"Insight into Renal Vascular and Nonvascular Interventions

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I have no financial or personal relationships to disclose
Renal Arterial Stenosis

Anatomy:

- Renal arteries (RA) arise from the lateral surface of the aorta at about the L1-L2 level.
- Right RA runs posterior to the IVC.
- Left RA passes behind the left renal vein (RV).
- At the renal hilum RA bifurcates into ventral and dorsal rami.
- Accessory RA supply one or both kidneys in 25-35%; may originate from aorta or iliac artery; most supply the lower pole.
Renal Arterial Stenosis

Anatomy:

- Kidney is the “end organ”
- Communications between extrarenal arteries (aorta, lumbar arteries, internal iliac artery, inferior adrenal artery) and intrarenal arteries (segmental, intralobar, arcuate) exist:
  - capsular, peripelvic, periureteric systems (Abrams/Cornell)
Atherosclerotic Renovascular Disease

**Etiology:**

- **Nephrosclerosis:** global damage of distal intrarenal vessels
- **Renovascular Hypertension** (RVH): stenosis/occlusion of main, accessory, or branch RA
- Reduction in intrarenal arterial pressure sensed by juxtaglomerular apparatus >> triggered renin-angiotensin-aldosterone system >> vasoconstriction + sodium and water retention
Etiology:

- **Ischemic nephropathy**: loss of renal function as a result of hypoperfusion from renal arterial disease

- **Microvascular changes**: diabetes, hyperlipidemia, hypertension

- **Drug-resistant hypertension**: refractory despite optimal doses of 3 drugs of different classes
Renal Arterial Stenosis

1. **Atherosclerosis**

- Aortic plaque extending to the RA ostium (2/3 of cases): within 10 mm of the aortic lumen
- “Independent” plaque in the truncal portion of RA
- Calcified / Partially calcified / Noncalcified
- Progressive stenosis in 1/3 to 2/3 of cases
- 50% symptomatic RA stenosis cases progress to RVH
- Typically > 50 years old; M > F
Renal Arterial Stenosis

2. Fibromuscular Dysplasia (FMD): 2nd most common cause of renal arterial stenosis

3. Dissection

4. Vasculitis: Takayasu arteritis, radiation arteritis

5. Coarctation syndromes: neurofibromatosis, tuberous sclerosis

6. Trauma

7. Extrinsic compression
Renal Arterial Stenosis

**Diagnosis:**

1. **Ultrasound Doppler**
   - Intrastenotic peak systolic velocity (PSV) > 180 cm/sec
   - PSV renal/aortic ratio > 3.0 to 3.5
   - Prolonged acceleration time > 0.06-0.07 sec
   - “Parvus et tardus” waveform: damping and slowing of the time to peak systole, indicates significant stenosis
   - Intrastenotic aliasing artifact
Elevated flow velocity at the level of the stenosis and aliasing artifact

Elevated acceleration index and “Parvus et tardus” waveform
Renal Arterial Stenosis

Diagnosis:

1. **Computed Tomography Angiography (CTA)**

2. **Magnetic Resonance Imaging Angiography (MRA)**
   - 90-100% sensitivity and 75-100% specificity

3. **Catheter Angiography**
   - “Gold standard” for the diagnosis of RVH
CTA Maximum Intensity Projection (MIP), coronal
Renal Arterial Stenosis

When to treat?

- **Hemodynamic Significance:**
  1. Reduction in luminal diameter > 75%
  2. Systolic pressure gradient across the stenosis in the main renal artery > 10-20 mm Hg, or > 20% of aortic systolic pressure

- Stenosis with 50-75% reduction of luminal diameter may be hemodynamically significant >>> pressures measurement +

**Clinical significance:** drug resistant or accelerated hypertension, recurrent flush pulmonary edema, renal failure
Renal Arterial Stenosis

**Contraindications:**
- Renal atrophy
- Uncorrectable coagulopathy
- Diffuse intrarenal vascular disease
- Ulcerative/unstable plaque >> risk of peripheral embolization

**Pre-procedure:**
- Hold antihypertensives on day of procedure or decrease dose by 50% within 48 hours before the procedure
- Prefer INR < 1.5
- Prehydrate with IV normal saline for 4-6 hours
6 mm balloon angioplasty
over 0.035 inch Rosen wire
Telescoping Technique

- 7 French Guiding catheter (55 cm long)

- 4-5 French selective catheter: Cobra, SOS Omni, Sidewinder (depending on the angle of RA)

- 0.035/0.0018 inch guidewire
7 French Flexor Ansel guiding vascular sheath; Cook Medical

4-5 French hydrophilic Cobra (C2) selective catheter; Cook Medical

4-5 French hydrophilic SOS Omni catheter; Angiodynamics
6 mm balloon angioplasty
0.014-1.018 inch guidewire
balloon-mounted stent,
7 mm diameter

Stent vs. balloon
- Ostial stenosis
- Insufficient
  angioplasty (> 30%
  residual stenosis)
- Calcified stenosis

