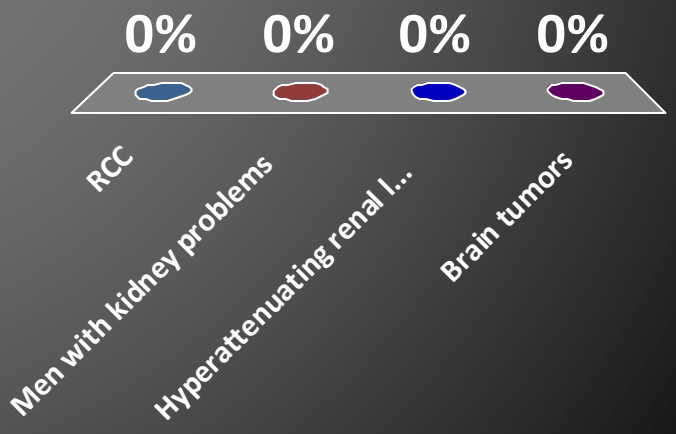
What is the theme of today's Rad-Path conference?

A. RCC

B. Men with kidney problems

★C. Hyperattenuating renal lesions

D. Brain tumors



Hyperattenuating renal masses

- Higher attenuation than renal parenchyma (~30 HU) so basically anything 40-90 HU
- Causes? Some examples:
  - Densely packed cells
  - Diffuse microcalcifications
  - Colloid/proteinaceous
  - Hemorrhage

EDUCATION EXHIBIT 1131

RadioGraphics

Hyperattenuating Renal Masses: Etiologies, Pathogenesis, and Imaging Evaluation[1]

Stuart G. Silverman, MD • Koenraad J. Mortele, MD • Kemal Tuncali, MD • Masahiro Jinzaki, MD • Edmund S. Cibas, MD

- Colloid/proteinaceous
- Hemorrhage

Hyperattenuating renal lesions: Ddx

Benign

Nonenhancing

- "Hyperdense" cyst
- Hematoma

Enhancing

- AML
- Oncocytoma
- Vascular anomalies
- Focal (hemorrhagic) pyelonephritis
- Tuberculosis
- Leiomyoma
- Extramedullary hematopoiesis
- Metanephric adenoma

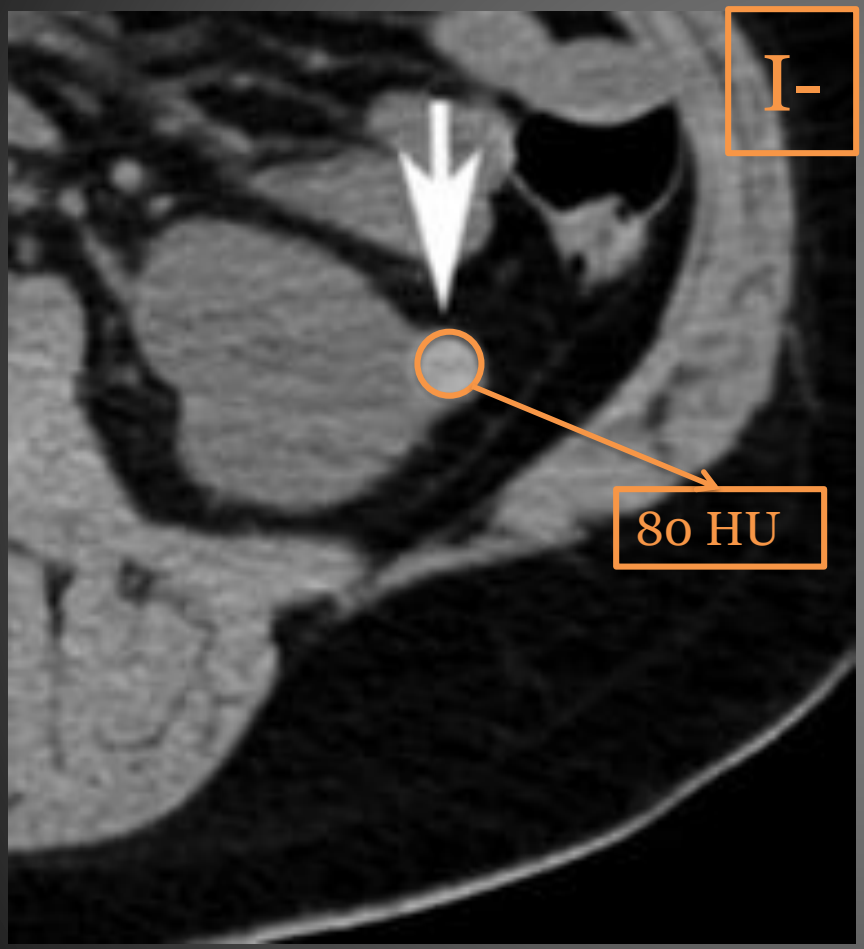
Malignant

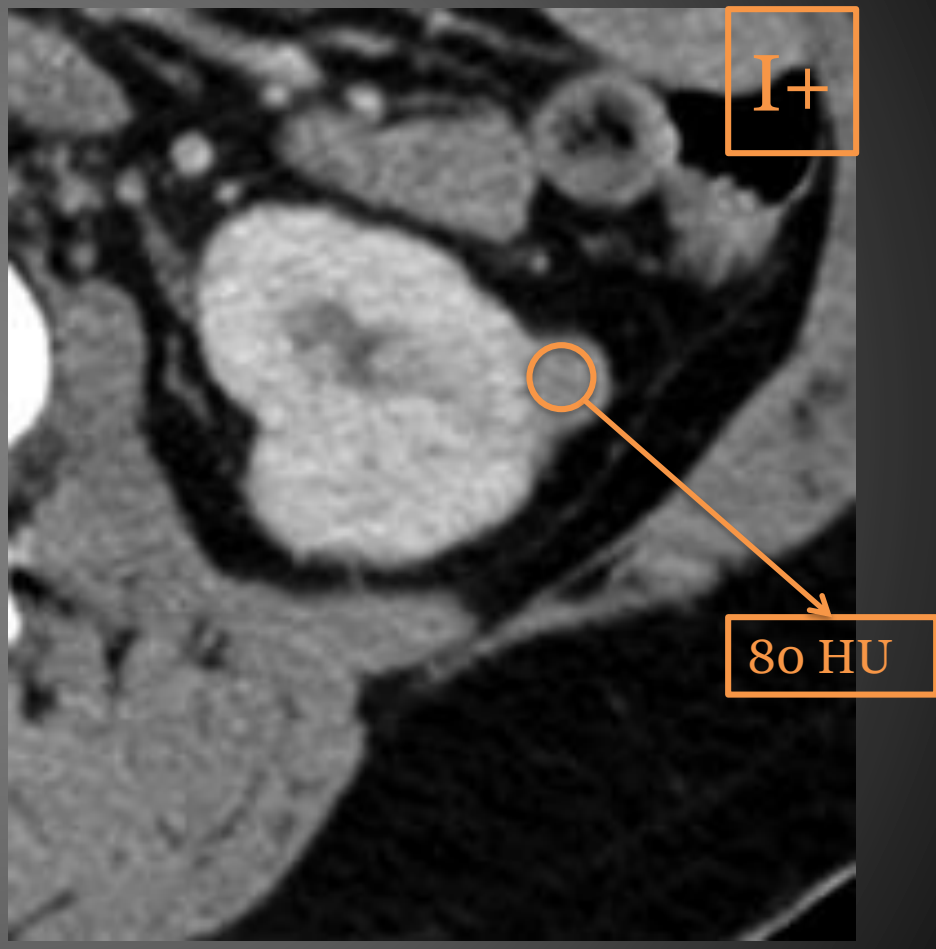
- RCC (papillary, clear cell, chromophobe)
- Lymphoma
- Metastases
- Leiomyosarcoma

Silverman, S.G., et al. Radiographics, 2007.

Benign

“Hyperdense” cysts

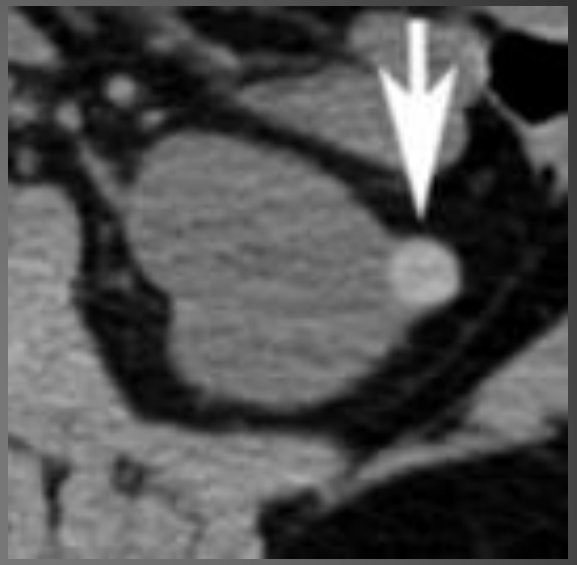


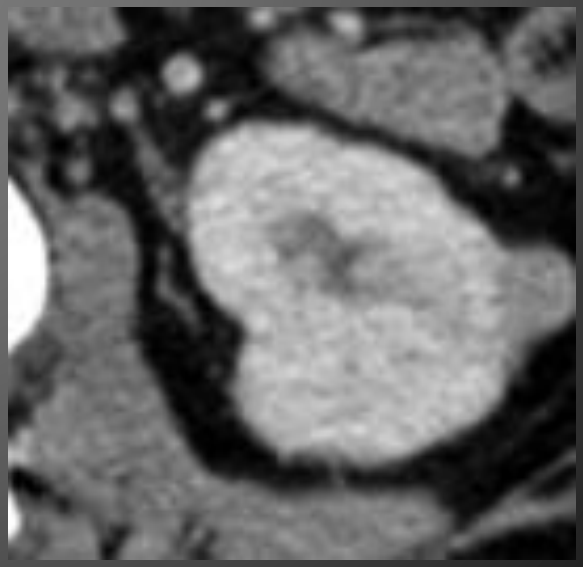


Silverman, S.G., et al. Radiographics, 2007.

