

"Insight into Renal Vascular and Nonvascular Interventions

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Conflict of Interest Declaration: Nothing to Disclose

Presenter: Anatoly Shuster

Title of Presentation: "Insight into Renal
Vascular and Nonvascular Interventions"

**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 juxta-glomerular 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

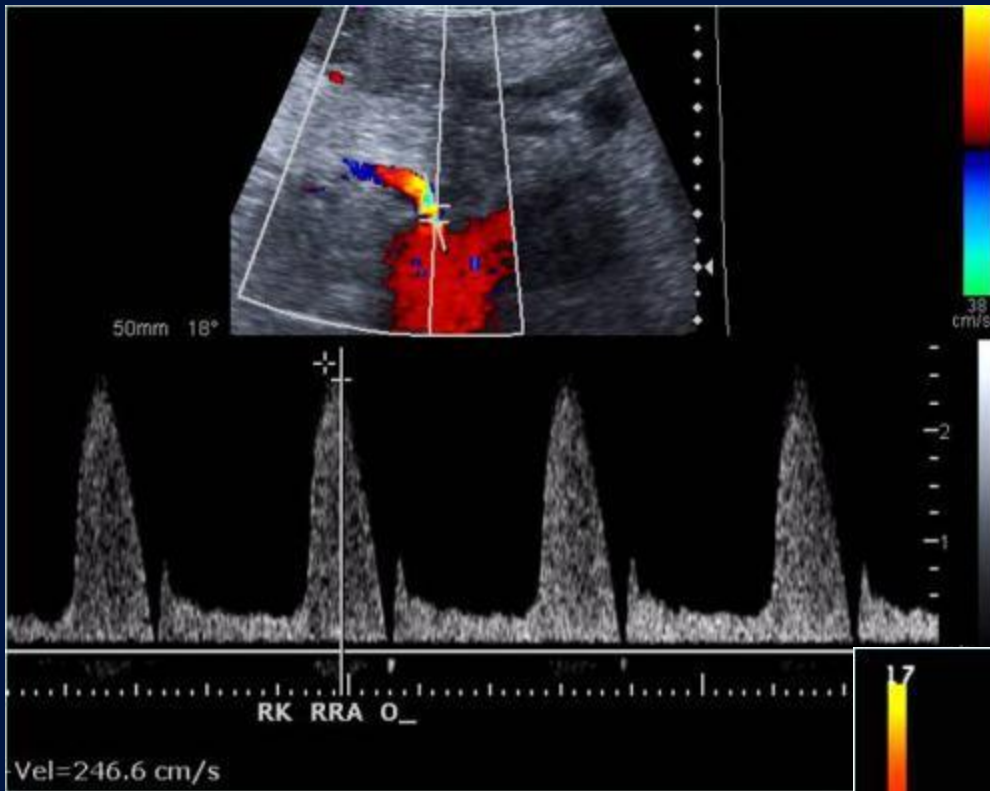
2. Fibromuscular Dysplasia (FMD): 2nd most common cause of renal arterial stenosis
3. Dissection
4. Vasculitis: Takayasu arteritis, radiation arteritis
5. Coarctation syndromes: neurofibromatosis, tuberous sclerosis
6. Trauma
7. Extrinsic compression

Renal Arterial Stenosis

Diagnosis:

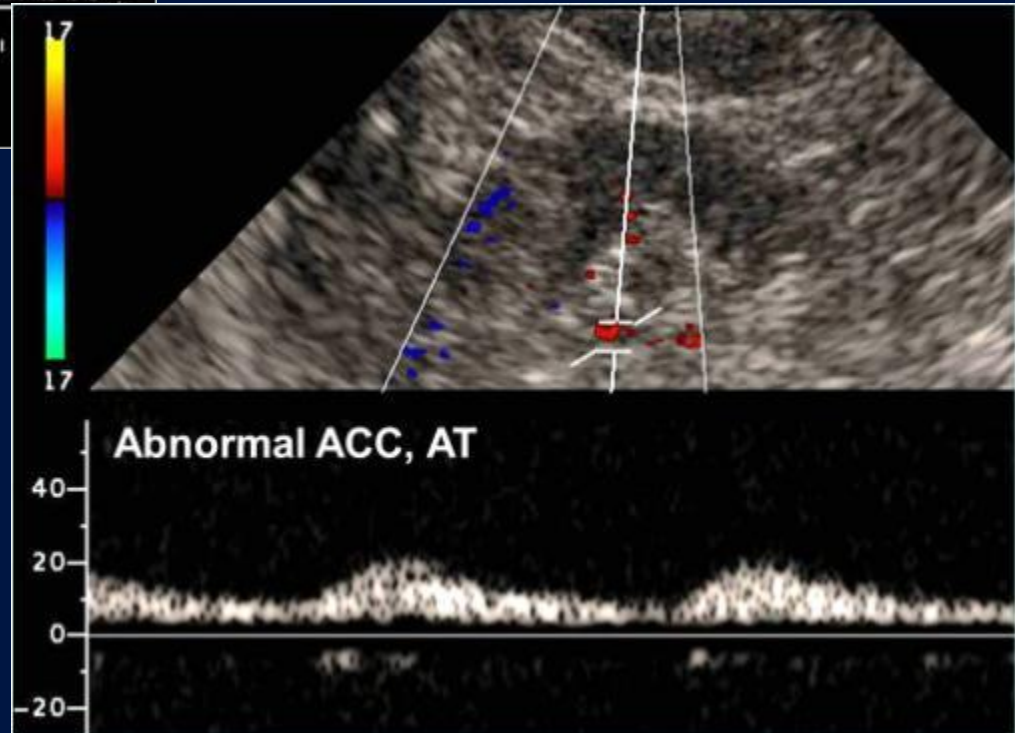
1. Ultrasound Doppler

- ❑ 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 acceleration index
and “Parvus et tardus”
waveform

