Use of Duplex Ultrasound Following Renal Interventions

• 65 yo woman with CAD s/p PCI, DM2, and uncontrolled HTN

- On labetalol, amlodipine, losartan, and chlorthalidone
- Still uncontrolled → clinic BPs still greater than 140/90
Renal and Mesenteric Artery Duplex:
Appropriate Indications

- Malignant or resistant HTN
- Worsening BP control in a long-standing hypertensive pt
- HTN in a young person (≤ 35 yo)
- Unexplained discrepancy between kidney sizes (≥1.5 cm)
- Azotemia
- Increased Cr after ace-inhibitors/ARBs
- Acute renal failure with aortic dissection
- Epigastric bruit
- Refractory CHF of unclear etiology
- “Flash” pulmonary edema
- Postprandial pain/weight loss unclear etiology; previous GI w/u

Renal and Mesenteric Artery Duplex:
Employ Methodical Approach

- Image the aorta (supra-celiac to aortic bifurcation)
- Image and measure velocities in the celiac, SMA, and IMA
- Image the renal veins (bearing in mind this can be retro-aortic)
- Image each renal artery in its entirety (origin, proximal, mid, and distal). Do not spot check.
- Look for accessory renal arteries (occur in 20-25%)
- Evaluate blood flow in the renal parenchyma and measure resistive indices in upper, mid, and lower poles
- Evaluate the kidney for cysts, tumors, hydronephrosis
- Measure each kidney three times; take the longest length

Renal and Mesenteric Artery Duplex:
Employ Methodical Approach

- Make sure patient is NPO, preferably for ≥ 12 hours
- If patient images are suboptimal, do not continue
- Technical difficulties particularly true for inpatients

Patient MM
Renal Artery Duplex: Velocity Criteria

<table>
<thead>
<tr>
<th>Duplex Criteria</th>
<th>Stenosis</th>
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</thead>
<tbody>
<tr>
<td>RAR &lt; 3.5 and PSV &lt; 200 cm/sec</td>
<td>0-59%</td>
</tr>
<tr>
<td>RAR ≥ 3.5 and PSV ≥ 200 cm/sec</td>
<td>60-89%</td>
</tr>
<tr>
<td>RAR &gt; 3.5 and EDV ≥ 150 cm/sec</td>
<td>80-99%</td>
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<tr>
<td>Absence of flow and low amplitude parenchymal signal</td>
<td>Occluded</td>
</tr>
</tbody>
</table>

Renal aortic ratio (RAR) =

\[
\frac{\text{Renal artery PSV}}{\text{Pre-renal aortic PSV}}
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Renal Artery Duplex: Exceptions for PSV and RAR

1. *Aortic aneurysm* may render the RAR of limited use. In this case, a renal artery PSV of at least 200 cm/sec with turbulence must be demonstrated to verify a stenosis of 60-99%.

2. Abnormally low/high aortic velocities may also render the RAR of limited use. In these cases, a renal artery PSV of at least 200 cm/sec with turbulence must be demonstrated to verify a stenosis of 60-99%.


Reporting

- **Normal**: Findings consistent with 0-59% stenosis in the proximal right/left renal artery. No hemodynamically significant stenosis noted.

- > 60% stenosis: Findings consistent with 60-99% stenosis within the proximal right/left renal artery. This may represent a hemodynamically significant stenosis.

- >80% stenosis: Findings consistent with 80-99% stenosis within the proximal right/left renal artery. The EDV > 150 cm/sec suggest stenosis > 80%.

- FMD: There are elevated velocities, turbulence, and tortuosity in the mid to distal segments of the right/left renal artery, suggesting the presence of fibromuscular dysplasia.

Percutaneous revascularization indications

- All renal arteries with stenosis do not need to be (and should not be) stented.

- There must be a good clinical indication and hemodynamically significant stenosis (ie stenosis should be more than 70% on angiography or intravascular ultrasonography).

Indications for stenting:

- **Hypertension** (Class IIa, LOE B). Patients with hemodynamically significant renal artery stenosis and accelerated hypertension, resistant hypertension, and malignant hypertension.

- **Preservation of renal function** (Class IIa, LOE B). Patients with renal artery stenosis and progressive kidney disease with bilateral renal artery stenosis or a stenosis to a solitary functioning kidney.

- **Congestive heart failure** (Class I, LOE B). Patients with hemodynamically significant renal artery stenosis (ie, > 70%) and recurrent, unexplained CHF or pulmonary edema.
Patient MM: Post stenting

Surveillance Imaging After Renal Artery Stenting

- Baseline duplex ultrasound at first office visit after procedure
- Surveillance ultrasounds at 6, 12, 18, and 24 months
- After 24 months → annual surveillance

In-stent restenosis

Ultrasound velocity criteria for renal in-stent restenosis

- PSV 250 cm/sec and RAR > 4.5 (PPV 96%)
- PSV 280 cm/sec and RAR > 4.5 (PPV 94%)
- PSV > 395 cm/sec and RAR > 5.1

Accuracy of duplex sonography scans after renal artery stenting

- Revised duplex criteria and outcomes for renal stents and stent grafts following endovascular repair of juxtarenal and thoracoabdominal aneurysms
- Retrospective study (2009). 6 of 231 covered stents developed ISR.
- Retrospective study (2014). N = 132 arteries. PSV ≥ 296 cm/sec and RAR > 4.4 (PPV 96%)

- PSV 250 cm/sec → sensitivity of 59%, specificity of 95%, accuracy of 83%, and PPV of 87%
- PSV 395 cm/sec and RAR 5.1 → ISR > 70%

N = 47, retrospective study (2010)
- PSV 250 cm/sec → sensitivity of 59%, specificity of 95%, accuracy of 83%, and PPV of 87%
Post-Intervention Reporting

- **Patent stent:** Patent stent noted in the proximal right/left renal artery, without evidence of significant stenosis. Velocities have decreased from the previous study performed on XYZ (PSV 502 cm/sec to 152 cm/sec).

- **Post-angioplasty for FMD:** Compared with the previous study of XYZ, reduced velocities are now noted in the mid-distal segment of the right/left renal artery (PSV 400 cm/sec to 125 cm/sec).

- **In-stent restenosis:** There are elevated velocities (PSV 580.5 cm/sec, EDV 121 cm/sec) and color Doppler turbulence noted, consistent with in-stent restenosis. (No percent stenosis).

Transplant Renal Artery Evaluations

- Transplant renal arteries are well visualized due to superficial location in iliac fossa
- Mild hydronephrosis may be noted in the immediate post-operative state

**Common issues**
- Arterial stenoses:
  - Intimal hyperplasia at anastomosis
  - Clamp injury at proximal and mid renal artery
  - Inflow stenosis affecting common or external iliac arteries
- Renal vein stenosis (due to clamp injury)
- Renal vein thrombosis

Transplant Renal Artery Ultrasound Criteria

- ≥ 200 cm/sec and post-stenotic turbulence → highly specific for transplant renal artery stenosis
- Color Doppler turbulence/aliasing
- Parenchymal resistive indices
- Renal-iliac ratio 2.5 to 3.0

Bilateral Renal Artery Stenosis After Renal Denervation

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- Likely rare in patients who have received RDN
- In Symplicity HTN-1, only 1 new RAS was noted in 153 patients after 3 years
- ? Routine surveillance imaging program

Thank you

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