Proteinaceous or hemorrhagic cyst

- Most common
- Small (<3 cm)
- Round
- Well-circumscribed
- Homogeneous*
- Non-enhancing**

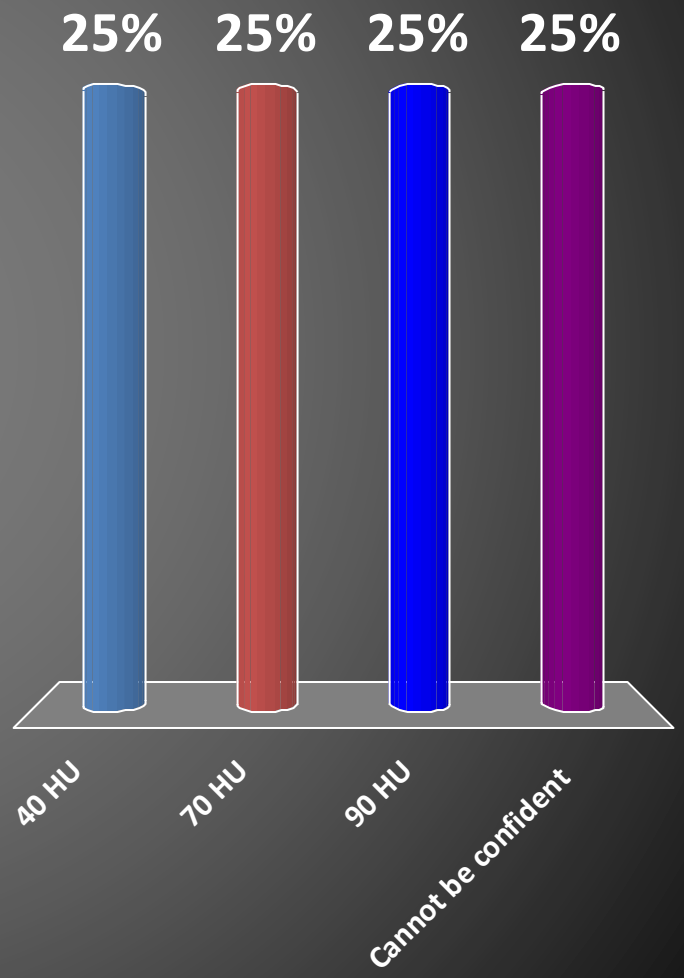




Silverman, S.G., et al. Radiographics, 2007.

To make a confident diagnosis on an I- exam, a hyperdense cyst must measure at least:

A. 40 HU
B. 70 HU
C. 90 HU
D. Cannot be confident

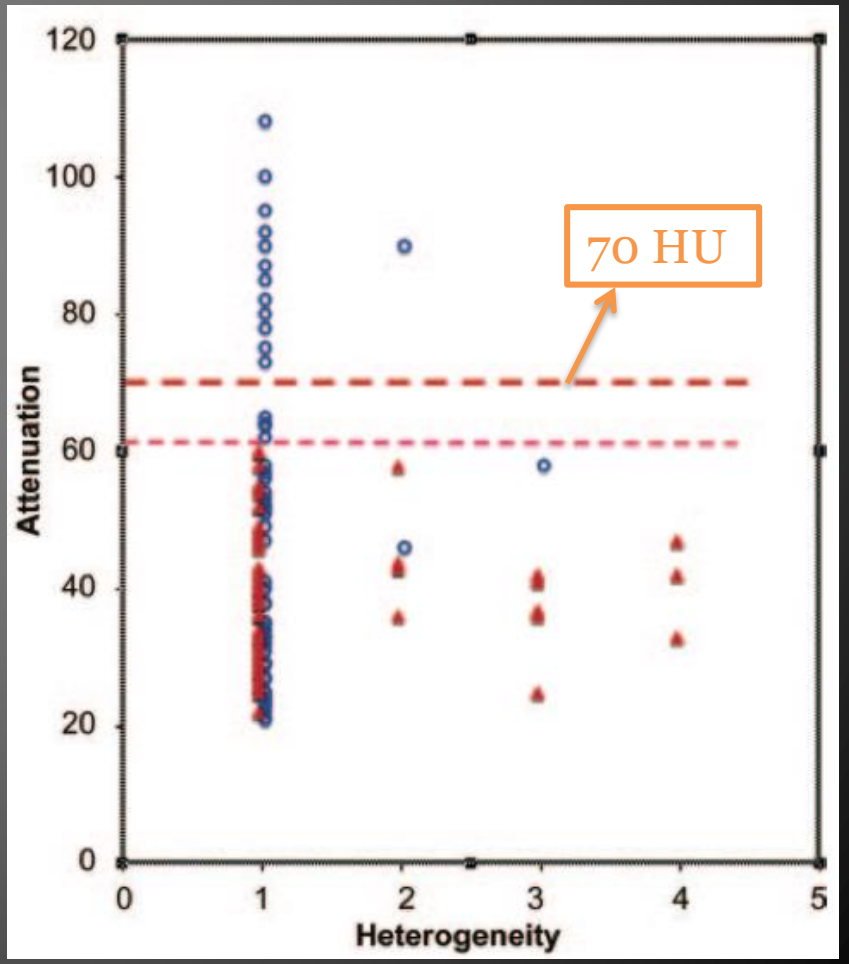


Radiology

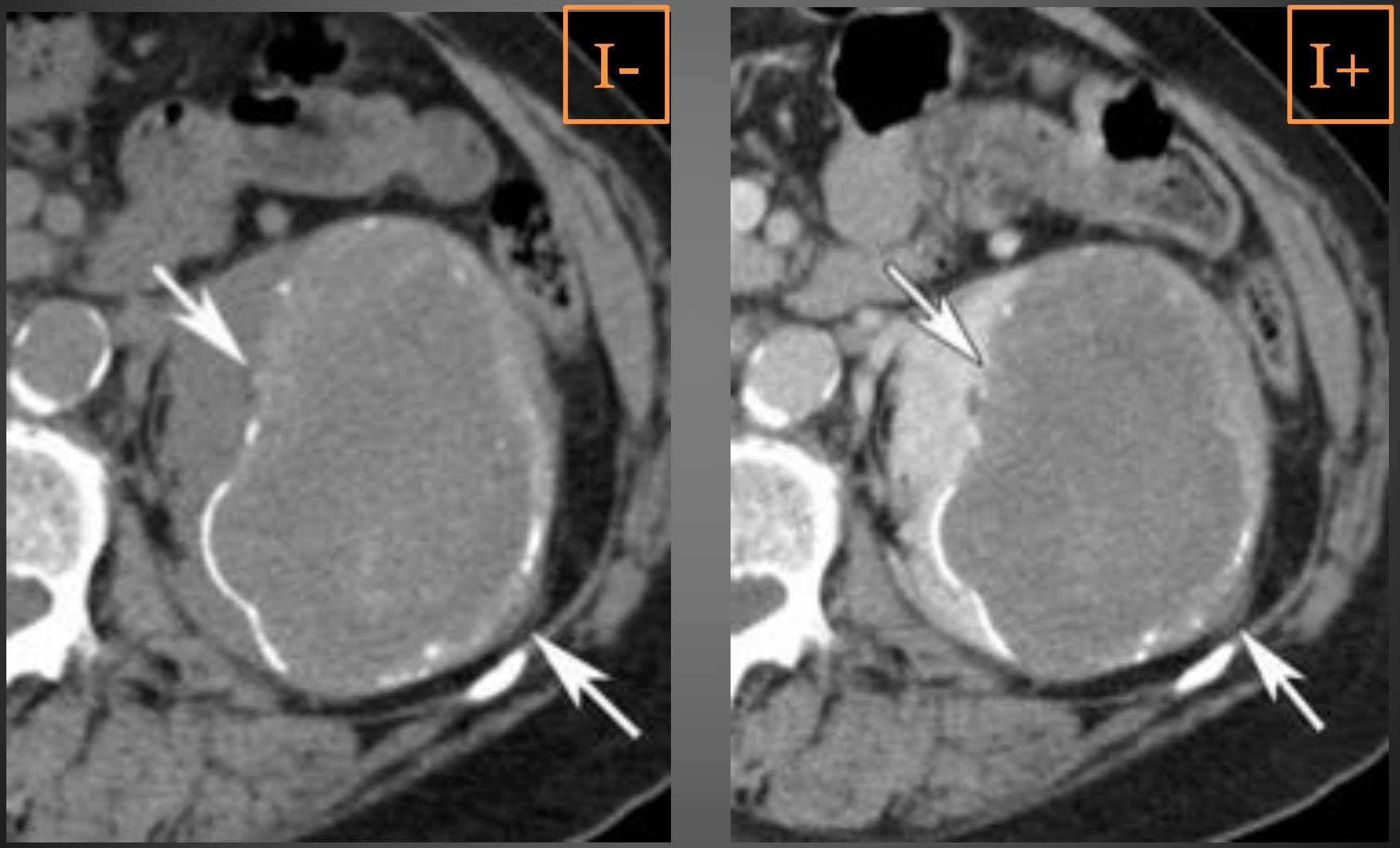
Ari I. Jonisch, MD
Ami N. Rubinowitz, MD
Pradeep G. Mutalik, MD
Gary M. Israel, MD

Can High-Attenuation Renal Cysts Be Differentiated from Renal Cell Carcinoma at Unenhanced CT?[1]

- Attenuation >70 HU
- Homogeneous



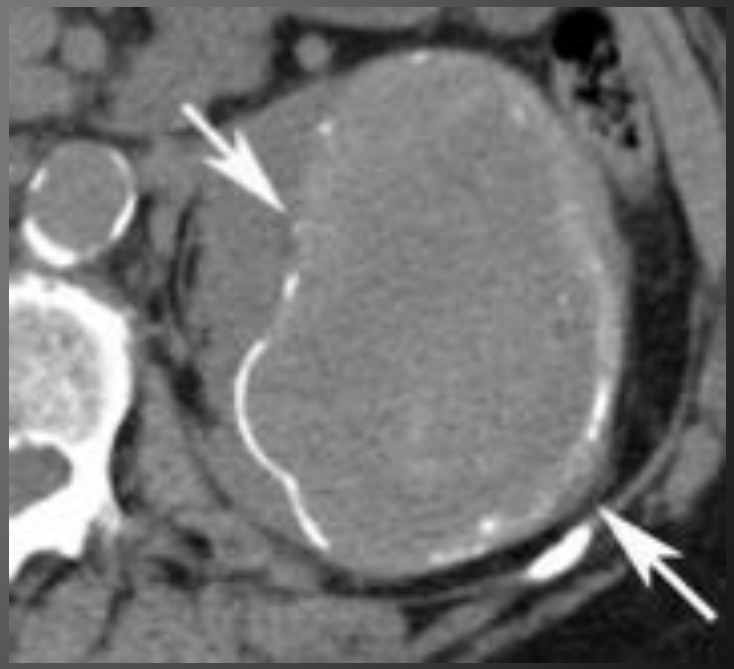
Hematoma



Silverman, S.G., et al. Radiographics, 2007.