Elevated flow velocity at the
level of the stenosis and
aliasing artifact



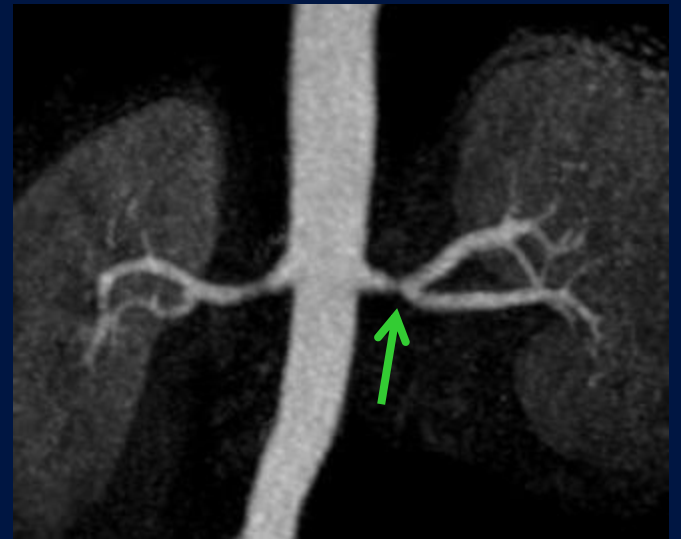
Renal Arterial Stenosis

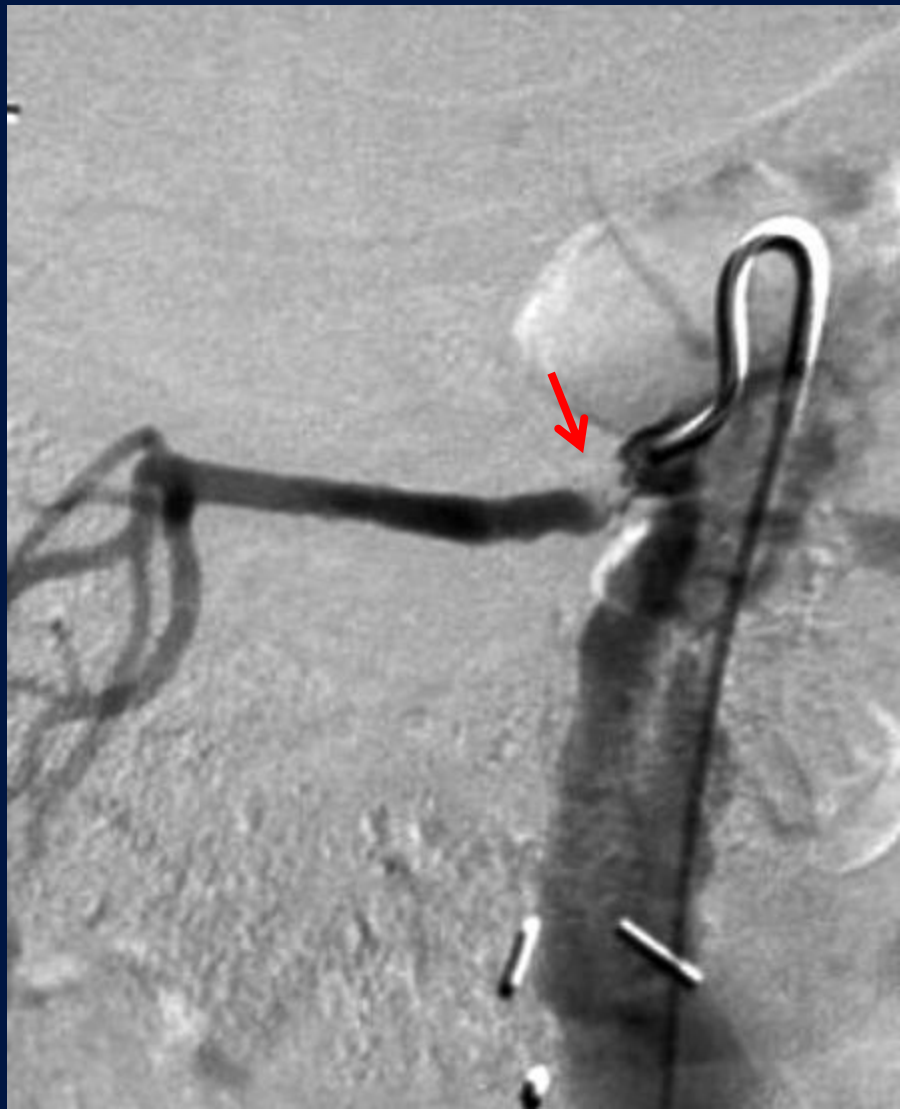
Diagnosis:

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 flash pulmonary edema, renal failure

Renal Arterial Stenosis

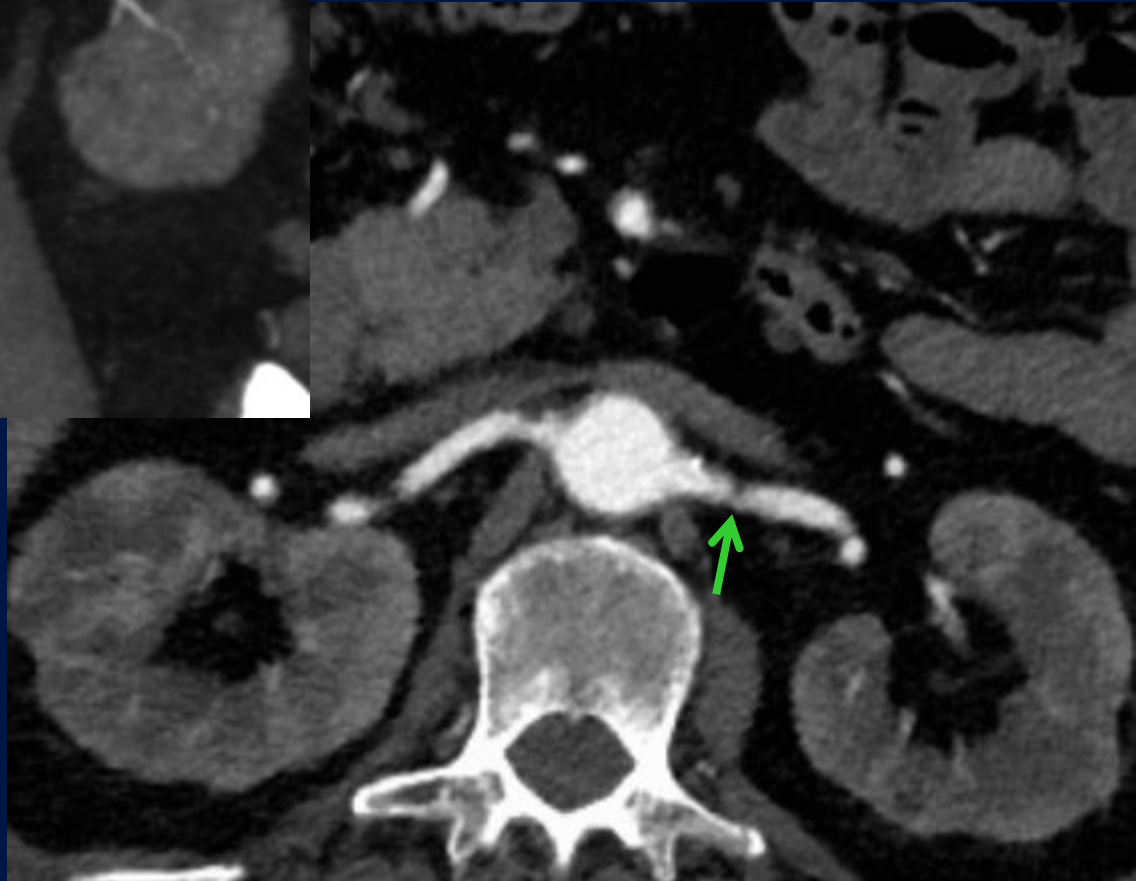
Contraindications:

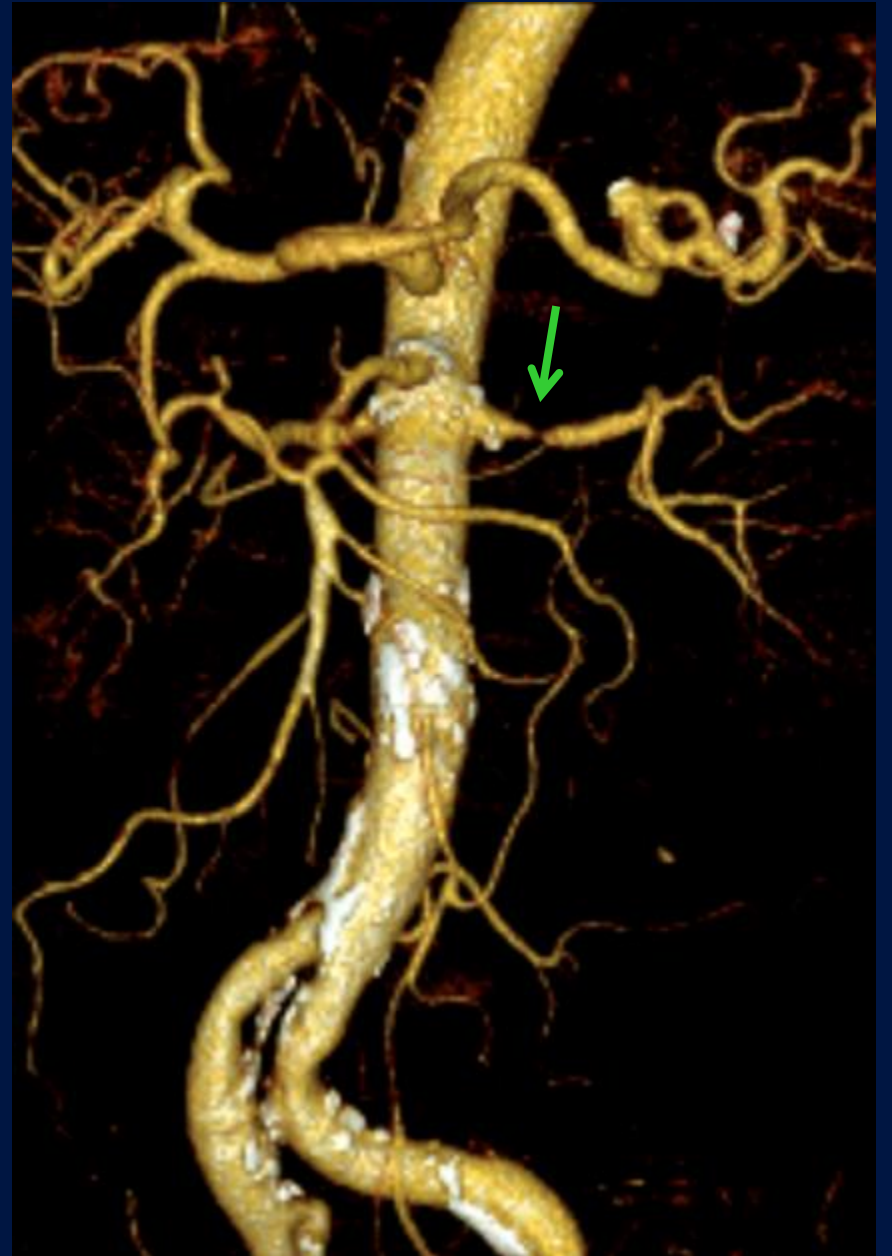
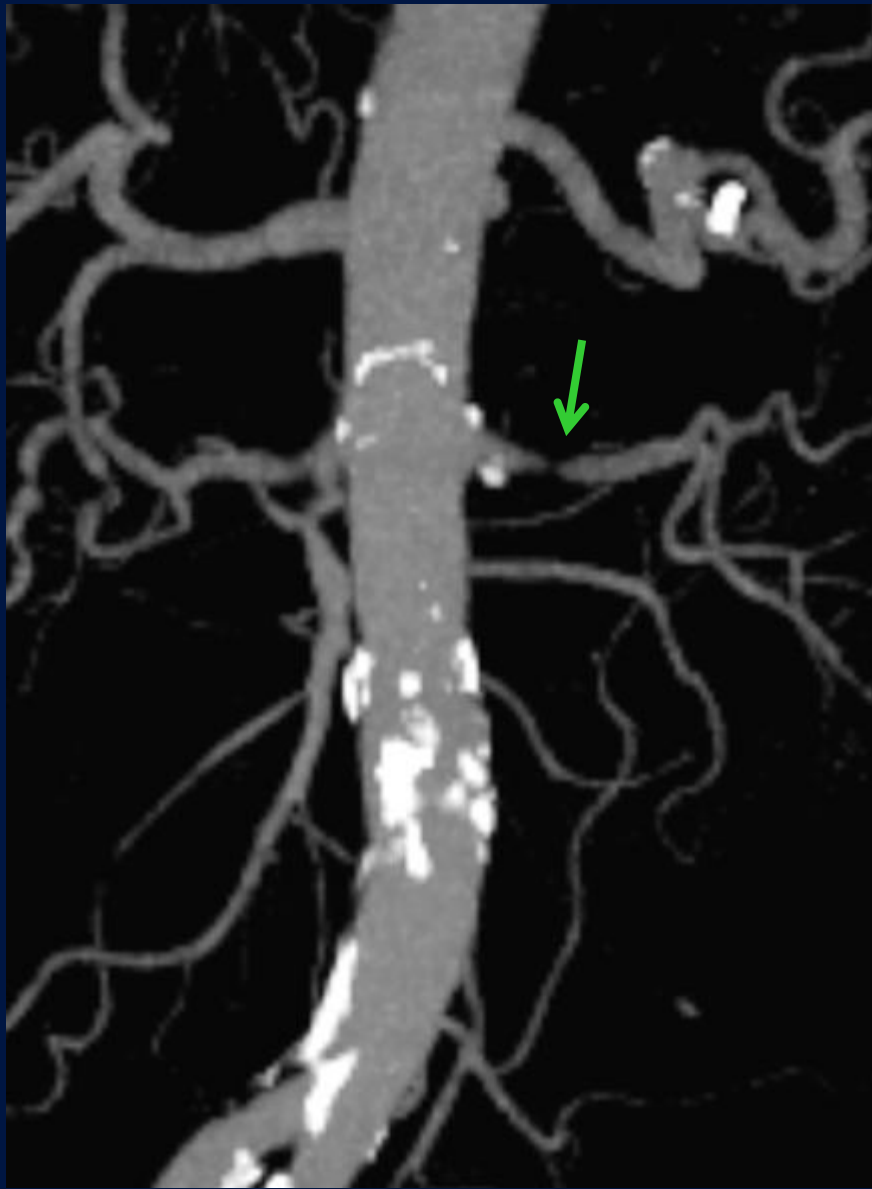
- ❑ Renal atrophy
- ❑ Uncorrectable coagulopathy
- ❑ Diffuse intrarenal vascular disease
- ❑ Ulcerative/unstable plaque >> risk of peripheral embolization

