NAME THAT NEPHROGRAM

Kristina M. Nowitzki, M.D., Ph.D. and Hao S. Lo, M.D.

University of Massachusetts Medical School, Worcester, MA

University of Massachusetts Medical School

UMassMemorial Health Care

Outline

I. Introduction highlighting normal renal enhancement physiology including normal CT nephrogram phases.

II. Cases organized in a quiz format, with etiologies including:
   a. obstructive
   b. vascular
   c. traumatic
   d. infectious/inflammatory
   e. neoplastic

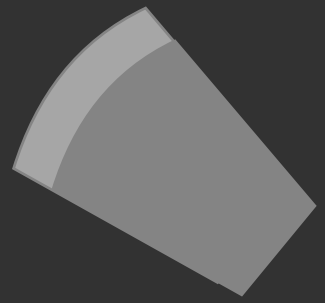
Would you like to skip the brief introduction?

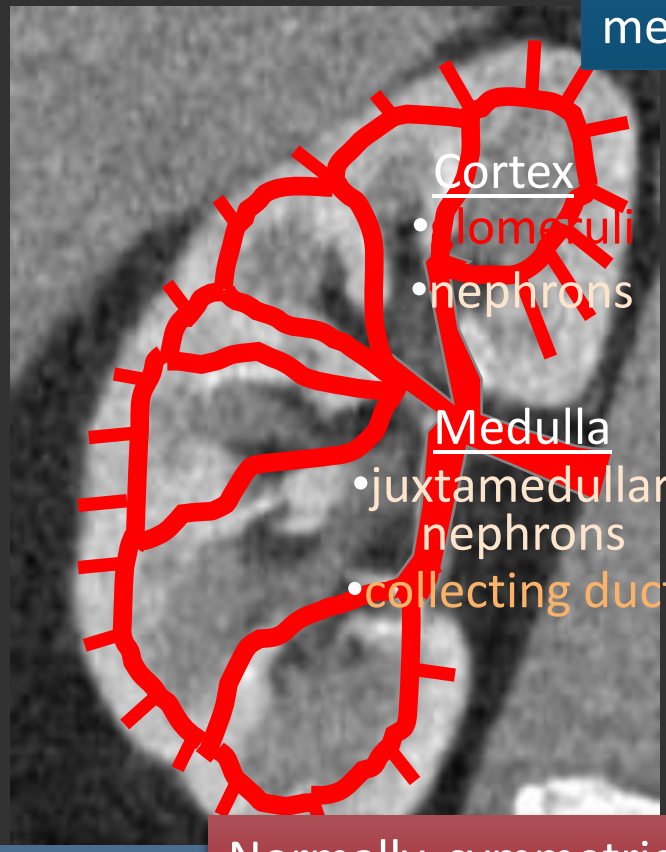
Click the menu button at any point to skip/return to the case menu:

Introduction

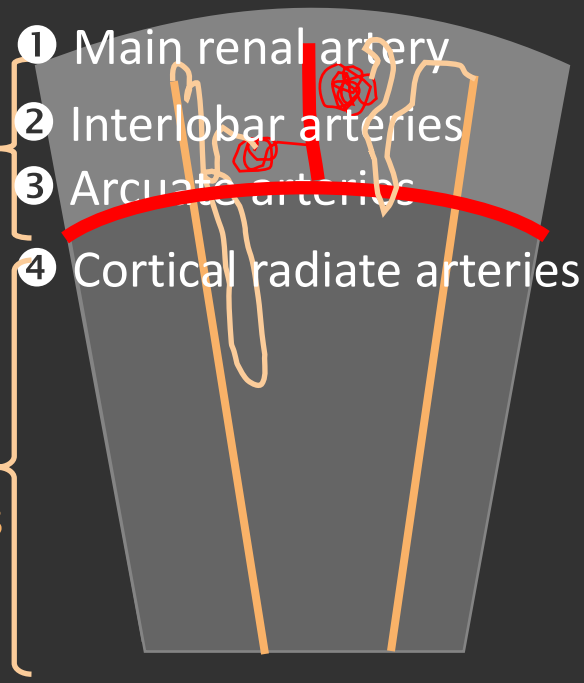
Basics of Renal Contrast Enhancement

IV contrast briskly enters the kidneys through





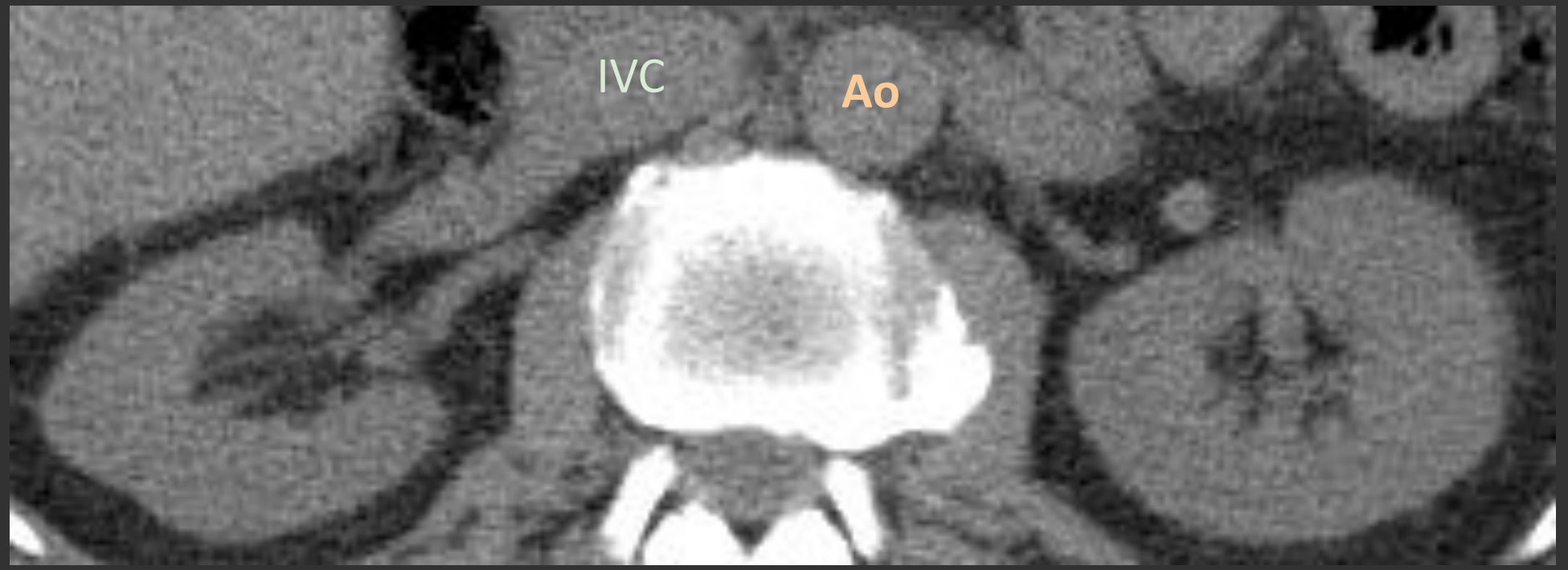
Excreted primarily by glomerular filtration, contrast begins to fill the tubules and collecting ducts and medullary tissue begins to enhance.