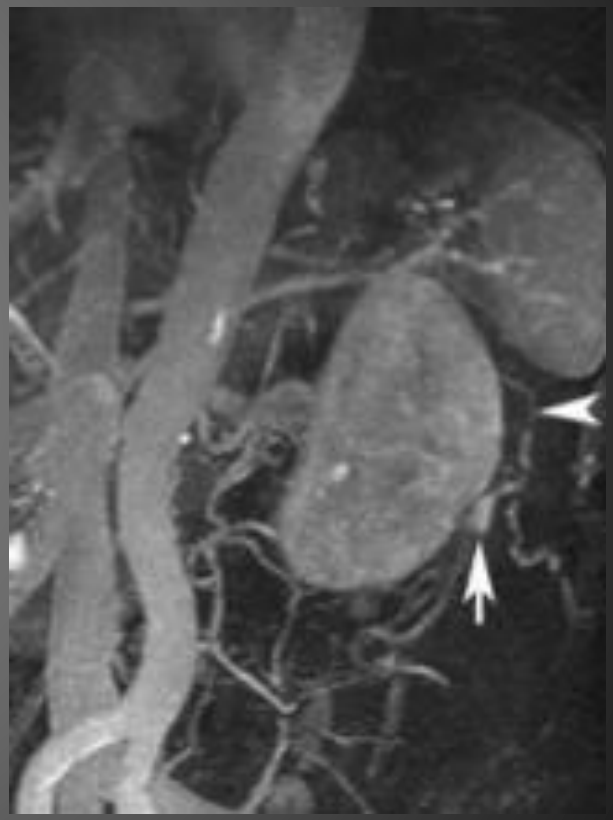
Hematoma

- Spontaneous, post-traumatic, tumor**
- Usually perinephric (crescentric)
  - Less commonly, masslike
- Non-enhancing
- +/- perinephric stranding
- +/- peripheral calcifications



Silverman, S.G., et al. Radiographics, 2007.

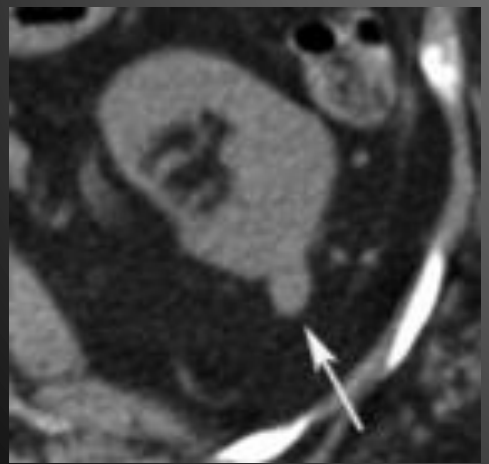
Vascular anomalies

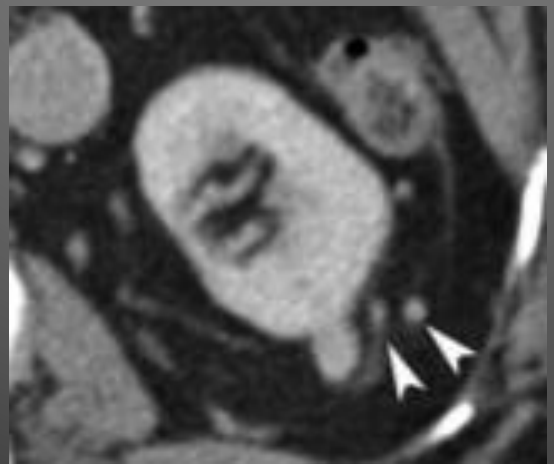


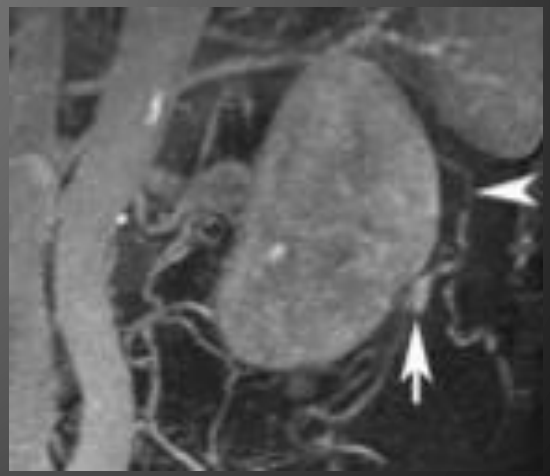
Silverman, S.G., et al. Radiographics, 2007.

Vascular anomalies

- AVM, pseudoaneurysm, aneurysm
- Thrombus can be high attenuation
- Saccular/tubular shape
- Attenuation matches nearby blood vessels
- Look for draining veins

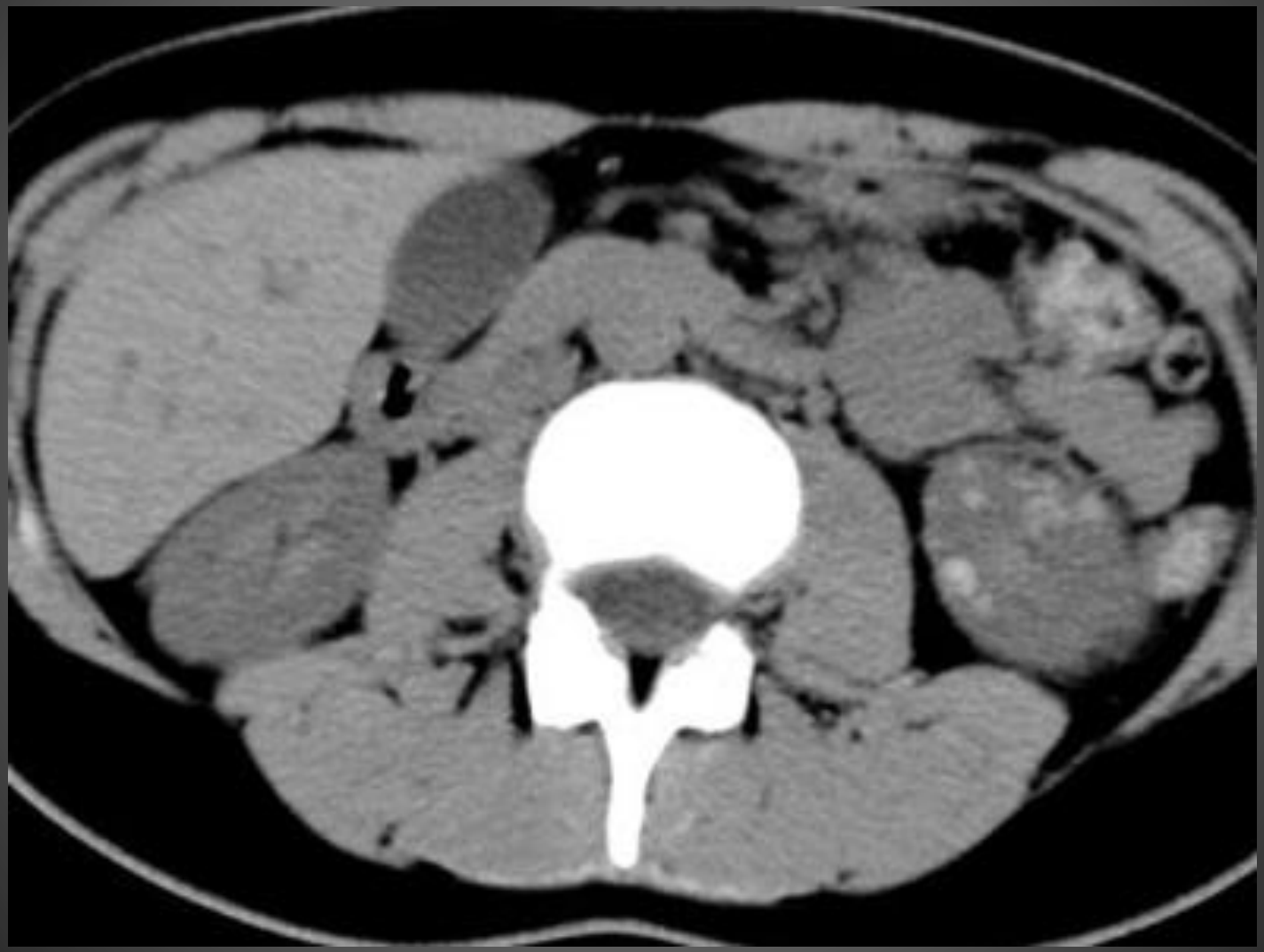






Silverman, S.G., et al. Radiographics, 2007.

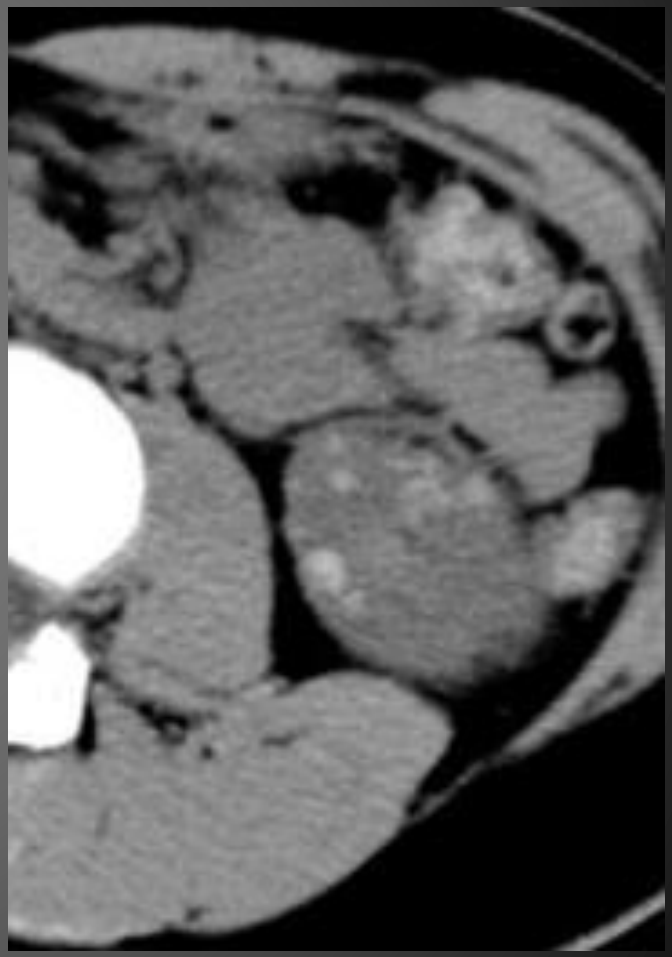
Focal (hemorrhagic) pyelonephritis



Craig, W.D., B.J. Wagner, and M.D. Travis. Radiographics, 2008.