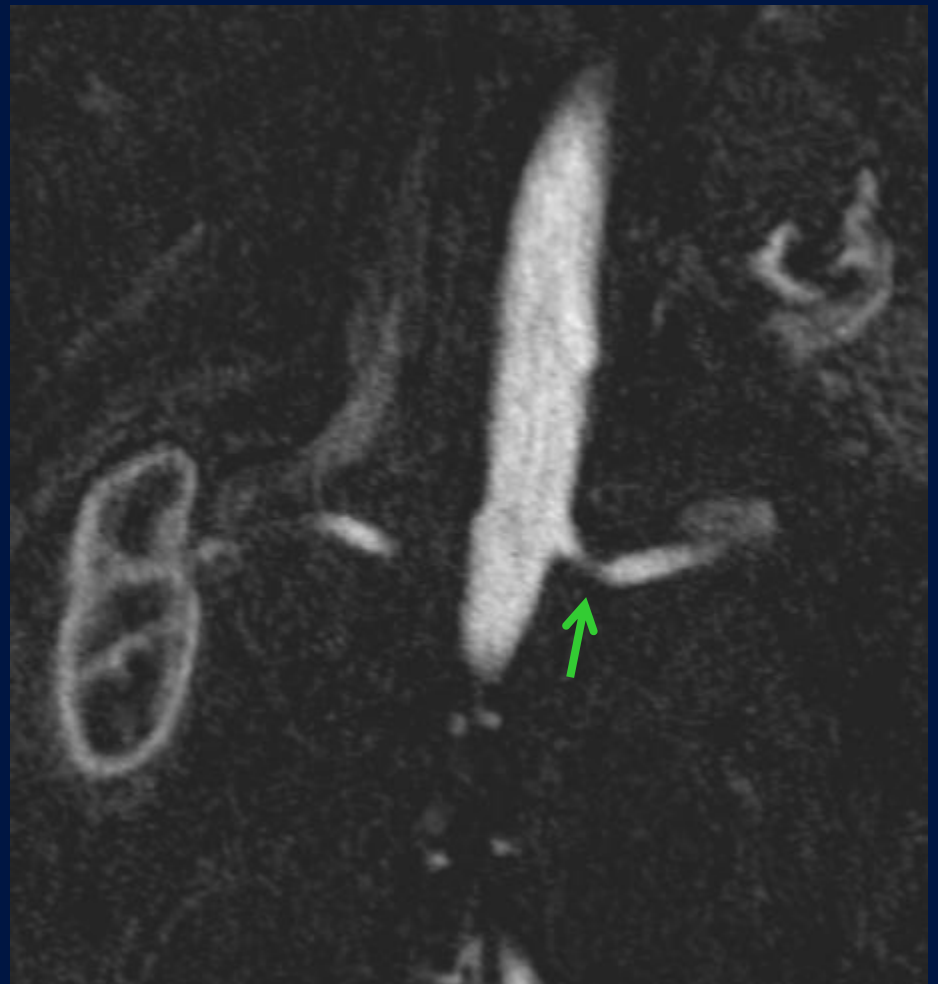
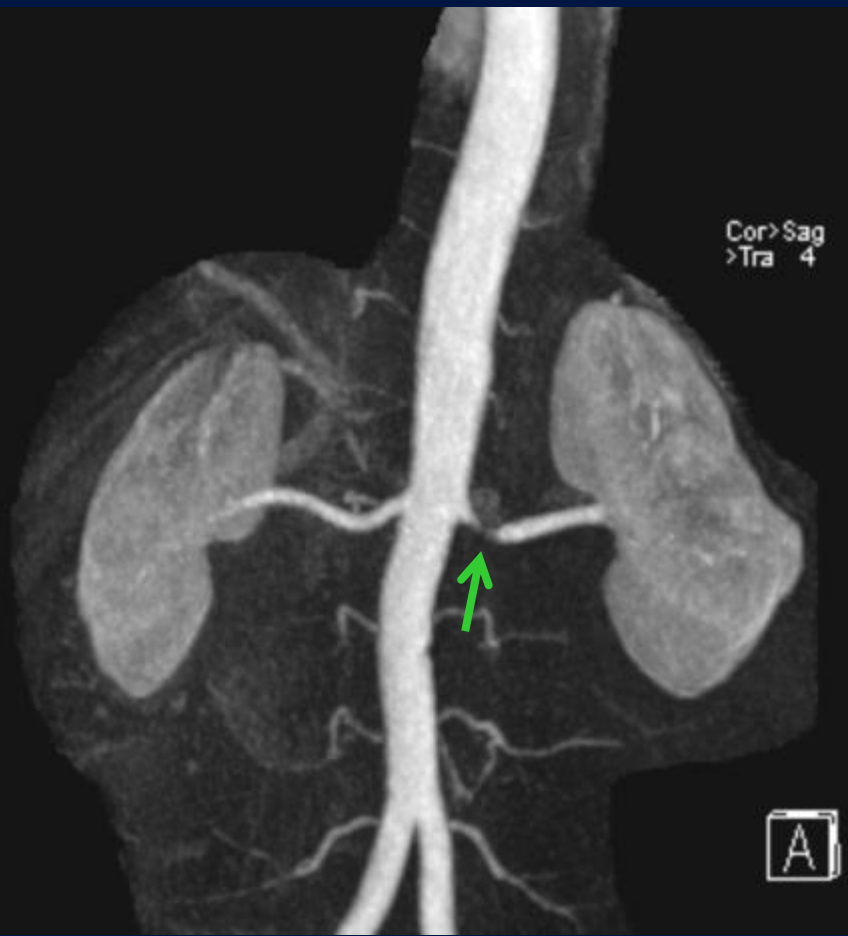
Pre-procedure:

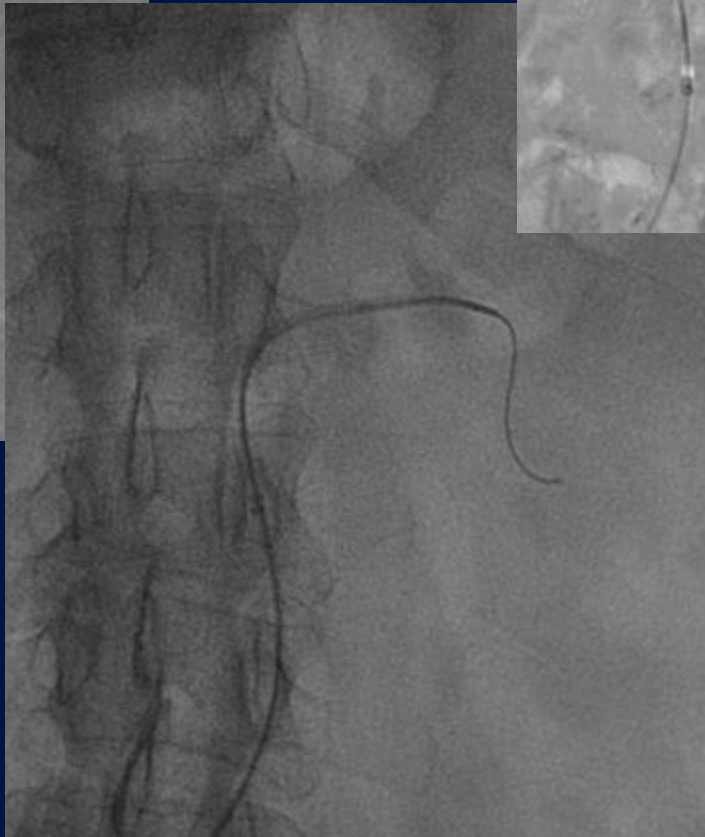
- ❑ Hold antihypertensives on day of procedure or decrease dose by 50% within 48 hours before the procedure
- ❑ Prefer INR < 1.5
- ❑ Prehydrate with IV normal saline for 4-6 hours

Case # 1









6 mm balloon angioplasty
over 0.035 inch Rosen wire



Telescoping Technique

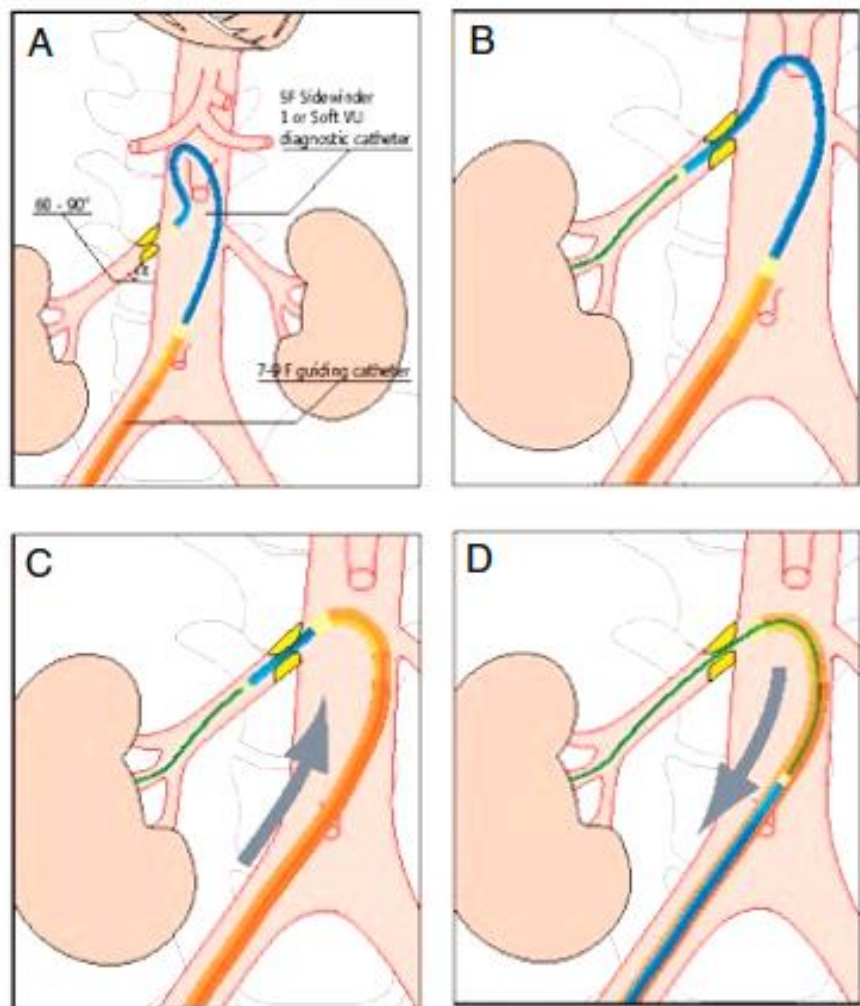
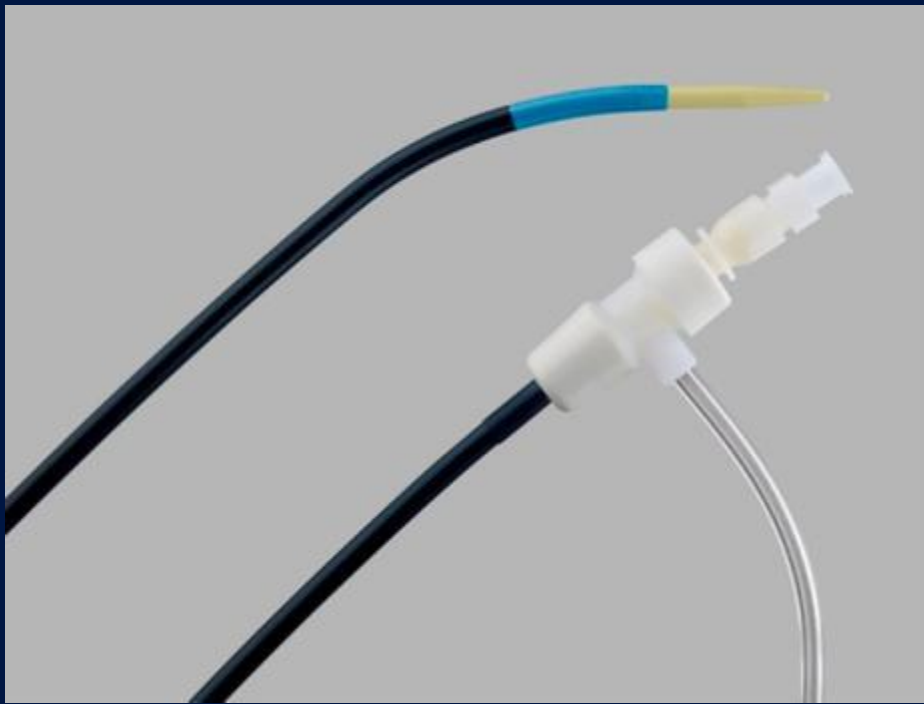


Figure 5. Telescoping technique. (A) Cannulation of the renal artery origin with a 5 Fr diagnostic catheter (Sidewinder or SOS Omni Soft VU) through the 7 Fr guiding catheter. (B) A 0.014 inch or 0.018 inch extra-support guidewire is advanced into the renal artery; optionally, the lesion can additionally be crossed with the diagnostic catheter. (C) The guiding catheter advanced over the 5 Fr diagnostic catheter close to the renal artery origin. (D) Guiding catheter in position, 5 Fr catheter removed.