Early in imag
arteries and
enhancemen

Normally, symmetric patterns of renal enhancement termed “nephrograms” can be seen in a predictable time course after contrast administration…

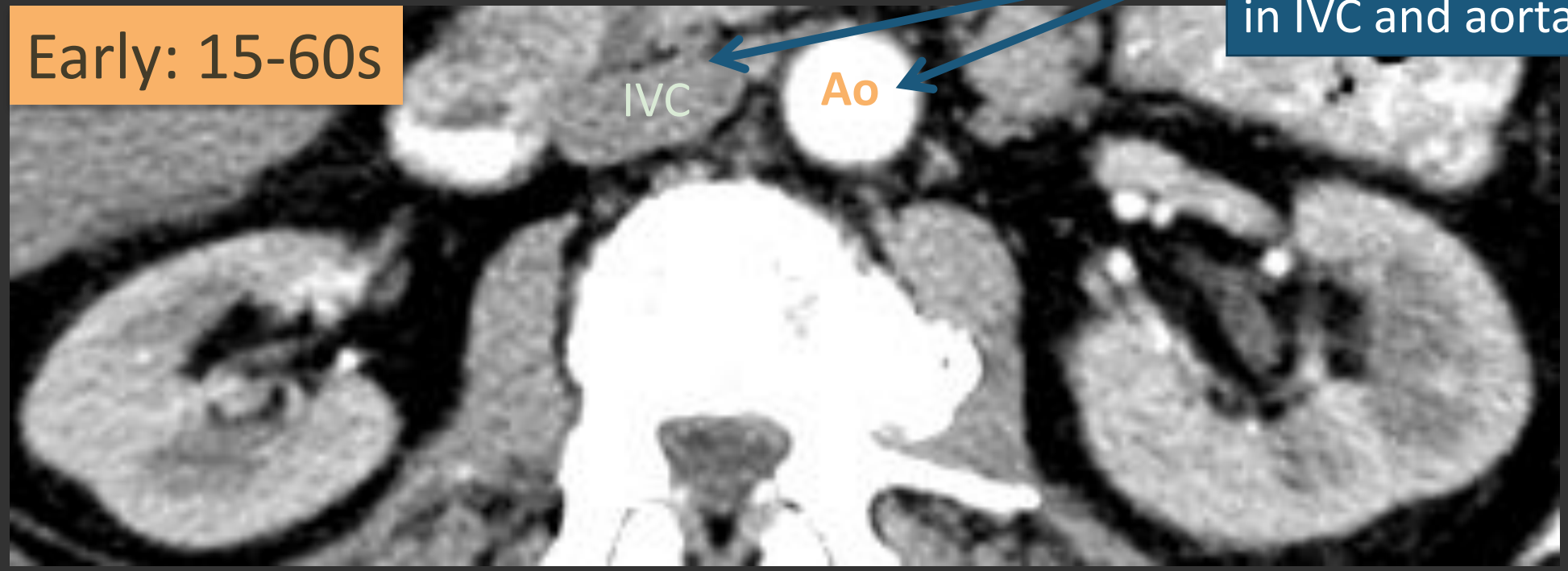
Noncontrast



Cortex, Medulla: 30-40 HU

Introduction

Corticomedullary

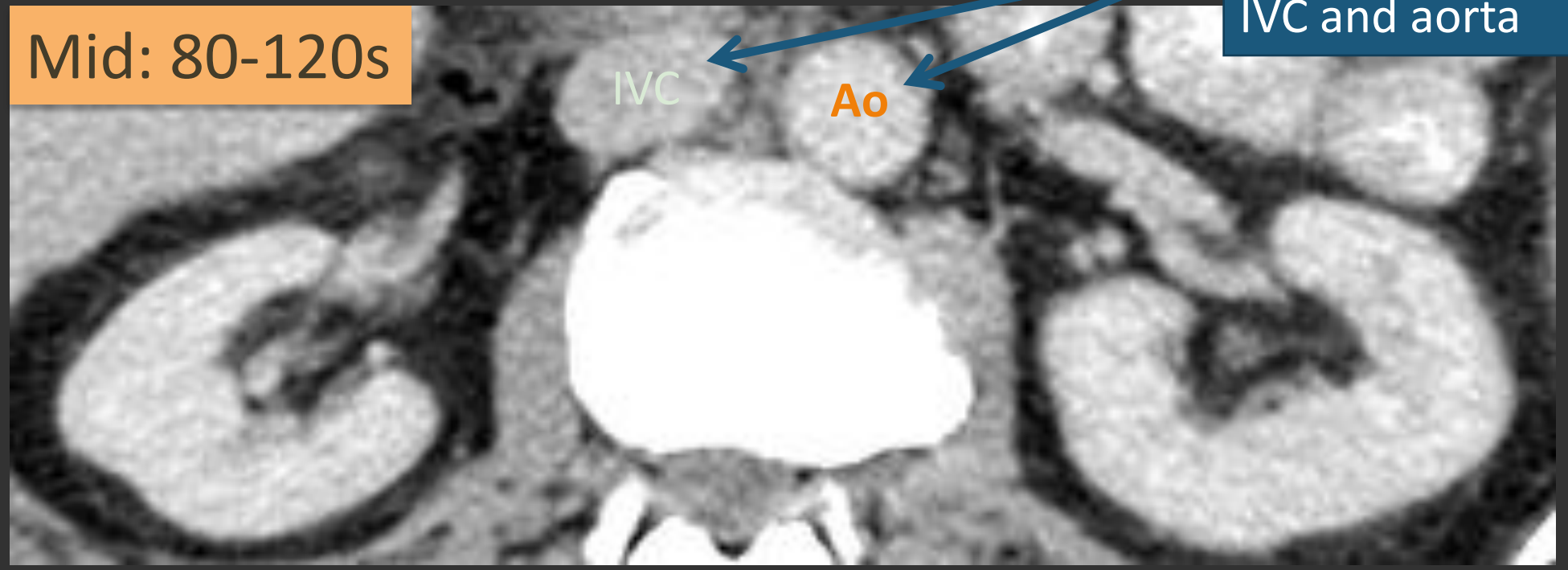


Cortex enhances briskly as contrast fills cortical capillaries.

Maximal differentiation between cortex and medulla
e.g. @40-50s : cortex = **145-185** HU, medulla = **50-90** HU