Focal (hemorrhagic) pyelonephritis

- Clinical diagnosis
- Imaging often “normal”
- Wedge-shaped/rounded areas of decreased enhancement
- Loss of corticomedullary differentiation
- Associated inflammation
- Rarely, hyperattenuating (hemorrhagic)



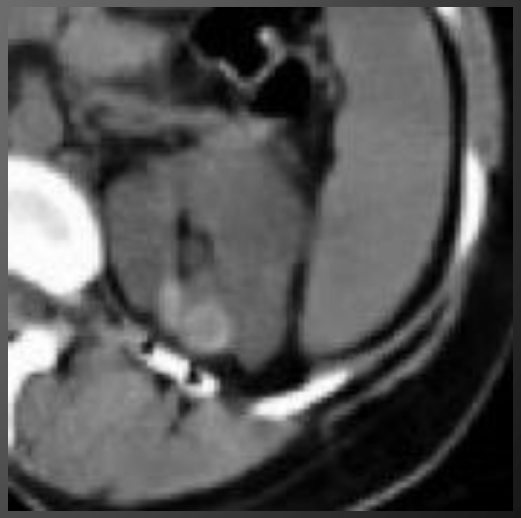
Craig, W.D., B.J. Wagner, and M.D. Travis. Radiographics, 2008.

Tuberculosis

Merchant, S., A. Bharati, and N. Merchant. Indian J Radiol Imaging, 2013.

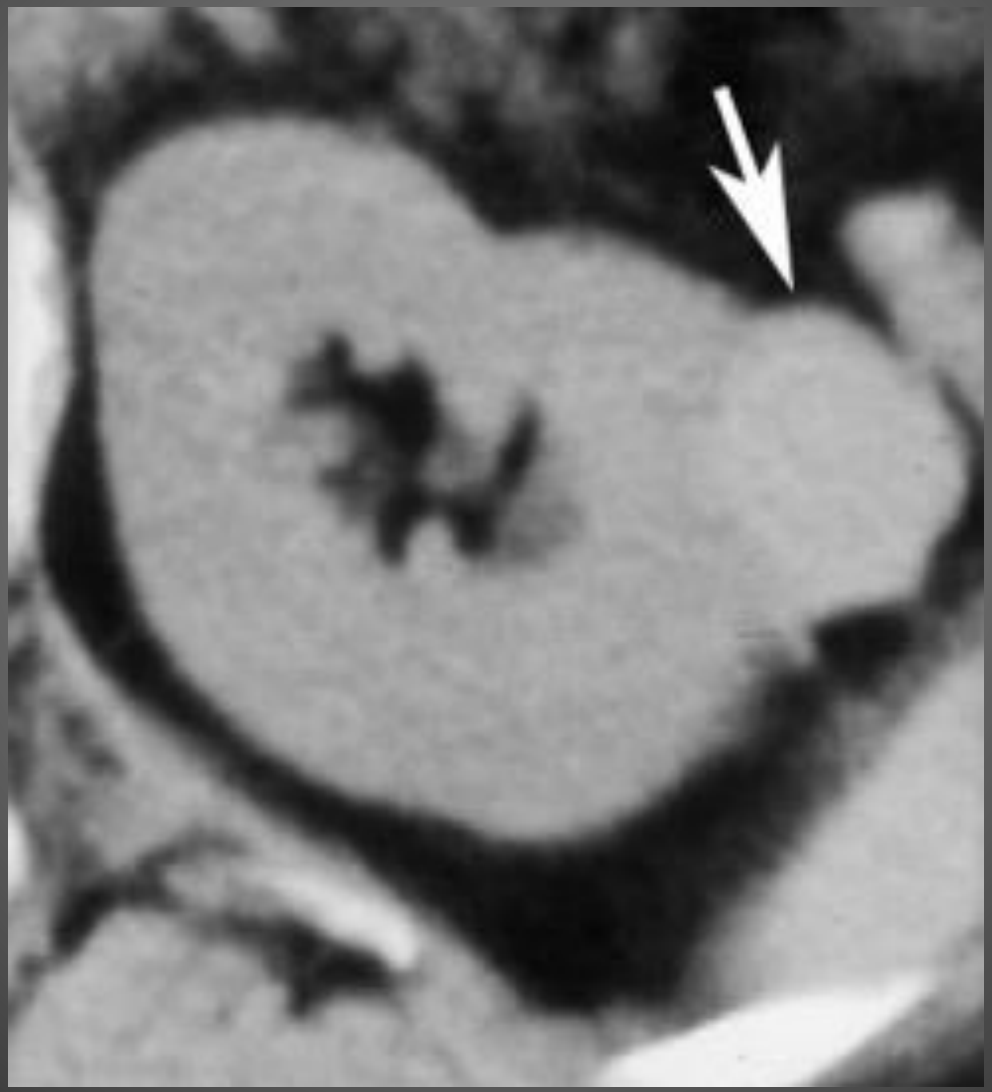
Tuberculosis

- #1 extrapulmonary site
- Presentation is atypical for UTI
- Hematuria & culture-negative
- Granulomas → spread into medulla, papillae & collecting
- Triad:
  - Calcifications
  - Urothelial thickening, stricture
  - Cortical scarring
  - **Stage of disease



Craig, W.D., B.J. Wagner, and M.D. Travis. Radiographics, 2008.
Merchant, S., A. Bharati, and N. Merchant. Indian J Radiol Imaging, 2013.

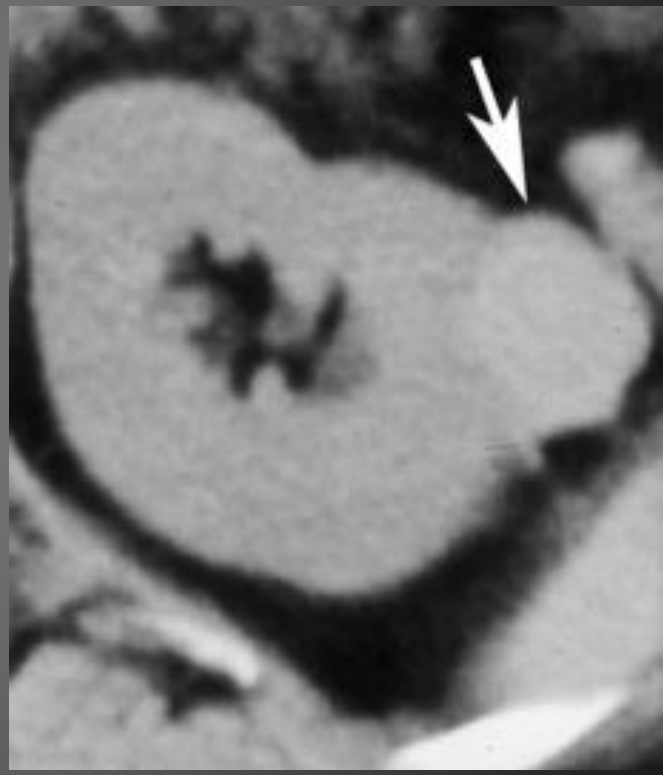
Leiomyoma



Silverman, S.G., et al. Radiographics, 2007.

Leiomyoma

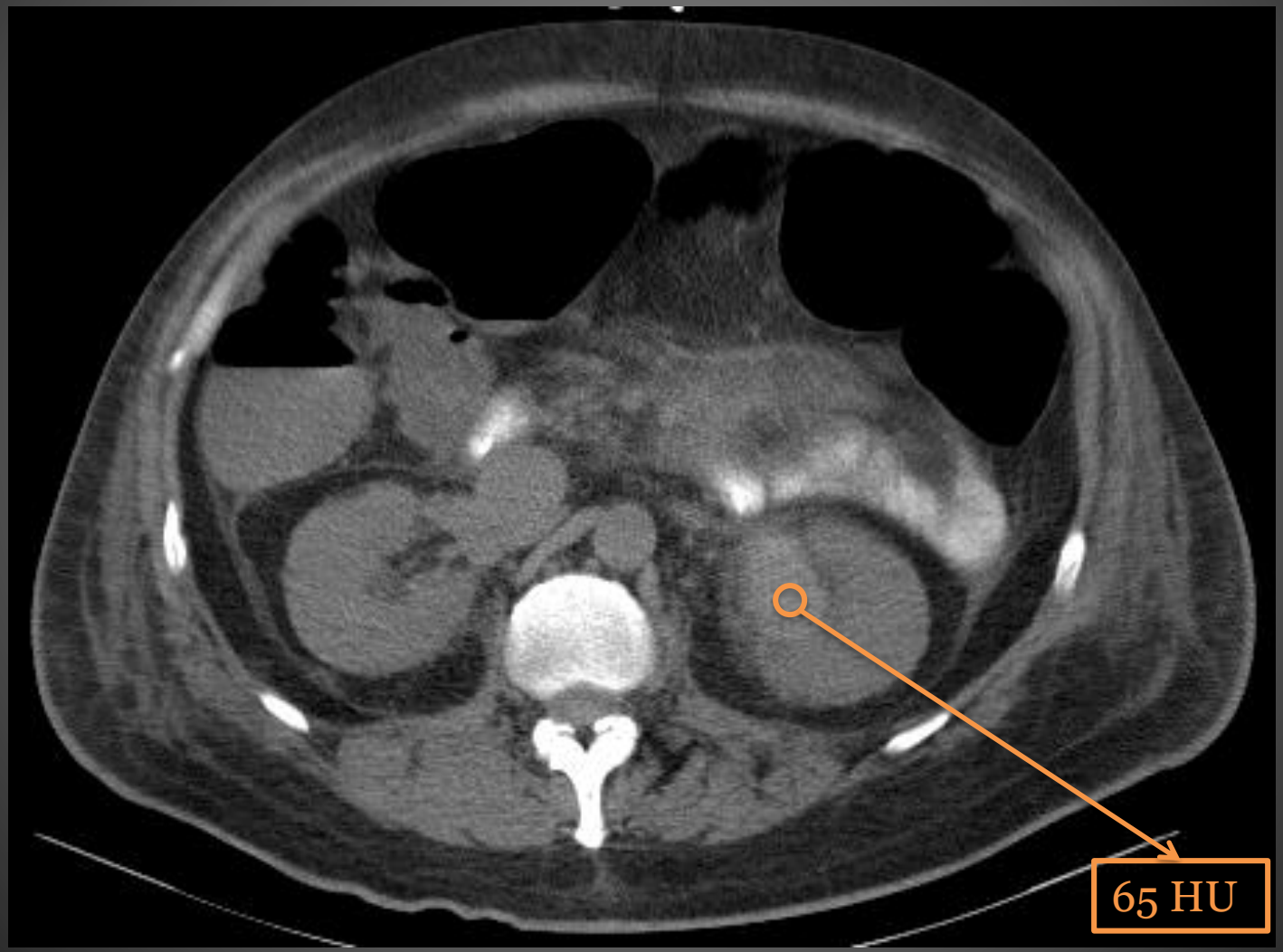
- 1.5% of benign renal tumors
- Arise from smooth muscle of renal capsule, calyces, or blood vessels
- Well-defined, round, hyperdense, homogeneously enhancing
- DDx: Leiomyosarcoma, AML
  - Need histology



Silverman, S.G., et al. Radiographics, 2007.