- 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



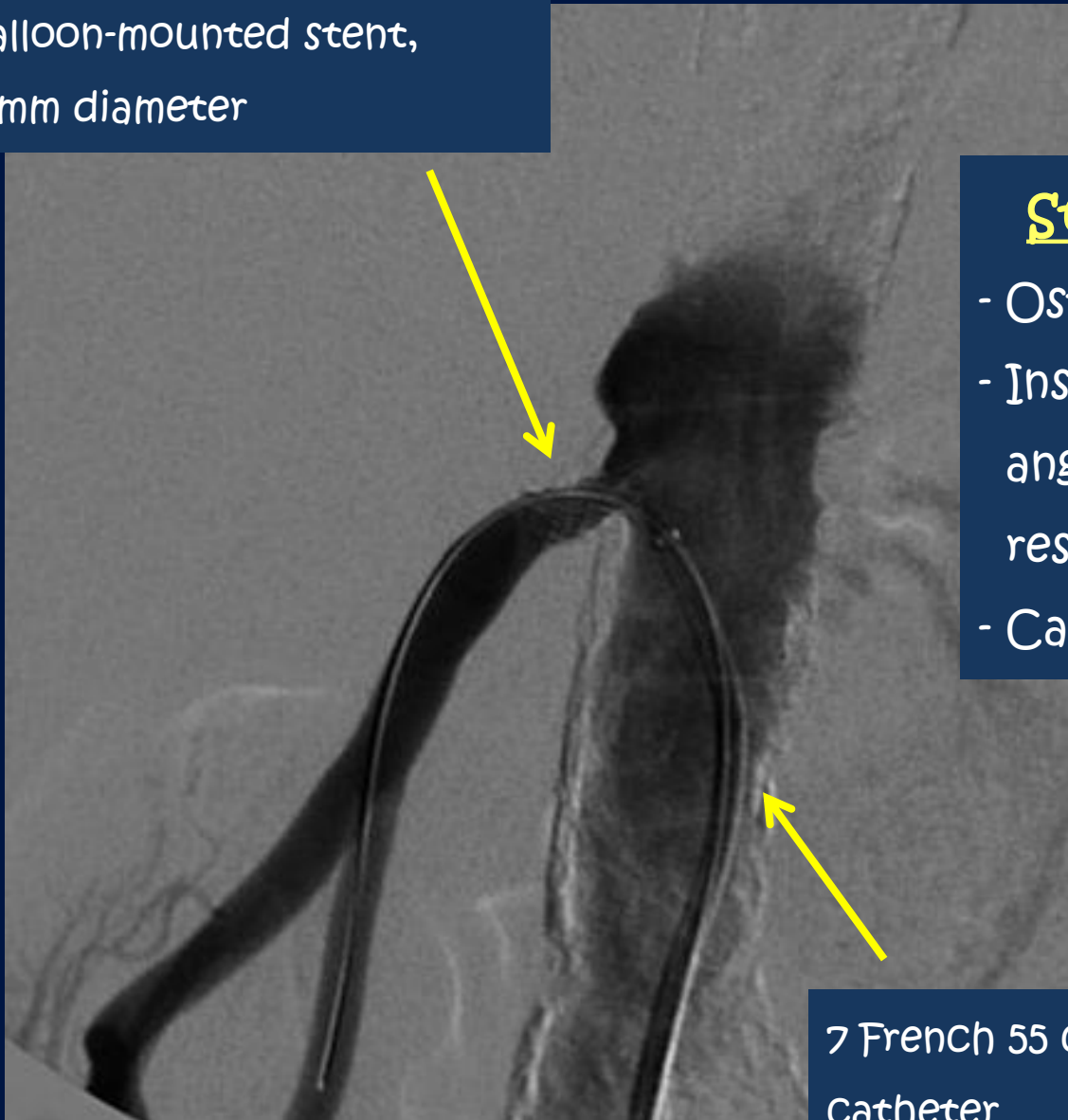
4-5 French hydrophilic
SOS Omni catheter;
Angiodynamics



6 mm balloon angioplasty



0.014-1.018 inch guidewire
balloon-mounted stent,
7 mm diameter

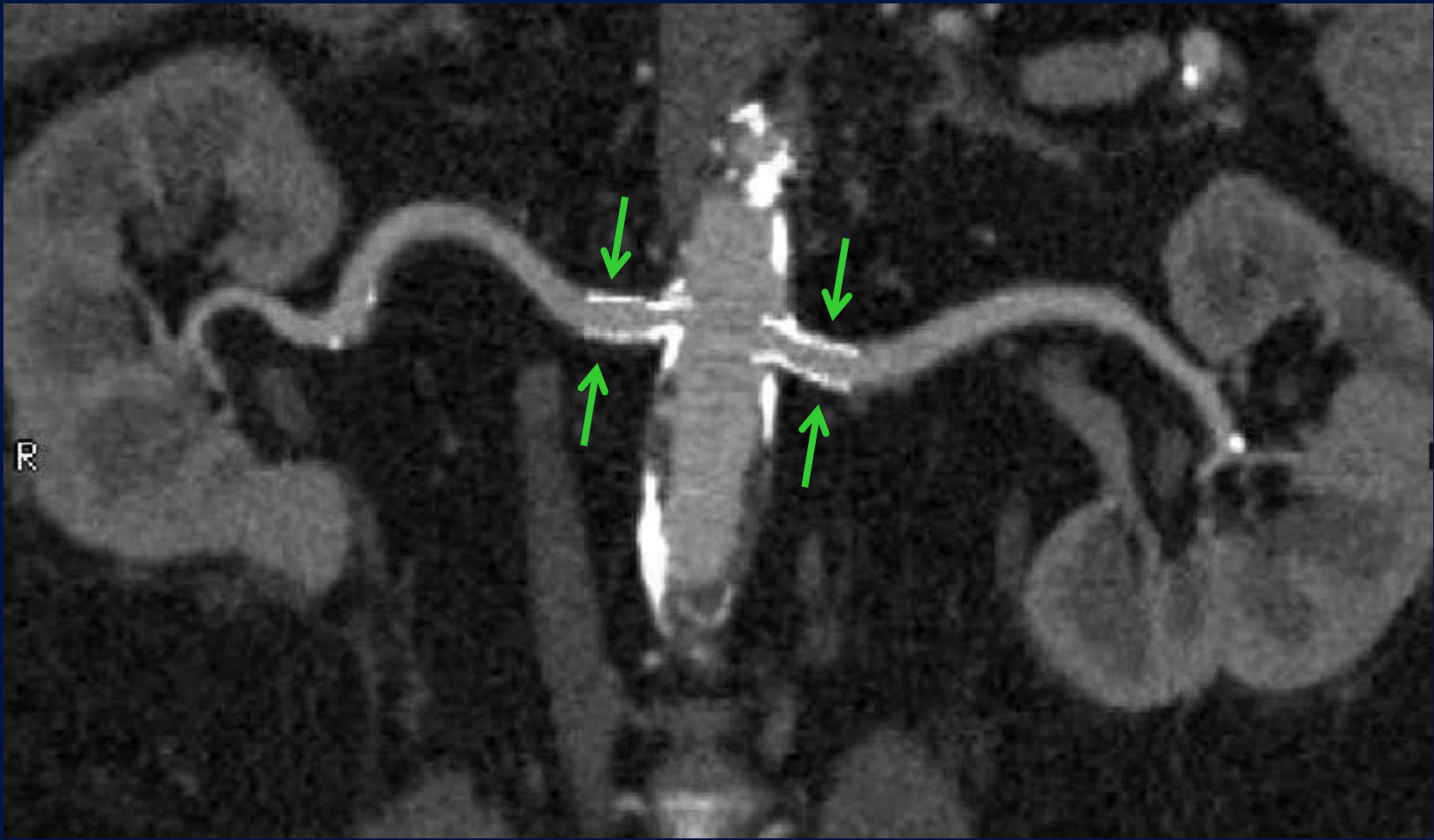


Stent vs. balloon

- Ostial stenosis
- Insufficient angioplasty (> 30% residual stenosis)
- Calcified stenosis