Introduction

Nephrographic



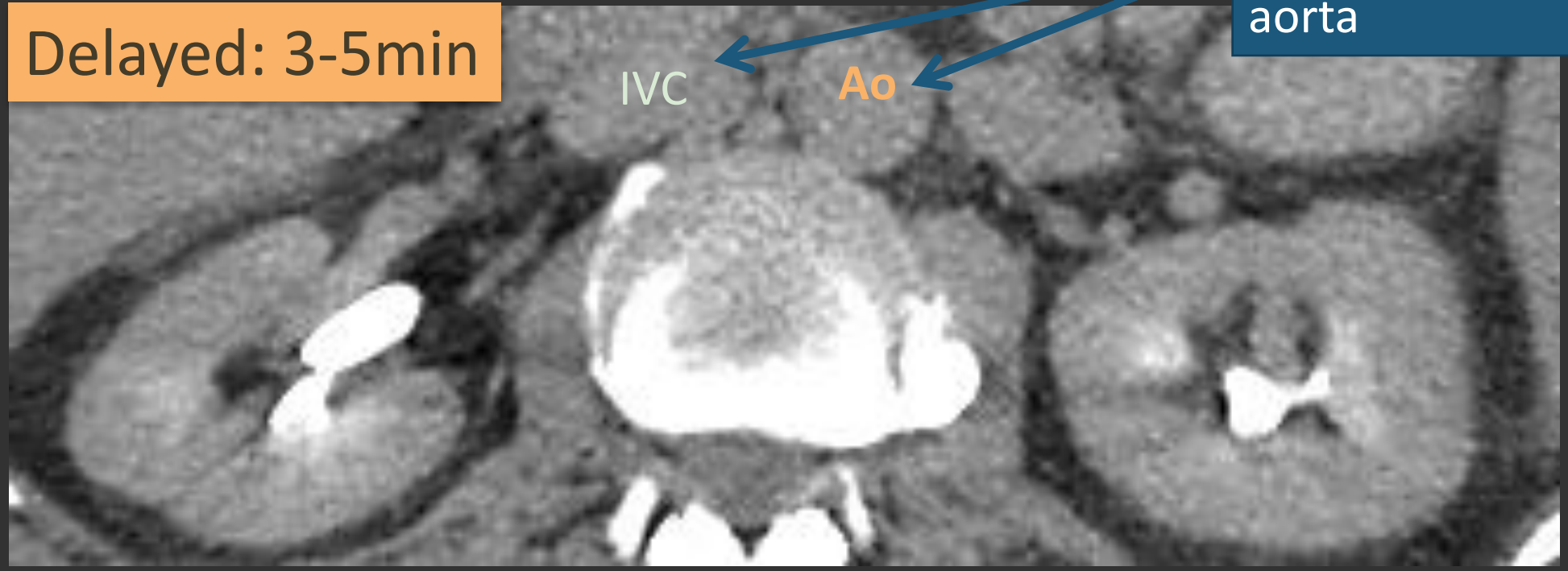
Contrast is filtered by glomeruli, enters loops of Henle and collecting ducts.

Homogeneous enhancement of both cortex and medulla

Excretory

Contrast no longer seen in the IVC or aorta

Delayed: 3-5min



Contrast is excreted into the calyces.

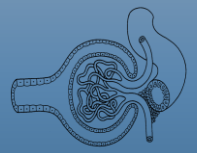
Introduction

Altered Nephrograms

Nephrograms can be altered by problems in one of four basic categories:


Blood flow in


Blood flow out


Nephron Function


Urine outflow

Examples of each of these will be outlined in the specific cases that follow.

NAME THAT NEPHROGRAM

Case 1	Case 5	Case 9	Case 13
Case 2	Case 6	Case 10	Case 14
Case 3	Case 7	Case 11	
Case 4	Case 8	Case 12	

Case 1

33 year old presents after MVA

Arterial phase MIP image with essentially absent nephrogram in a normal size right kidney. There is a pararenal hematoma (arrow). Abrupt cutoff of the right main renal artery near its origin (arrowhead) indicates total transection. A normal corticomedullary nephrogram is seen on the left.

Name that nephrogram:

Absent Nephrogram

Most likely diagnosis:

Right renal artery transection

Case 2

69 year old presents with flank pain

Arterial phase image with absent nephrogram on the right. There is loss of the normal renal sinus fat. A normal right main renal artery is seen (arrow). Additional sections through the lung bases and liver (not shown) showed diffuse metastatic disease. A normal corticomedullary nephrogram is seen on the left.

Name that nephrogram:

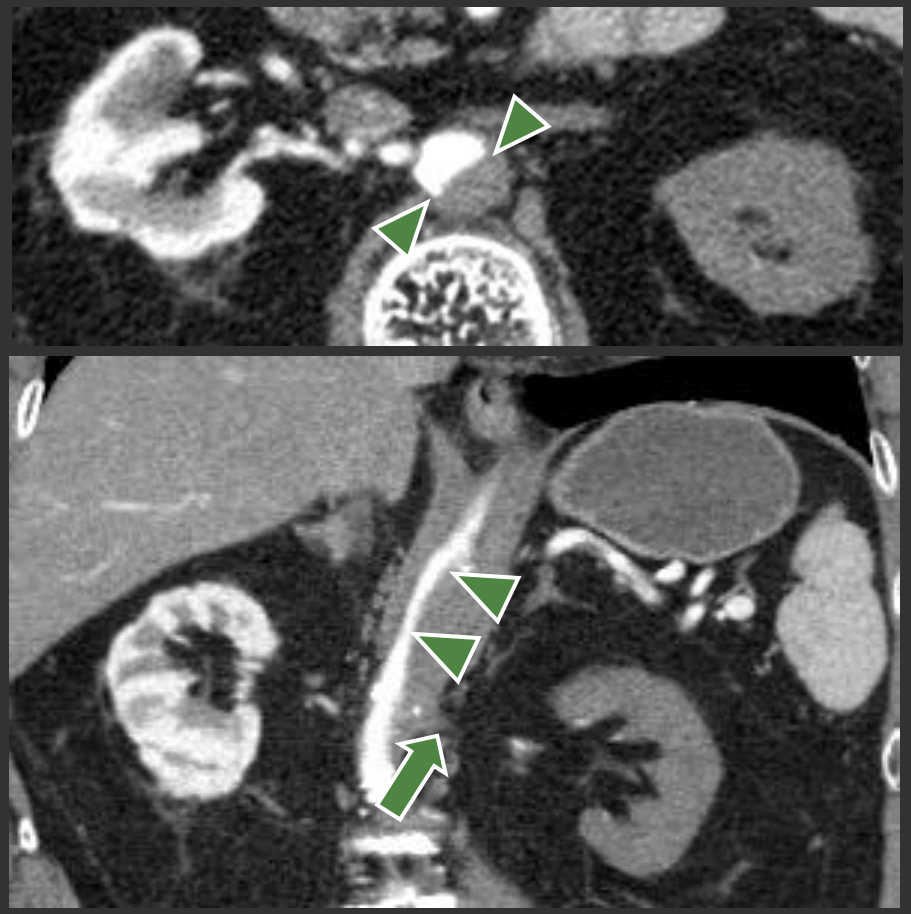
Absent Nephrogram

Most likely diagnosis:

Right infiltrative renal malignancy

Case 3

69 year old presents with chest pain



Arterial phase images with absent nephrogram on the left. There is a long segment aortic dissection (arrowheads) involving the left renal artery (arrow). A normal corticomedullary nephrogram is seen on the right.