StatDx: Renal Tumors, Atypical and Rare

Extramedullary hematopoiesis



Gupta, R., A. Seith, and B. Guglani. Int Urol Nephrol, 2009.

Extramedullary hematopoiesis

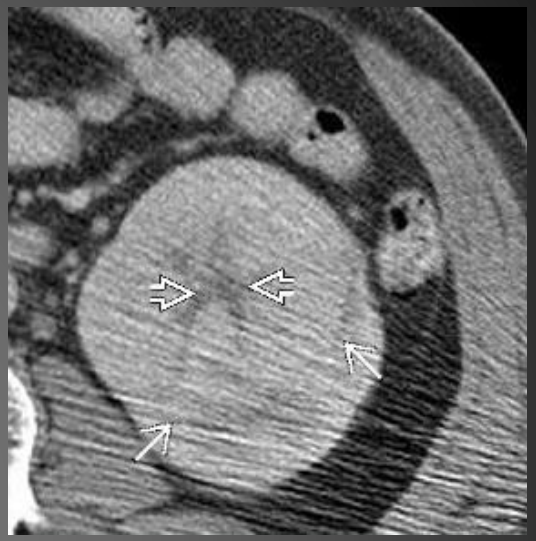
- Due to erythropoiesis failure in bone marrow (ex: myelofibrosis)
- Most often spleen, liver, lymph nodes
- Renal involvement rare
  - Parenchymal, intrapelvic, perirenal
- Differential: RCC, urothelial carcinoma, lymphoma
  - Diagnosis of exclusion

Gupta, R., A. Seith, and B. Guglani. Int Urol Nephrol, 2009.

Oncocytoma

Oncocytoma

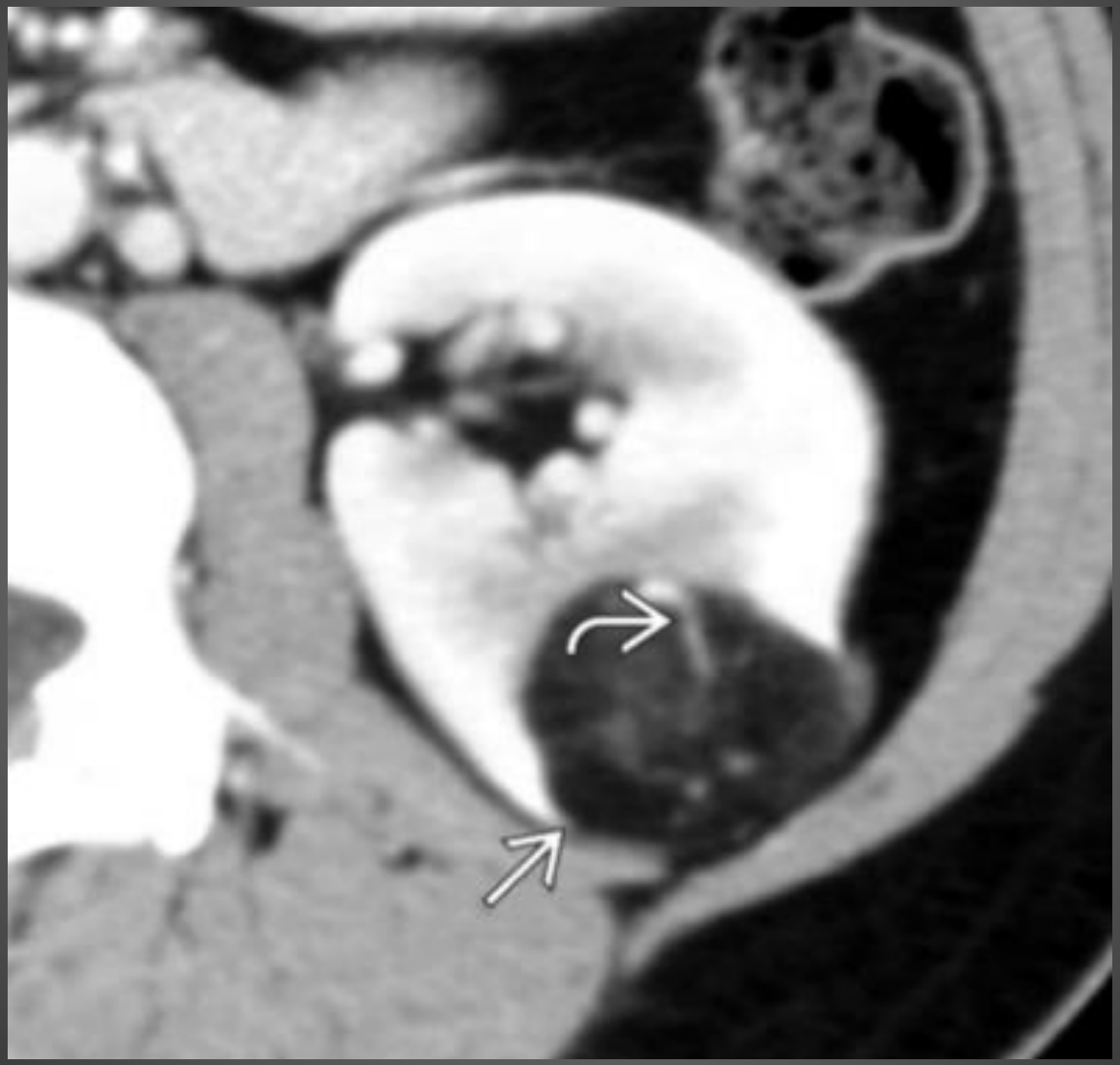
- 2nd most common benign tumor
- Epithelial cells, arising from collecting ducts
- Average = size 7 cm
- Variable appearance
  - +/- central stellate scar*
- No malignant features
- Enhancing (< renal parenchyma)



Silverman, S.G., et al. Radiographics, 2007.

StatDx: Oncocytoma

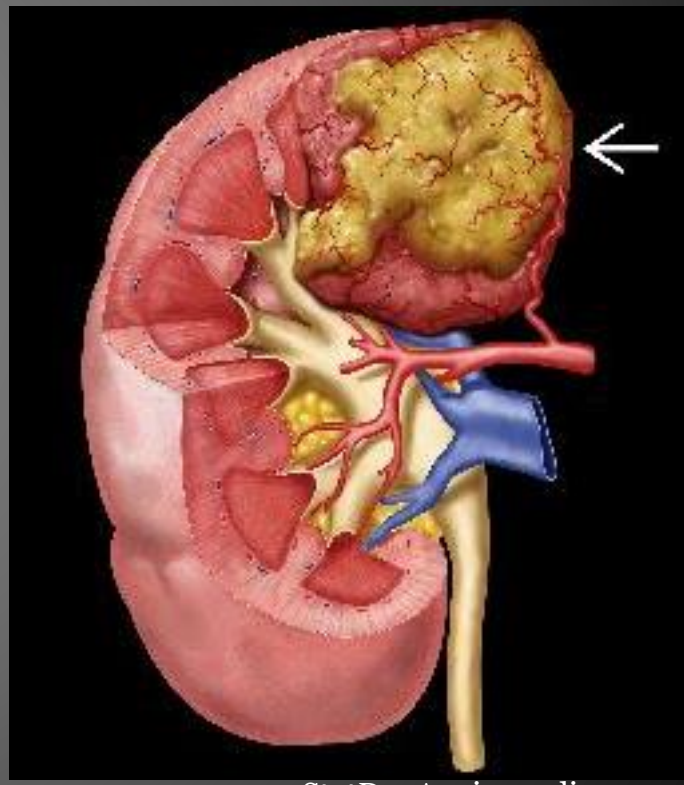
Angiomyolipoma



StatDx: Angiomyolipoma

Angiomyolipoma (AML)

- Macroscopic fat (-10 HU)
- 4-5% contain little to no fat
  - MR usually unhelpful
    - Fat suppression sequences
    - Chemical shift imaging (in/out of phase)
- Noncalcified*
- Large feeding arteries
- Ddx: liposarcoma
  - Usually RP
  - No claw sign



StatDx: Angiomyolipoma

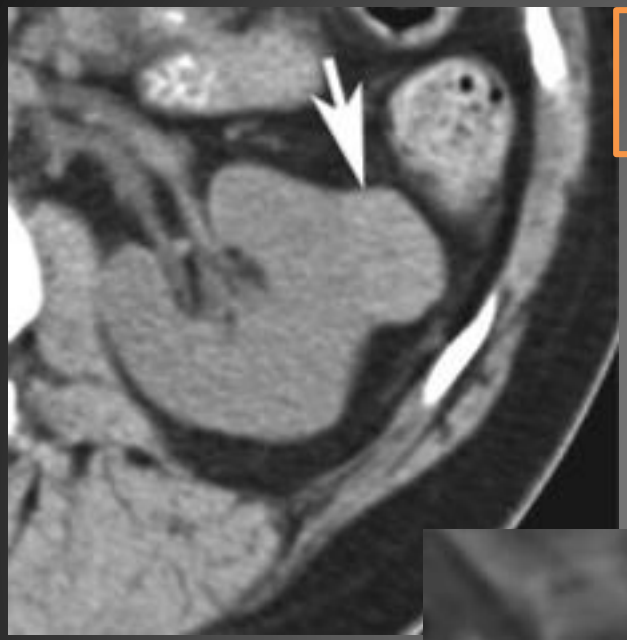
Silverman, S.G., et al. Radiographics, 2007.