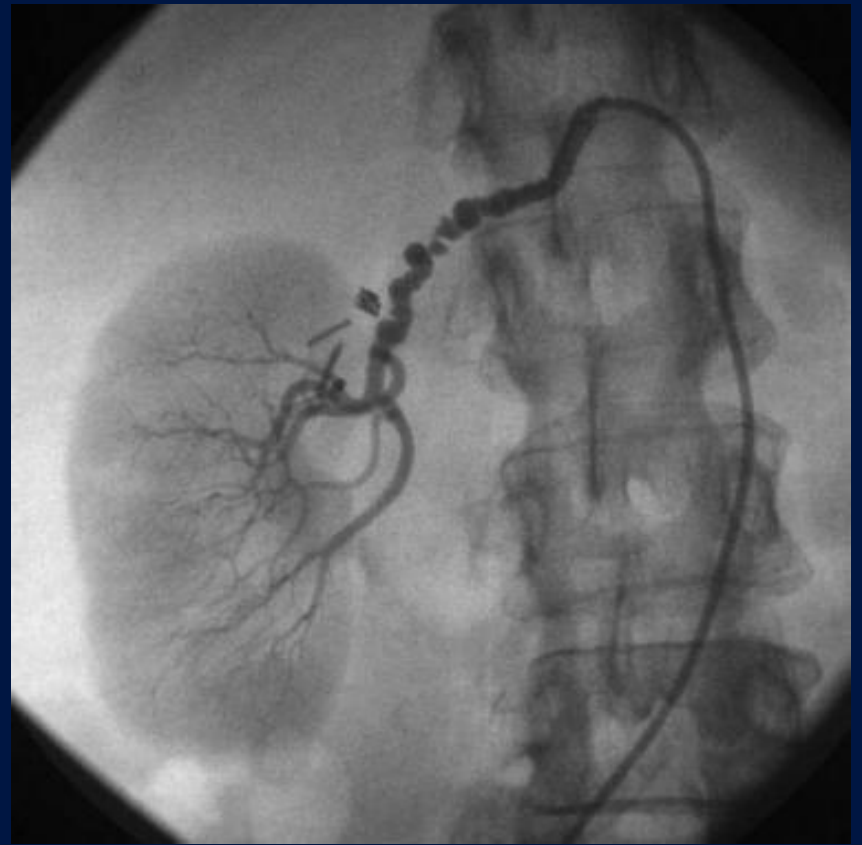
7 French 55 cm long guiding
Catheter

Bilateral Renal Stents



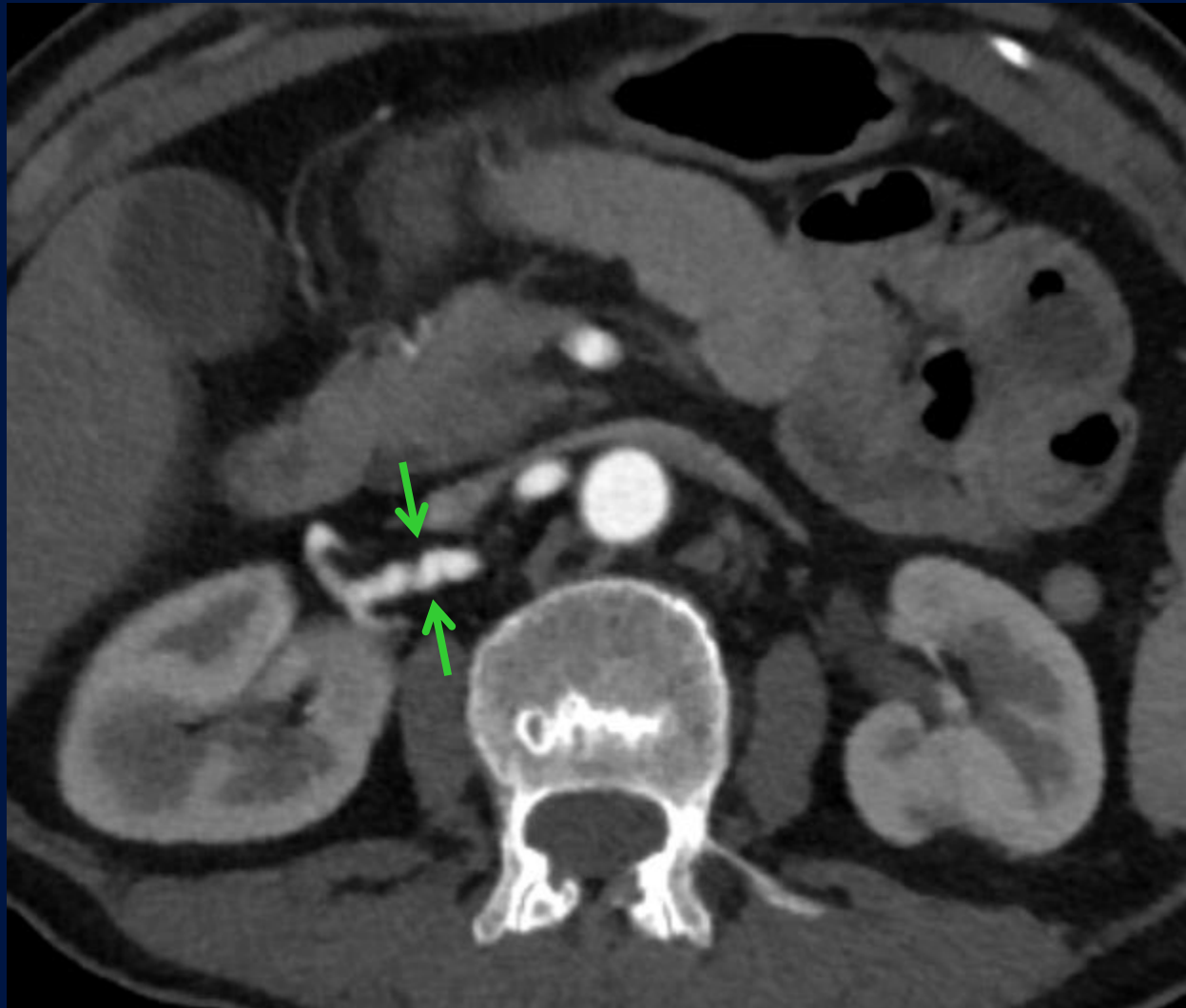
Fibromuscular Dysplasia (FMD):