Name that nephrogram:

Absent Nephrogram

Most likely diagnosis:

Aortic dissection involving the left renal artery

Cases 1-3

Absent Nephrogram

- ☑ Most commonly the result of complete arterial occlusion
- ☑ Especially in blunt abdominal trauma with renal pedicle injury

No blood in	• Acute, complete arterial occlusion • transection (look for hematoma), dissection, thromboembolic disease
No blood out	• Acute, complete venous occlusion (less common than arterial causes) • hypercoagulable state, tumor invasion, nephrotic syndrome
No nephrons	• Infiltrative mass (lymphoma, diffuse TCC, mets) • Congenital or acquired (XGP, TB autonephrectomy)
No urine out	• Uncommon (e.g. multicystic dysplastic kidney)

Cases 4

28 year old presents with flank pain

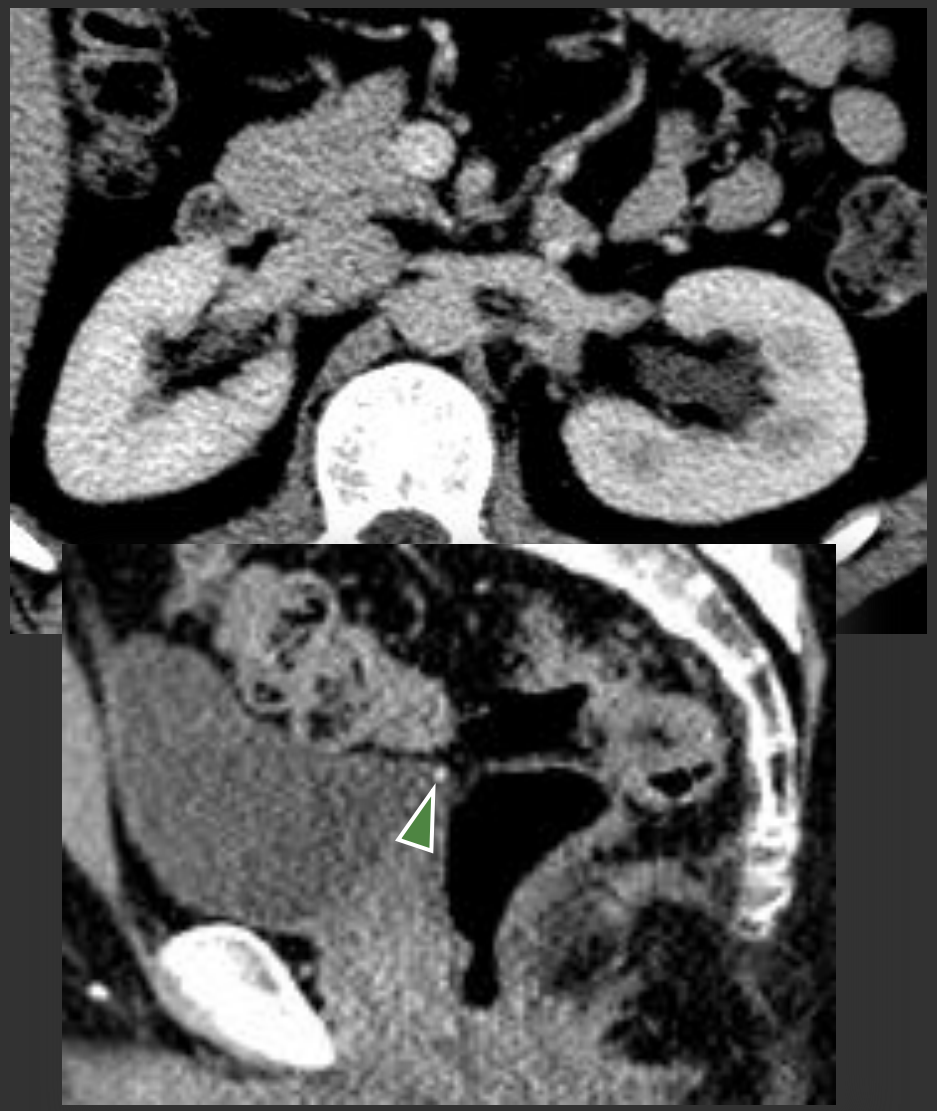
Name that nephrogram:

Most likely diagnosis:

Need a hint? Click here

Cases 4

28 year old presents with flank pain

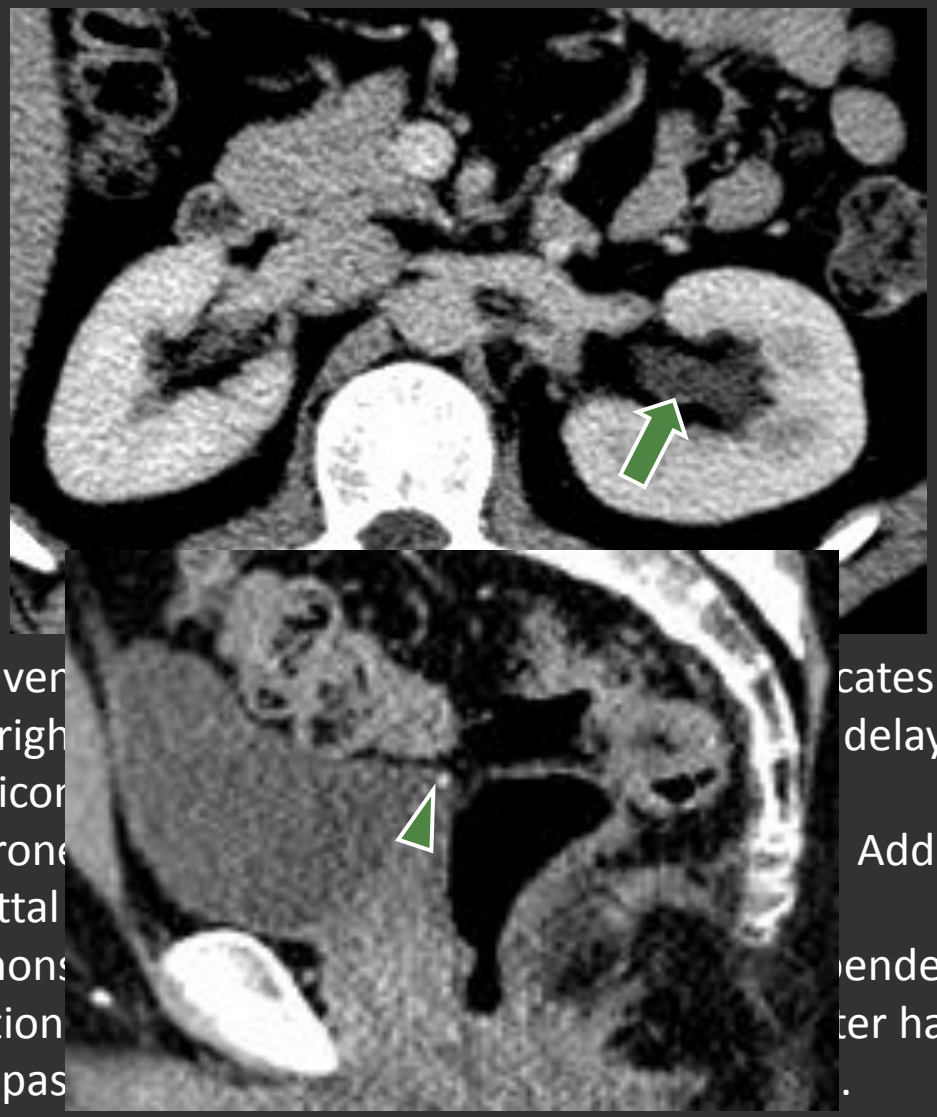


Name that nephrogram:

Most likely diagnosis:

Cases 4

28 year old presents with flank pain



Name that nephrogram:

Unilateral Delayed Nephrogram

Most likely diagnosis:

Obstructing ureteral stone

The ver cates that
the righ delayed
corticor
hydrone Additional
sagittal
demons endent
portion ter having
just pas .