The many faces of AML

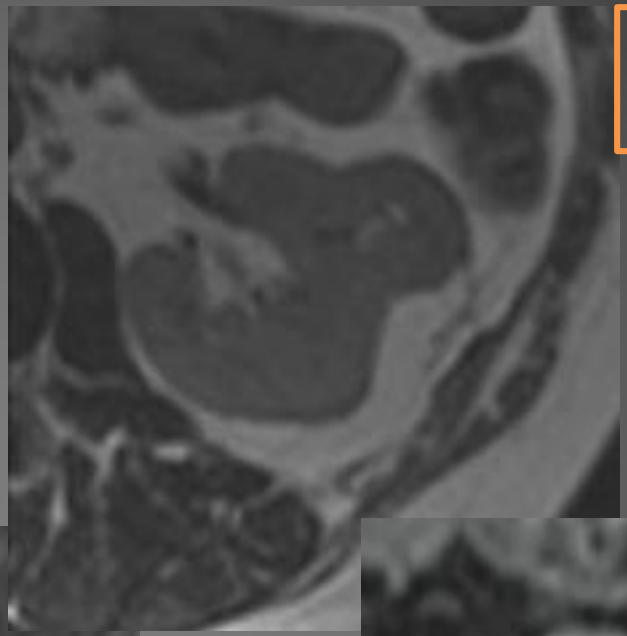
Jinzaki, M., et al.
Radiology, 1997.
Silverman, S.G., et al.
Radiographics, 2007.

StatDx: Angiomyolipoma

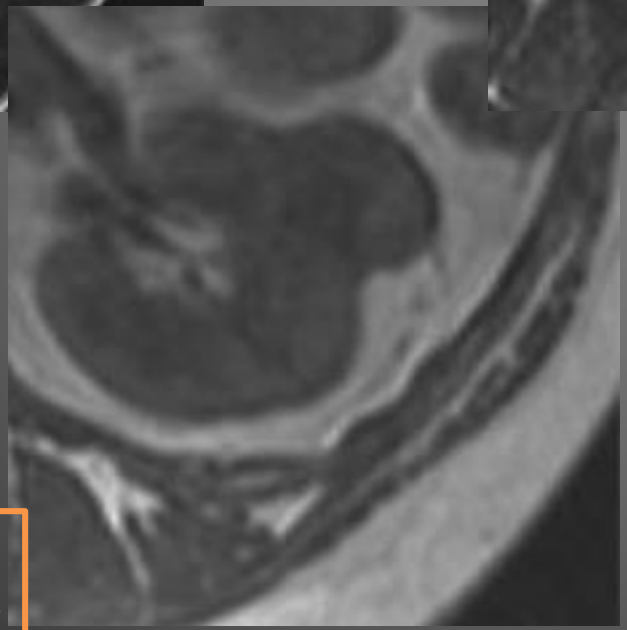
Fat-poor AML



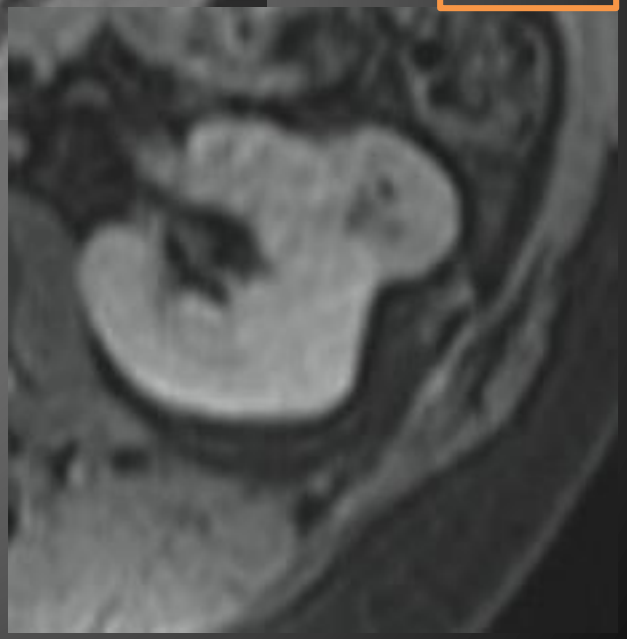
I-



T2



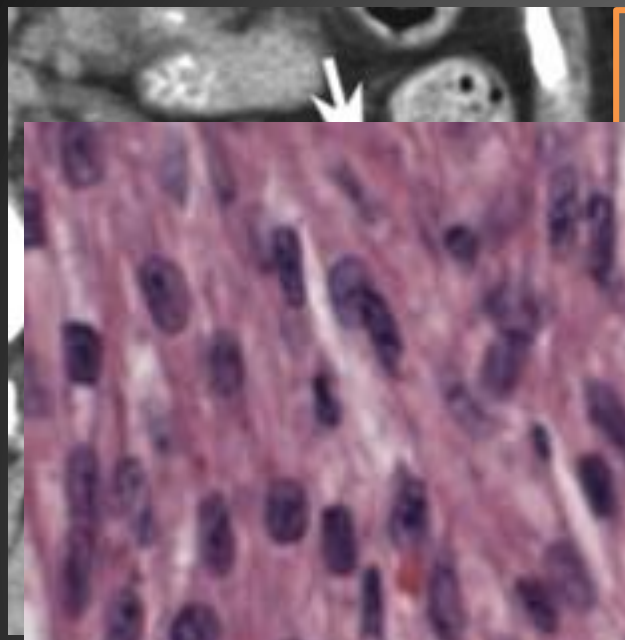
T1



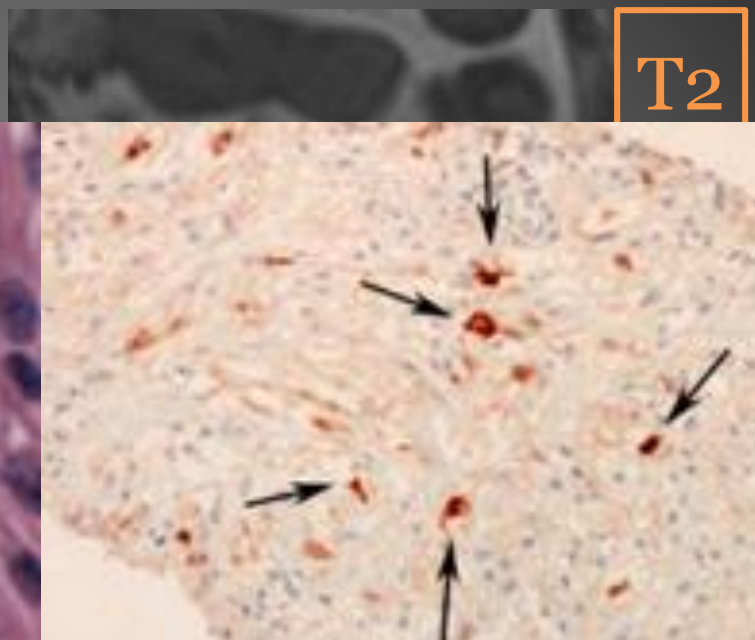
Post

Jinzaki, M., et al. Radiology, 1997.
Silverman, S.G., et al. Radiographics, 2007.

Fat-poor AML



I-



T2

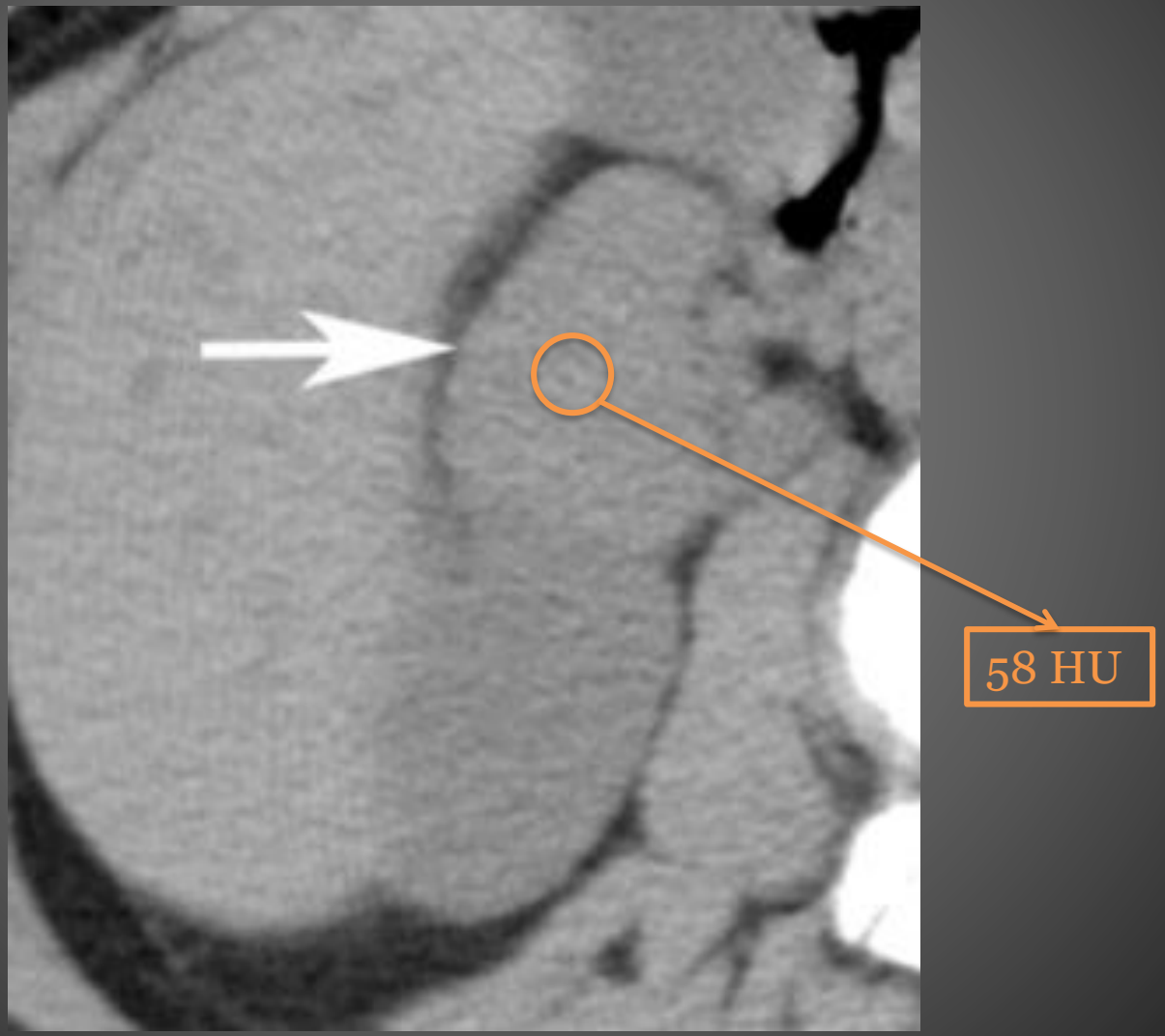
T1

Jinzaki, M., et al. Radiology, 1997.