7 French 55 cm long guiding catheter
Bilateral Renal Stents
Fibromuscular Dysplasia (FMD):

- 2nd most common cause of renal arterial stenosis
- < 30 years old
- F > M (3-4 : 1)
- Involve mid and distal RA >> segmental RA
- Medial fibroplasia- most common type (70-80%)
- “Beaded” appearance
- Rarely leads to ischemic nephropathy or complete occlusion
- Balloon angioplasty alone usually effective
- Other arteries: internal carotid, iliac, subclavian, vertebral
Irregular “beaded” appearance of the RA
Complications

- 5-10% of cases
- RA dissection or rupture >> stent placement >> surgery
- RA thrombosis
- Distal thrombus microembolization
- Access site complications: hematoma, CFA pseudoaneurysm
- Contrast nephropathy
Renal Arterial Embolization

RA Aneurysm

- True aneurysms: dysplastic, FMD, connective tissue disorders: neurofibromatosis, Ehlers-Danlos syndrome, vasculitis: poliarteritis nodosa (multiple aneurysms) and Takayasu arteritis, congenital

- False aneurysms: trauma, inflammation/Infection, post-transplant, dissection, drug use (cocaine, methamphetamines), tumor related

Arteriovenous Fistulas and Malformations

Traumatic Hemorrhage

- Grade IV injuries
**Renal Arterial Embolization**

**Dysplastic aneurysms:**
- Near the first bifurcation of the main RA
- 75% of patients have elevated blood pressure
- Succular or fusiform

**Complications:** rupture, thrombosis
- Risk of rupture is heightened in pregnant women

**When to treat:** “rule of 2 cm”, regardless of size in women of child-bearing potential, symptomatic patients, all pseudoaneurysms

**Endovascular treatment options:** covered stent placement for main RA aneurysms, embolization with microcoils or glue for intrarenal aneurysms
Traumatic RA pseudoaneurysm and AV fistula
RA Aneurysm Coil Embolization
RA pseudoaneurysm with microcoils
Renal Arterial Dissection

- Extension of aortic dissection
- Trauma: iatrogenic (e.g., catheterization, injury by guidewire), blunt or penetrating trauma
- FMD
- Segmental Arterial Mediolysis
- Spontaneous
RA Rupture
**Renal Transplant Vascular Complications**

- Develop up to 25% of cases

- **Arterial stenosis** - most common problem, 4-10% of cases, occurs between 3 months to 2 years after placement, usually located at the anastomosis

- **Arterial thrombosis** - result of operative injury to the donor or recipient artery, arterial kinking, acute rejection, hypotension, thrombophilic state, atherosclerosis

- **Renal vein thrombosis**

- Vascular injury, pseudoaneurysm or arteriovenous fistula formation from percutaneous biopsy
Renal Neoplasms

**Benign**
- Adenoma/Oncocytoma
- Angiomyolipoma (*tuberous sclerosis*: multiple bilateral lesions)

**Malignant:**
- Renal Cell Carcinoma (RCC); *von Hippel-Lindau disease*
- Transitional Cell Carcinoma (TCC)
- Wilms Tumor
- Metastases (including lymphoma)
Complications:
2. Bleeding/hematoma
3. Infection
4. Pneumothorax
Renal Lesion
Core Biopsy

17 Gauge
Introducer,
Needle
18 Gauge Gun
Horseshoe kidney
mass lesion
CT Guided Biopsy of a horseshoe kidney mass lesion

Confirmed RCC
Renal Oncology

**Endovascular Transcatheter Embolization:**

- Devascularization before open or laparoscopic nephrectomy to minimize intraoperative bleeding (within 24 hours of surgery)
- Palliative therapy in patient with unresectable disease
- Treatment or prevention hemorrhagic complications
- **Embolic agents:** 1. Absolute ethanol (1-5 mL)+ occlusion balloon placement to avoid reflux. Postembolization syndrome: fever, pain, nausea. 2. Microspheres (300-500-micron). 3. Microcoils
Renal Oncology

Radiofrequency Ablation or Cryoablation

- Percutaneous ablation under US or CT fluoroscopy guidance
- Definitive treatment for cortical tumors (RCC) of ≤ 4 cm
- Ablation of larger tumors is feasible if they are exophytic
- Central or hilar lesion, or lesions invading collecting system are less favorable
LeVeen Needle Electrode (Boston Scientific)
Percutaneous Nephrostomy

- US/Fluoroscopy guided or CT guided (in obese patients)

Indications:

- Hydronephrosis + Infection
- Hydronephrosis + Pain
- Hydronephrosis + Renal failure
- Diversion of Urine: traumatic urinary tract injury, malignant or inflammatory urinary fistula, hemorrhagic cystitis
- Access for diagnostic or therapeutic interventions
Hydronephrosis
8 French nephrostomy
Complications:

2. Perirenal/retroperitoneal hematoma
3. Clot within the collecting system
4. AV fistula, pseudoaneurysm
5. Infection (including sepsis)
Hobbs Catheter (8 Fr) Insertion through the mid ureteric stenosis
Ileal conduit
Balloon angioplasty of severe stenosis of the distal ureter