Cases 5

32 year old presents with abdominal pain, hematuria

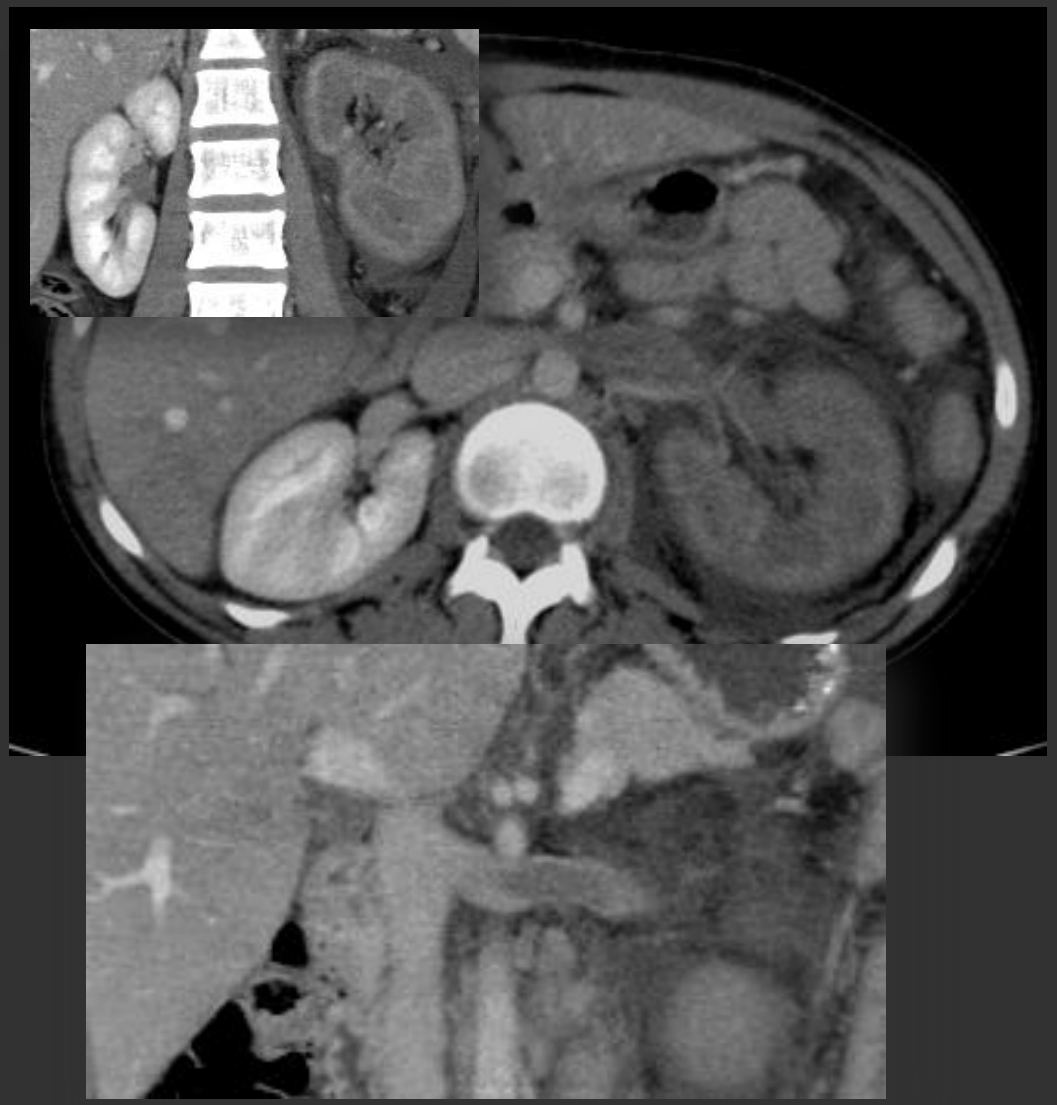
Name that nephrogram:

Most likely diagnosis:

Need a hint? Click here

Cases 5

32 year old presents with abdominal pain, hematuria



Name that nephrogram:

Most likely diagnosis:

Cases 5

32 year old presents with abdominal pain, hematuria

Enlarged, edematous left kidney with extremely delayed corticomedullary nephrogram throughout. The renal arteries are opacified, but no contrast is seen within the left renal vein. Coronal view confirms large filling defect within the left renal vein. External compression of the left renal vein by the superior mesenteric artery (Nutcracker syndrome) was suspected.

Name that nephrogram:

Unilateral Delayed Nephrogram

Most likely diagnosis:

Acute renal vein thrombosis

Cases 6

35 year old male s/p MVA

There is a delayed nephrogram on the left with a small subcapsular hematoma (arrow). Irregularity of the left posterior cortex is consistent with laceration.

Name that nephrogram:

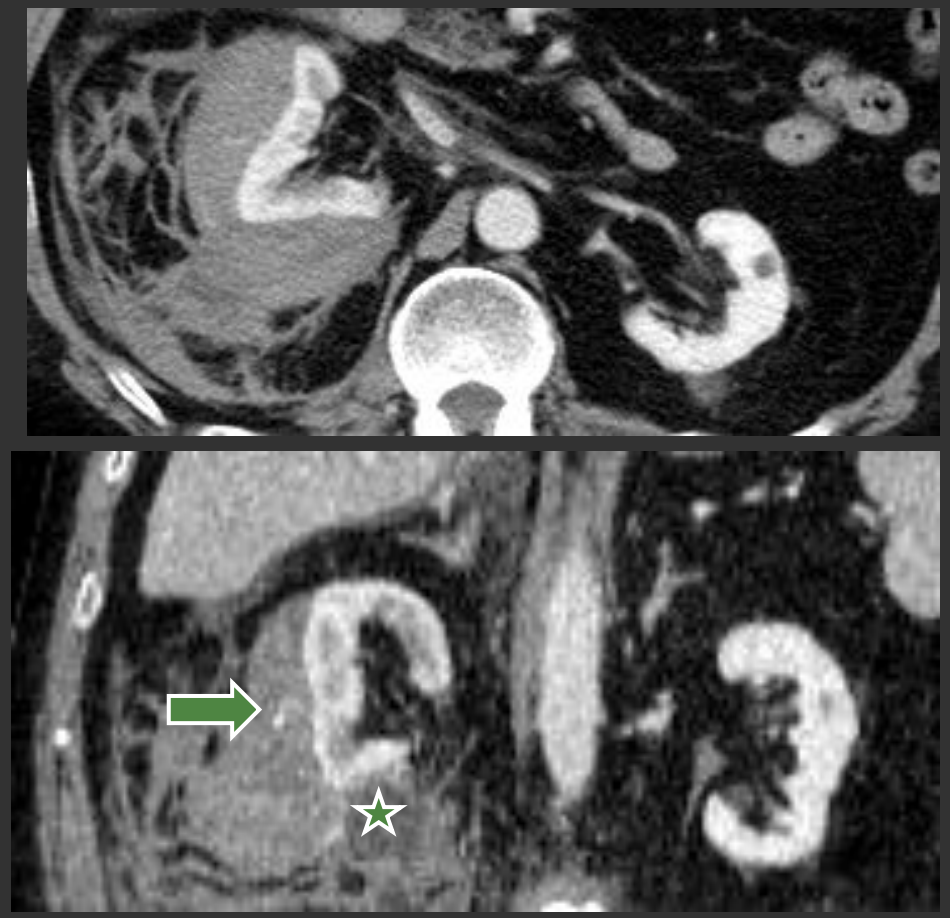
Unilateral Delayed Nephrogram

Most likely diagnosis:

Traumatic left subcapsular hematoma and associated laceration

Cases 7

73 year old on rivaroxaban with acute flank pain



There is a large subcapsular hematoma on the right with mass effect on the right kidney which demonstrates a delayed corticomedullary nephrogram. Extravasation of IV contrast (arrow) is consistent with ongoing hemorrhage. A small cyst is also present in the right lower pole (star).