Silverman, S.G., et al. Radiographics, 2007.

Malignant

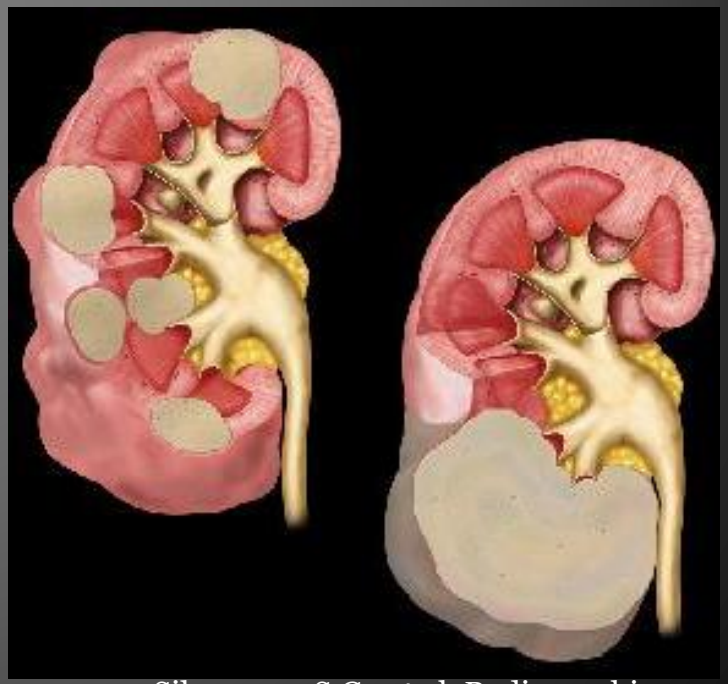
Lymphoma



Silverman, S.G., et al. Radiographics, 2007.

Lymphoma

- NHL > HL (10:1)
- Primary only 3%
- Usually hypoattenuating
- Variable pattern
  - Solitary (10%)
  - Multiple (60%)
  - Diffuse infiltration (20%)
  - Perirenal (10%)
- Homogeneous
- Minimal enhancement



Silverman, S.G., et al. Radiographics, 2007.
StatDx: Renal Lymphoma

Metastases

StatDx: Metastases and Lymphoma, Renal

Metastases

- 54 masses in patients with a known extrarenal primary cancer and unknown renal mass
- 31 masses (57%) = RCC
- Most common primaries = lymphoma & lung
  - N=36
  - 50% were RCC
- → Biopsy indicated

Rybicki, F.J., et al. AJR Am J Roentgenol, 2003.

Metastases

Percutaneous Biopsy of Renal Masses: Sensitivity and Negative Predictive Value Stratified by Clinical Setting and Size of Masses

Frank J. Rybicki[1]
Kirstin M. Shu[1]
Edmund S. Cibas[2]
Julia R. Fielding[1,3]
Eric vanSonnenberg[1]
Stuart G. Silverman[1]

– N=36

– 50% were RCC

- → Biopsy indicated

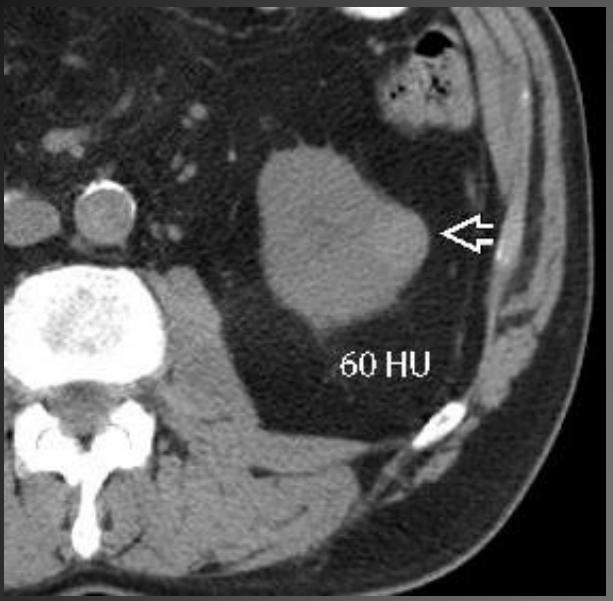
TABLE 4 Diagnoses of 54 Renal Masses in Patients with a Known Extrarenal Primary Malignancy

Primary Malignancy	No. of Masses	Diagnosis		
		Metastasis	Renal Cell Carcinoma	Benign
Lymphoma	20	9	10	1
Lung	16	8	8	0
Breast	5	1	3	1
Ovarian	3	0	3	0
Colon	2	1	1	0
Prostate	2	0	2	0
Bladder	2	0	2	0
Tongue	1	0	1	0
Testis	1	1	0	0
Leimyosarcoma	1	0	0	1
Duodenal	1	0	1	0
Total	54	20	31	3

Rybicki, F.J., et al. AJR Am J Roentgenol, 2003.

RCC

The many faces of RCC



RCC Subtypes

Subtype	%	CT features	MR features	Enhancement
Clear cell	70	Heterogeneous	T2 hyperintense +/- OOP signal dropout	Hyperenhancing
Papillary	10	Variable	T2 hypointense	Hypoenhancing
Chromophobe	5	Homogeneous	T2 hypointense	Homogeneously enhancing
Multilocular Xp11.2 translocation Collecting duct Medullary Etc…	<1			

Prasad, S.R., et al. Radiographics, 2006.

Raman, S.P., et al. AJR Am J Roentgenol, 2013.

Approach to hyperdense lesion*

Findings on CT I-

Feature	Likely diagnosis
>70 HU (& homogen)	Hyperdense cyst
Focal fat	"Typical" AML
Stranding	Consider: Hematoma Pyelonephritis
Calcifications, scarring, stricture	TB

Findings on CT I+

Feature	Likely diagnosis
Nonenhancing	Hyperdense cyst Hematoma
HU ≈ nearby vessels +/- draining veins	Vascular anomaly
Enhancing; indeterminate	MRI and/or biopsy

Findings on MRI

Feature	Likely diagnosis
Focal fat suppression	"Typical" AML
Signal drop on OOP	Clear cell RCC (usually T2 hyper) AML (usually T2 hypo)
T2 hypointense	"Fat-poor" AML (hyperenhancing) Papillary RCC (hypoenhancing)
T2 Iso- or hyperintense	RCC +/- oncocytoma

Adapted from Silverman, S.G., et al. Radiographics, 2007.

…Now what?

TABLE 4. *Proportion of clear cell, papillary and chromophobe RCC by tumor size*

Tumor Size (cm)	No. Clear Cell (%)	No. Papillary (%)	No. Chromophobe (%)
0.0–Less than 1.0	11 (25.6)	32 (74.4)	0 (0.0)
1.0–Less than 2.0	79 (59.9)	51 (38.6)	2 (1.5)
2.0–Less than 3.0	186 (70.2)	69 (26.0)	10 (3.8)
3.0–Less than 4.0	203 (72.0)	69 (24.5)	10 (3.6)
4.0–Less than 5.0	268 (80.2)	47 (14.1)	19 (5.7)
5.0–Less than 6.0	218 (82.0)	40 (15.0)	8 (3.0)
6.0–Less than 7.0	192 (83.5)	30 (13.0)	8 (3.5)
7.0 or Greater	813 (83.0)	98 (10.0)	68 (7.0)

Percentages indicate the proportion of RCC tumors in each size category that are clear cell, papillary and chromophobe, respectively.

Frank, I., et al. J Urol, 2003.

…Now what?

TABLE 4. *Proportion of clear cell, papillary and chromophobe RCC*

TABLE 5. *Proportion of low grade versus high grade tumors by RCC histological subtype and tumor size*

	No. Clear Cell (%)		No. Papillary (%)		No. Chromophobe (%)	
	Low Grade	High Grade	Low Grade	High Grade	Low Grade	High Grade
Tumor size (cm):						
0.0–Less than 1.0	10 (90.9)	1 (9.1)	32 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)
1.0–Less than 2.0	70 (88.6)	9 (11.4)	38 (74.5)	13 (25.5)	2 (100.0)	0 (0.0)
2.0–Less than 3.0	174 (93.6)	12 (6.5)	50 (72.5)	19 (27.5)	8 (80.0)	2 (20.0)
3.0–Less than 4.0	165 (81.3)	38 (18.7)	52 (75.4)	17 (24.6)	6 (60.0)	4 (40.0)
4.0–Less than 5.0	208 (77.6)	60 (22.4)	31 (66.0)	16 (34.0)	13 (68.4)	6 (31.6)
5.0–Less than 6.0	151 (69.3)	67 (30.7)	30 (75.0)	10 (25.0)	5 (62.5)	3 (37.5)
6.0–Less than 7.0	117 (60.9)	75 (39.1)	20 (66.7)	10 (33.3)	6 (75.0)	2 (25.0)
7.0 or Greater	308 (37.9)	505 (62.1)	55 (56.1)	43 (43.9)	51 (75.0)	17 (25.0)
Totals	1,203	767	308	128	91	34

