NAME THAT NEPHROGRAM

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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:
Basics of Renal Contrast Enhancement

IV contrast briskly enters the kidneys through the renal arteries:

1. Main renal artery
2. Interlobar arteries
3. Arcuate arteries
4. Cortical radiate arteries

Early in imaging, the distribution of arteries and capillaries governs renal enhancement.

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

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
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

Note arterial phase of contrast in IVC and aorta.
Nephrographic

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

Homogeneous enhancement of both cortex and medulla

Mid: 80-120s

Note venous phase of contrast in the IVC and aorta
Introduction

Excretory

Delayed: 3-5min

Contrast is excreted into the calyces.

Ao

IVC

Contrast no longer seen in the IVC or aorta
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
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
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
69 year old presents with chest pain

Name that nephrogram: Absent Nephrogram

Most likely diagnosis: Aortic dissection involving the left renal artery

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.
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 hematomas), 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)
28 year old presents with flank pain

Name that nephrogram:

Most likely diagnosis:

Need a hint? Click here
28 year old presents with flank pain

Name that nephrogram:

Most likely diagnosis:
28 year old presents with flank pain

Name that nephrogram:
- Unilateral Delayed Nephrogram

Most likely diagnosis:
- Obstructing ureteral stone

The venous phase of intravascular contrast indicates that the right nephrographic phase is normal with a delayed corticomedullary nephrogram on the left. Additional hydroureter and hydronephrosis is also present on the left. Additional sagittal images of the bladder demonstrate the dependent portion of the bladder with a punctate stone after having just passed through the left ureter.
32 year old presents with abdominal pain, hematuria

Name that nephrogram:

Most likely diagnosis:

Need a hint? Click here
32 year old presents with abdominal pain, hematuria

Name that nephrogram:

Most likely diagnosis:
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
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
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
**Unilateral Delayed Nephrogram**

- **Most common cause is obstructive uropathy**

<table>
<thead>
<tr>
<th>Slow blood in</th>
<th>• Renal artery stenosis</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Subcapsular hematoma (Page kidney)</td>
</tr>
</tbody>
</table>

| 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) |
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.
15 year old s/p MVA

Name that nephrogram:
Bilateral Striated Nephrogram

Most likely diagnosis:
Renal contusions

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).
69 year old with dropping systolic blood pressure

Striated nephrograms 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
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
- Acute pyelonephritis
- Ureteric obstruction
- Contusion
- Renal vein thrombosis

### Bilateral
- Acute pyelonephritis
- Tubular obstruction (e.g. proteinuria, myoglobinuria)
- Hypotension
- Autosomal recessive polycystic kidney disease

Cases 8-10
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
66 year old with abdominal pain

Name that nephrogram:
Spotted Nephrogram

Most likely diagnosis:
Vasculitis (polyarteritis nodosa)

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).
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.
54 year old with rising creatinine

Name that nephrogram:
**Bilateral Persistent Nephrogram**

Most likely diagnosis:
**Acute tubular necrosis (ATN), contrast induced nephropathy**

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

Name that nephrogram:
Bilateral Persistent (Striated) Nephrogram

Most likely diagnosis:
Tubular obstruction from multiple myeloma

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

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