Name that nephrogram:

Unilateral Delayed Nephrogram

Most likely diagnosis:

Spontaneous subcapsular hematoma associated with anticoagulation

Cases 4-7

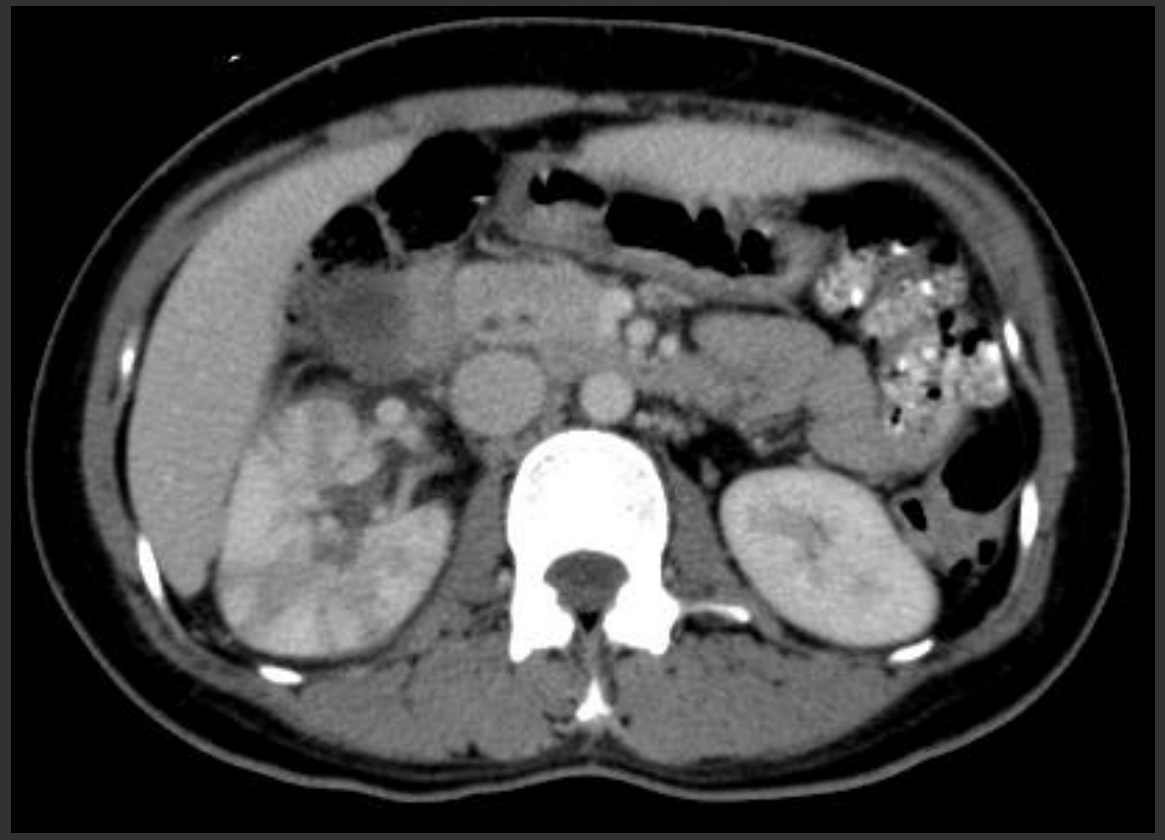
Unilateral Delayed Nephrogram

- ☑ Most common cause is obstructive uropathy

Slow blood in	• Renal artery stenosis • Subcapsular hematoma (Page kidney)
Slow blood out	• Renal vein occlusion or compression
Poor nephron function	• Unilateral pyelonephritis
Slow urine out	• Obstructive uropathy (e.g. stones, blood clot, tumor, lymphadenopathy)

Cases 8

23 year old with acute flank pain



There is a striated nephrogram on the right with radially oriented linear areas of poor enhancement involving both cortex and medulla. The left kidney demonstrates a normal nephrographic phase nephrogram.

Name that nephrogram:

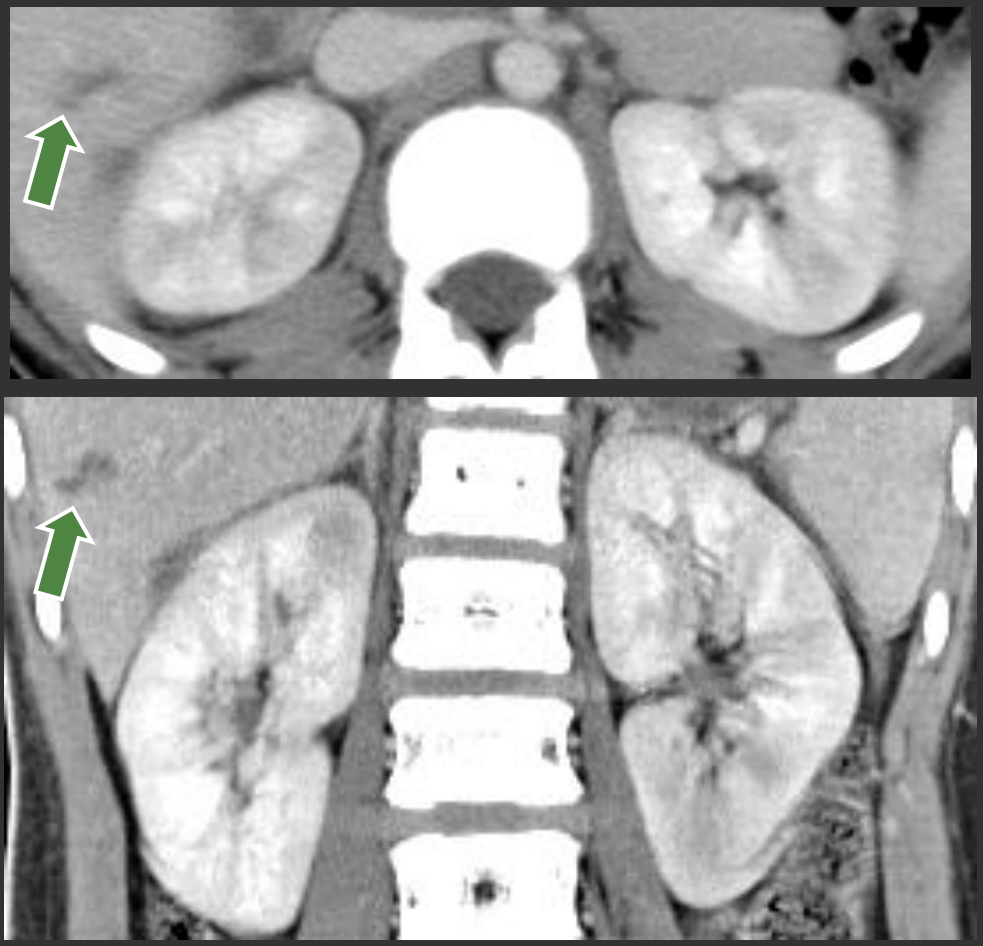
Striated Nephrogram

Most likely diagnosis:

Pyelonephritis

Cases 9

15 year old s/p MVA



Segmental areas of delayed medullary enhancement in both kidneys give the appearance of a patchy striated nephrogram. In the acute traumatic setting this most likely represents areas of contusion. A portion of a liver laceration is also seen (arrows).