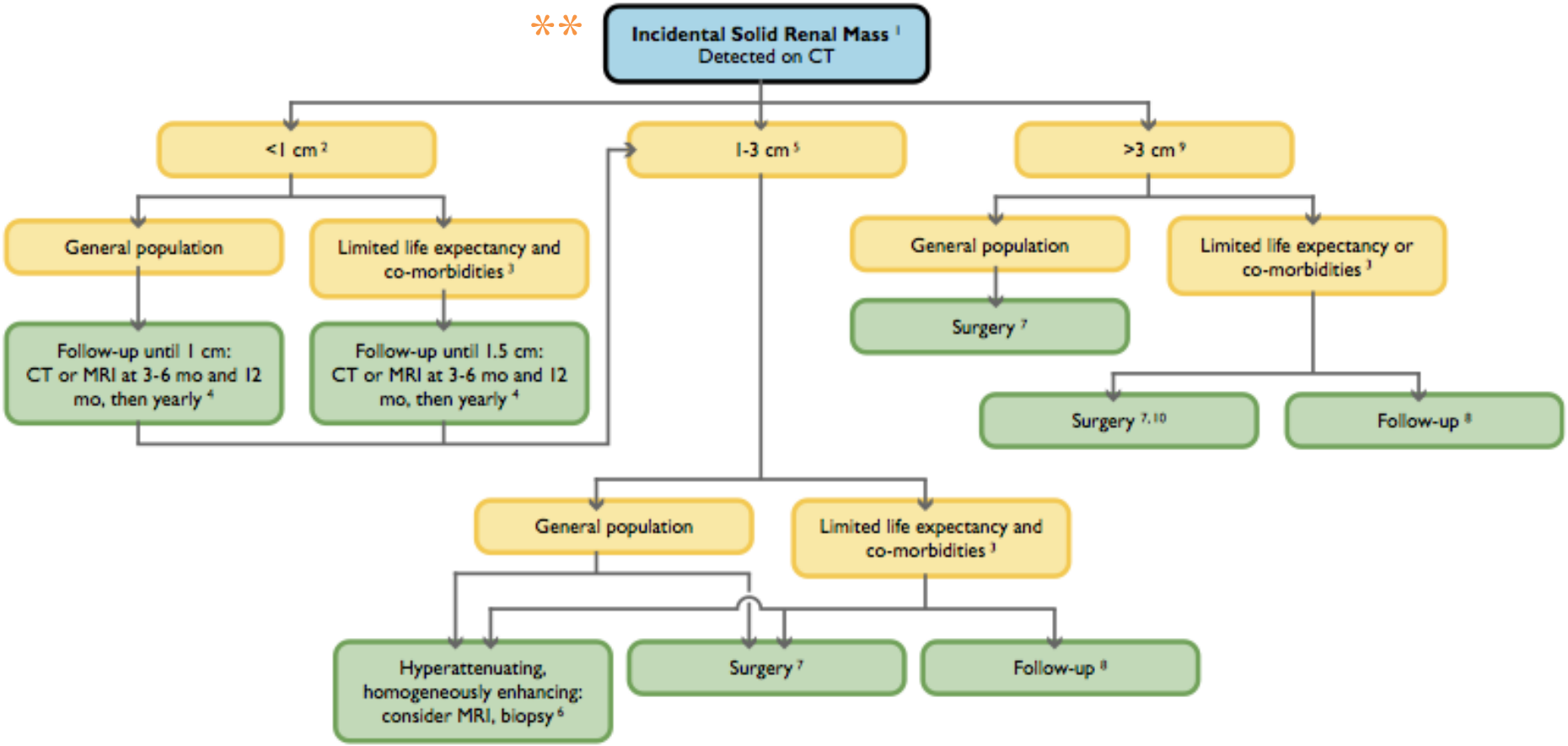
Percentages indicate the proportion of RCC tumors in each size and RCC subtype that are low grade and high grade, respectively.

6.0–Less than 7.0	192 (83.5)	30 (13.0)	8 (3.5)
7.0 or Greater	813 (83.0)	98 (10.0)	68 (7.0)

Percentages indicate the proportion of RCC tumors in each size category that are clear cell, papillary and chromophobe, respectively.

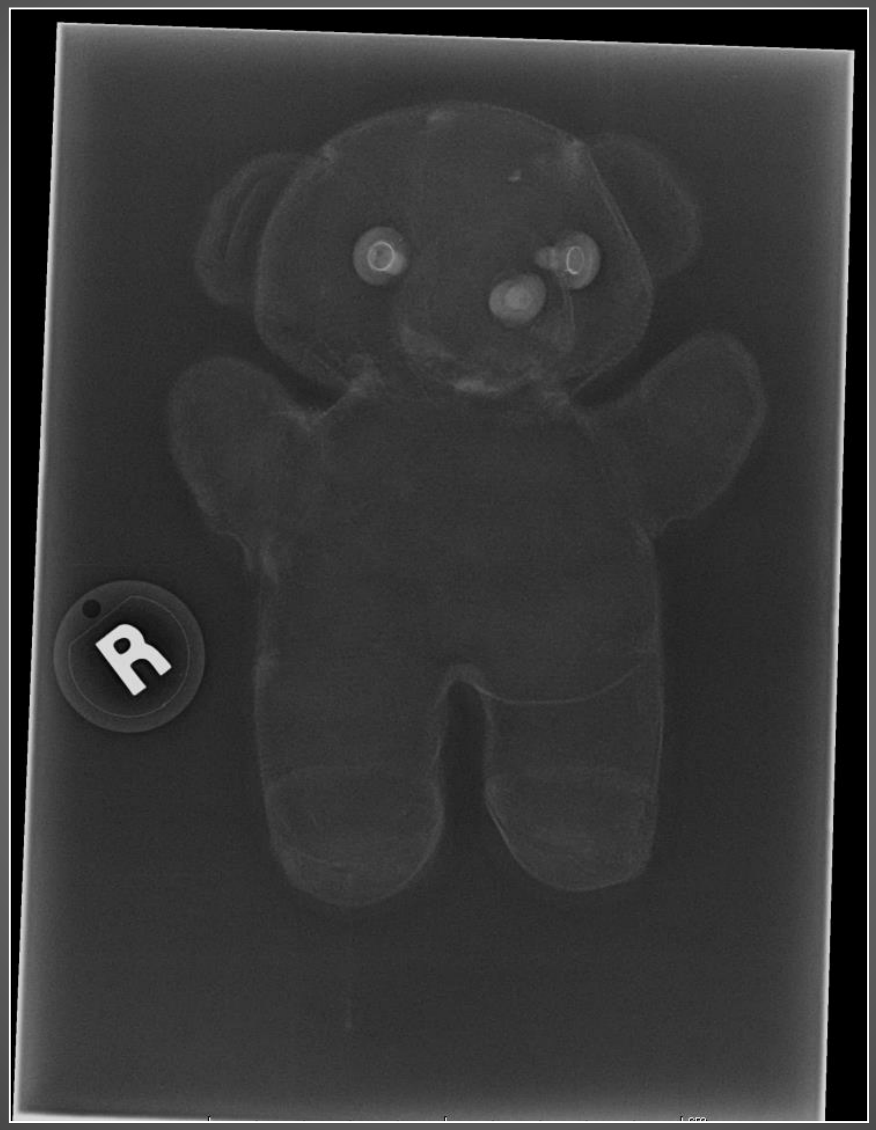
Frank, I., et al. J Urol, 2003.

…Guidelines



Berland, L.L., et al. J Am Coll Radiol, 2010.

Thank you!



References

Berland, L.L., et al., *Managing incidental findings on abdominal CT: white paper of the ACR incidental findings committee*. J Am Coll Radiol, 2010. **7**(10): p. 754-73.

Bluth, E.I., et al., *Indeterminate renal masses. American College of Radiology. ACR Appropriateness Criteria*. Radiology, 2000. **215 Suppl**: p. 747-52.

Coursey, C.A., et al., *ACR Appropriateness Criteria(R) acute onset flank pain--suspicion of stone disease*. Ultrasound Q, 2012. **28**(3): p. 227-33.

Craig, W.D., B.J. Wagner, and M.D. Travis, *Pyelonephritis: radiologic-pathologic review*. Radiographics, 2008. **28**(1): p. 255-77; quiz 327-8.

Frank, I., et al., *Solid renal tumors: an analysis of pathological features related to tumor size*. J Urol, 2003. **170**(6 Pt 1): p. 2217-20.

Gupta, R., A. Seith, and B. Guglani, *Renal hilar extramedullary hematopoiesis presenting as incidental unilateral renal hilar mass in adolescent male: a case report*. Int Urol Nephrol, 2009. **41**(1): p. 19-21.

Israel, G.M. and M.A. Bosniak, *Pitfalls in renal mass evaluation and how to avoid them*. Radiographics, 2008. **28**(5): p. 1325-38.

Jinzaki, M., et al., *Renal angiomyolipoma: a radiological classification and update on recent developments in diagnosis and management*. Abdom Imaging, 2014. **39**(3): p. 588-604.

Jinzaki, M., et al., *Angiomyolipoma: imaging findings in lesions with minimal fat*. Radiology, 1997. **205**(2): p. 497-502.

Jonisch, A.I., et al., *Can high-attenuation renal cysts be differentiated from renal cell carcinoma at unenhanced CT?* Radiology, 2007. **243**(2): p. 445-50.

Merchant, S., A. Bharati, and N. Merchant, *Tuberculosis of the genitourinary system-Urinary tract tuberculosis: Renal tuberculosis-Part II*. Indian J Radiol Imaging, 2013. **23**(1): p. 64-77.

Prasad, S.R., et al., *Common and Uncommon Histologic Subtypes of Renal Cell Carcinoma: Imaging Spectrum with Pathologic Correlation*. Radiographics, 2006. 26: 1795-1810.

Raman, S.P., et al., *Chromophobe renal cell carcinoma: multiphase MDCT enhancement patterns and morphologic features*. AJR Am J Roentgenol, 2013. **201**(6): p. 1268-76.

Remer, E.M., et al., *ACR Appropriateness Criteria on Renal Failure*. Am J Med, 2014. **127**(11): p. 1041-1048 e1.

Rybicki, F.J., et al., *Percutaneous biopsy of renal masses: sensitivity and negative predictive value stratified by clinical setting and size of masses*. AJR Am J Roentgenol, 2003. **180**(5): p. 1281-7.

Schuster, T.G., et al., *Papillary renal cell carcinoma containing fat without calcification mimicking angiomyolipoma on CT*. AJR Am J Roentgenol, 2004. **183**(5): p. 1402-4.

Silverman, S.G., et al., *Hyperattenuating renal masses: etiologies, pathogenesis, and imaging evaluation*. Radiographics, 2007. **27**(4): p. 1131-43.

Silverman, S.G., et al., *Management of the incidental renal mass*. Radiology, 2008. **249**(1): p. 16-31.