Name that nephrogram:

Bilateral Striated Nephrogram

Most likely diagnosis:

Renal contusions

Cases 10

69 year old with dropping systolic blood pressure

Striated nephorgrams are seen in both kidneys. The IVC (arrow, adjacent to the right renal artery) is markedly flattened, consistent with severe hypotension. Perfusion abnormalities were also seen in the liver and spleen (not shown).

Name that nephrogram:

Bilateral Striated Nephrogram

Most likely diagnosis:

Systemic hypotension

Cases 8-10

Striated Nephrogram

- Tubular stasis by pus (pyelonephritis) or interstitial edema results in rays of low enhancement. These same areas may demonstrate increased attenuation on delayed images due to hyperconcentration of contrast.

Unilateral	Bilateral
Acute pyelonephritis	Acute pyelonephritis
Ureteric obstruction	Tubular obstruction (e.g. proteinuria, myoglobinuria)
Contusion	Hypotension
Renal vein thrombosis	Autosomal recessive polycystic kidney disease

Cases 11

82 year old with abdominal pain

Spotted nephrogram in the left kidney, better appreciated on the coronal view. An additional lesion was seen in the lower pole of the right kidney (not shown). MIP image from the same study shows a small filling defect within an accessory renal artery supplying the left upper pole (arrow).

Name that nephrogram:

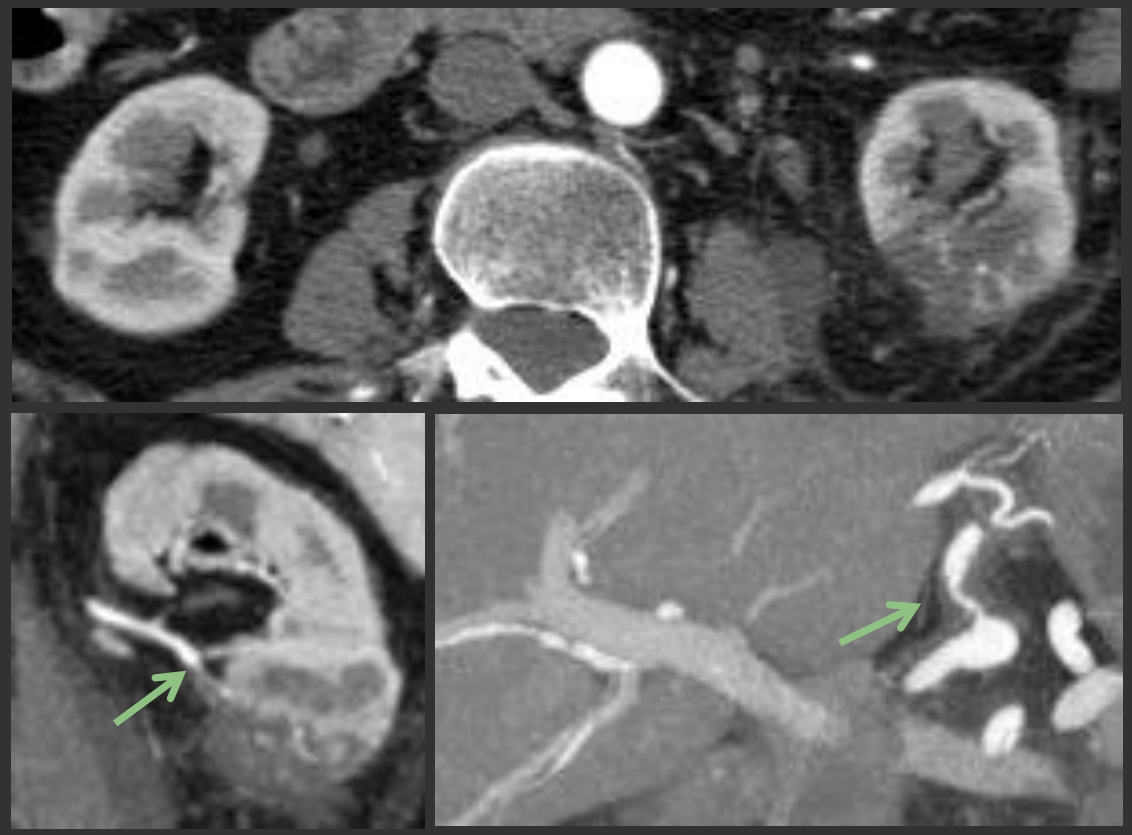
Spotted Nephrogram

Most likely diagnosis:

Renal infarcts from multiple emboli

Cases 12

66 year old with abdominal pain



Wedge shaped area of decreased perfusion in the lower pole of the left kidney. A normal corticomedullary nephrogram is seen on the right. On MIP images (lower), mural thickening with abrupt narrowing of a left lower renal artery branch (left). Similar segments of mural thickening and luminal narrowing seen in the left gastric artery (right).

Name that nephrogram:

Spotted Nephrogram

Most likely diagnosis:

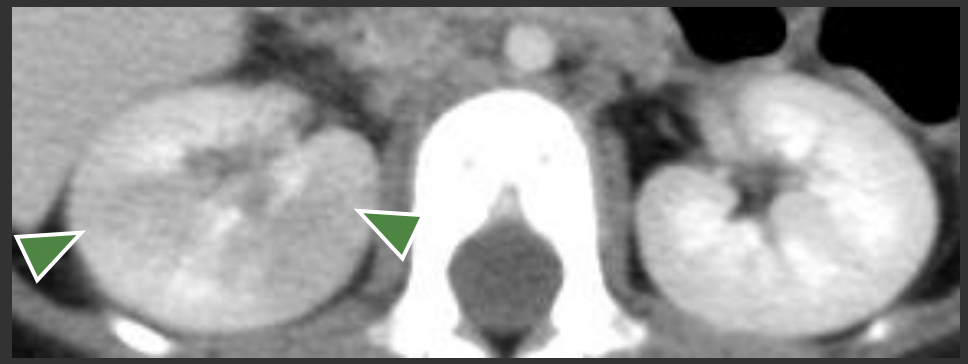
Vasculitis (polyarteritis nodosa)

Cases 11-12

Spotted Nephrogram

- ☑ Indicates segmental problems in perfusion or nephron function

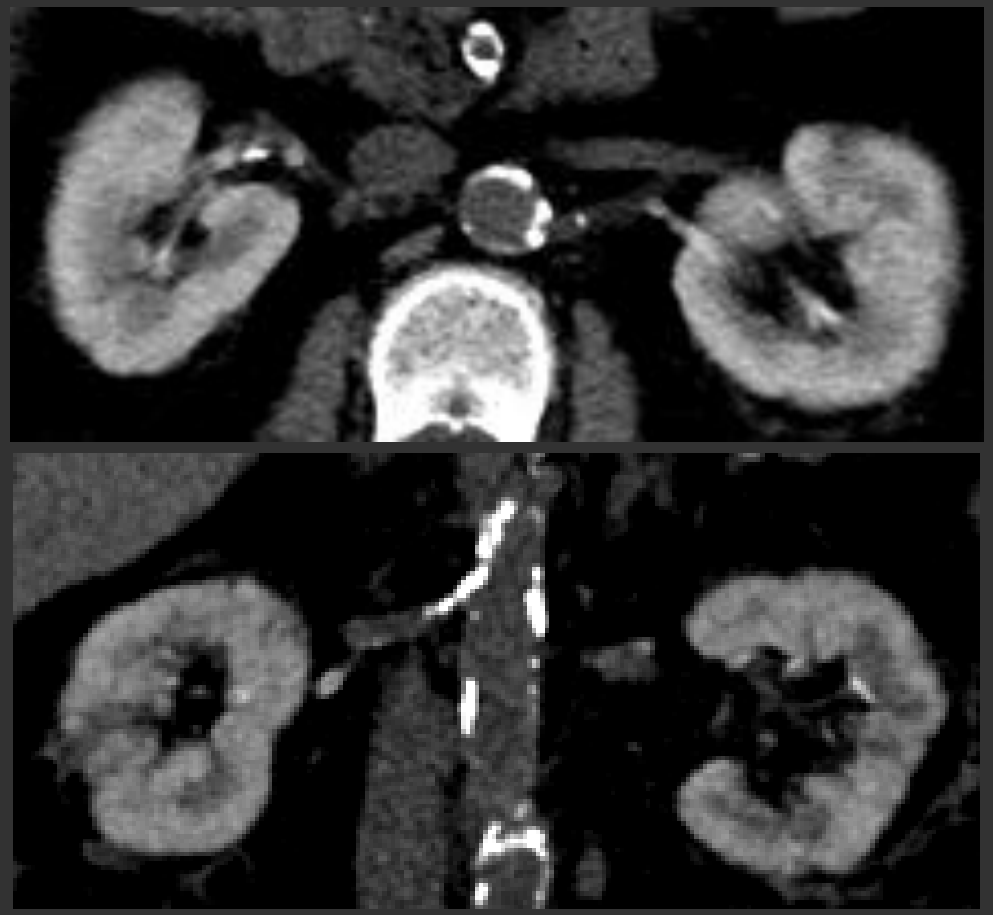
Blood in	• Embolic disease • Intrarenal vasculitis
Poor nephron function	• Pyelonephritis



Example of a spotted nephrogram appearance in a patient with right-sided pyelonephritis.

Case 13

54 year old with rising creatinine



Though no contrast is seen in the IVC or aorta, a corticomedullary nephrogram is present in both kidneys along with excretion of contrast. These findings represent retained contrast from a prior contrast enhanced study.

Name that nephrogram:

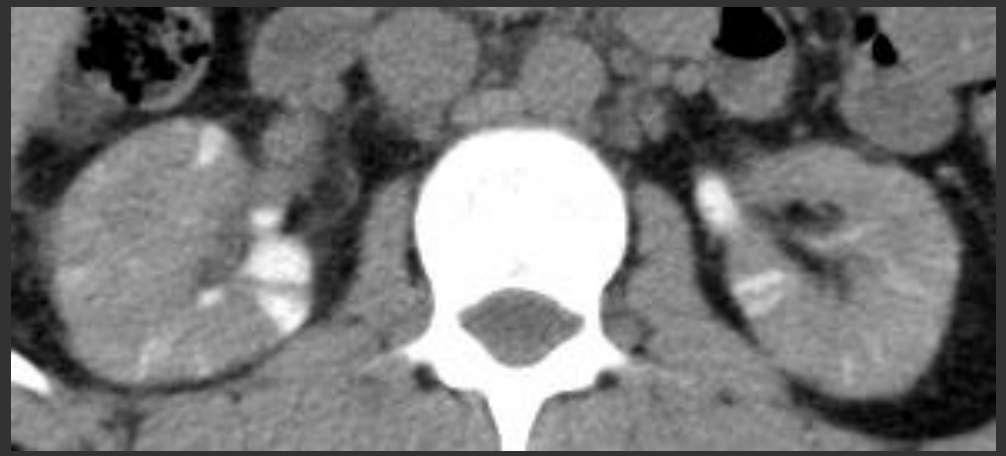
Bilateral Persistent Nephrogram

Most likely diagnosis:

Acute tubular necrosis (ATN), contrast induced nephropathy

Cases 14

35 year old with acute renal failure and suspicious lucent bone lesions



Striated nephorgrams are seen in both kidneys on this noncontrast study. The hyperdense areas represent hyperconcentrated retained contrast from a PE protocol chest CT performed earlier that day. The striated appearance of the delayed nephrogram is likely related to areas of tubular obstruction from amyloid deposits or Bence Jones proteins.

Name that nephrogram:

Bilateral Persistent (Striated) Nephrogram

Most likely diagnosis:

Tubular obstruction from multiple myeloma

Case 13-14

Bilateral Persistent Nephrogram

- ☑ Retention of contrast in cortex or cortex + collecting tubules for greater than 3 minutes.

Systemic Hypotension	• Look for CT findings of hypotension (flattened IVC, shock bowel, etc.)

Intrarenal obstruction	• Acute tubular necrosis (e.g. contrast induced nephropathy, hypoxic)
	• Mechanical intrarenal obstruction
	  • Urate crystals (e.g. tumor lysis syndrome)
	  • Protein (e.g. myoglobinuria, Bence Jones proteinuria)

Summary

- ☑ Asymmetric renal enhancement is a common finding in the acute care setting.
- ☑ Knowledge of the various etiologies can improve interpretative accuracy.

	Absent	Unilateral Delayed	Striated	Spotted	Persistent
Intrinsic renal/ureteral		Ureteral obstruction	Ureteral or tubular obstruction		ATN, tubular obstruction
Vascular	Complete arterial > venous occlusion	Renal artery stenosis, Renal vein occlusion	Renal vein thrombosis, Hypotension	Embolic disease, Vasculitis	Hypotension
Traumatic	Arterial transection, dissection	Subcapsular hematoma	Contusion		
Infectious	Xanthrogranulomatous pyelonephritis, Tuberculosis autonephrectomy	Acute pyelonephritis	Acute pyelonephritis	Acute pyelonephritis	
Neoplastic	Infiltrative tumor	Obstructing tumor/ lymphadenopathy			

References

Saunders, H. S., R. B. Dyer, R. Y. Shifrin, E. S. Scharling, R. E. Bechtold, and R. J. Zagoria. “The CT Nephrogram: Implications for Evaluation of Urinary Tract Disease.” *Radiographics: A Review Publication of the Radiological Society of North America, Inc* 15, no. 5 (September 1995): 1069–85; discussion 1086–88. doi:10.1148/radiographics.15.5.7501851.

Wolin, Ely A., David S. Hartman, and J. Ryan Olson. “Nephrographic and Pyelographic Analysis of CT Urography: Principles, Patterns, and Pathophysiology.” *AJR. American Journal of Roentgenology* 200, no. 6 (June 2013): 1210–14. doi:10.2214/AJR.12.9691.

Wolin, Ely A., David S. Hartman, and J. Ryan Olson. “Nephrographic and Pyelographic Analysis of CT Urography: Differential Diagnosis.” *AJR. American Journal of Roentgenology* 200, no. 6 (June 2013): 1197–1203. doi:10.2214/AJR.12.9692.