- ❑ 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



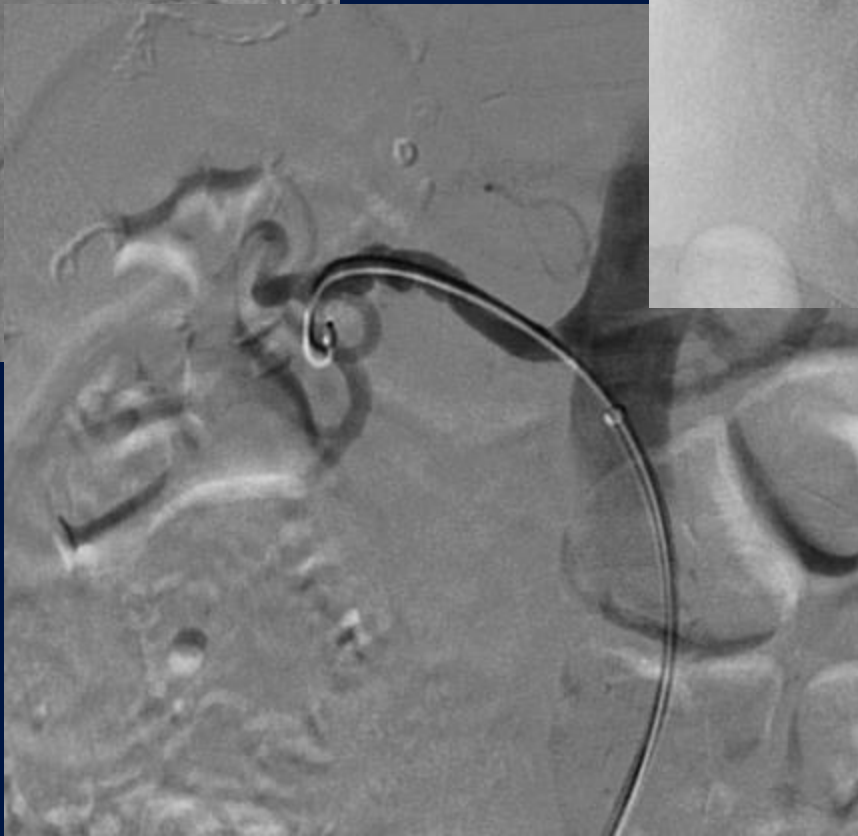
Irregular "beaded"
appearance of the RA





Case # 2







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: polyarteritis 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 injures

Renal Arterial Embolization

Dysplastic aneurysms:

- ❑ Near the first bifurcation of the main RA
- ❑ 75% of patients have elevated blood pressure
- ❑ Saccular or fusiform

Complications: rupture, thrombosis

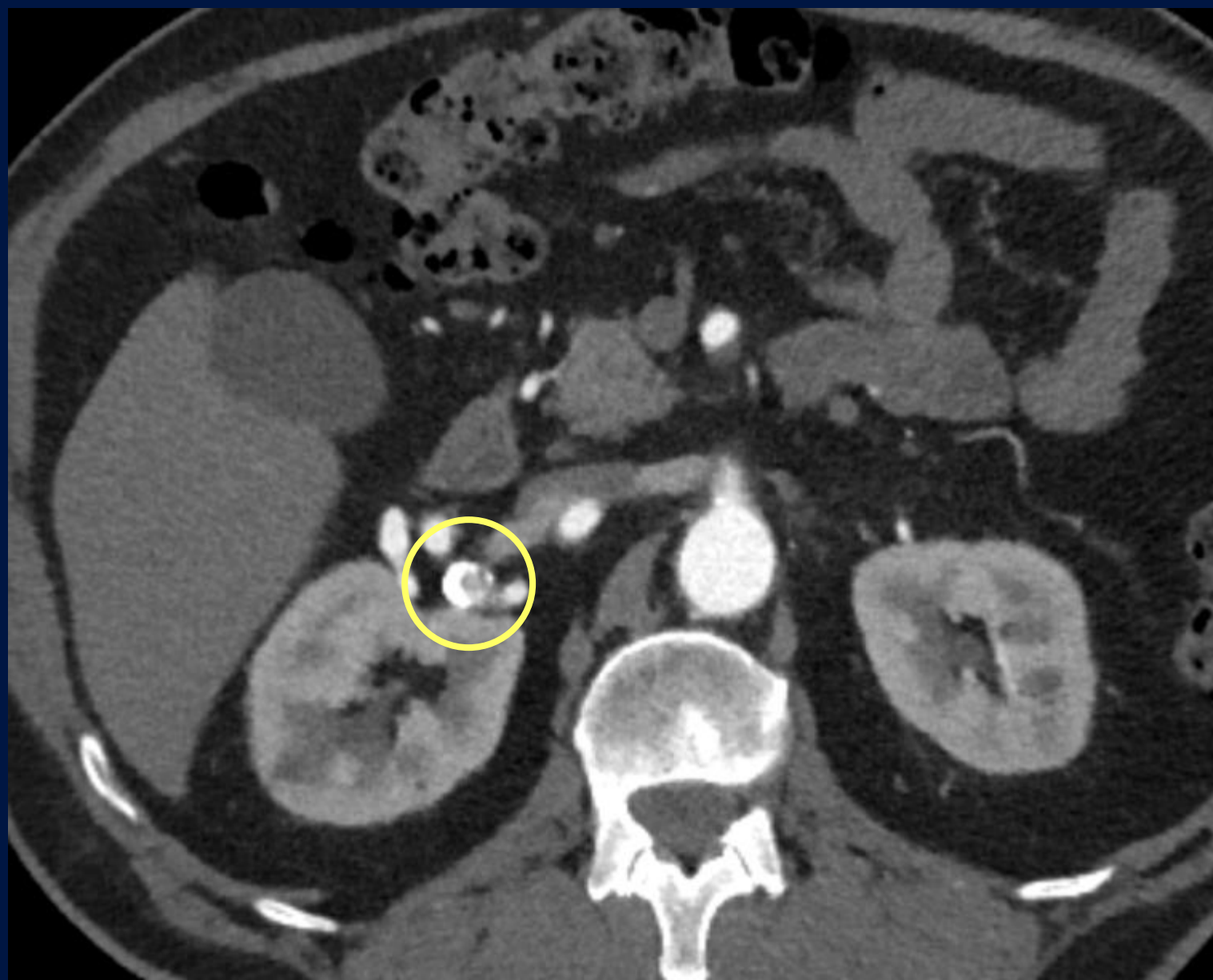
- ❑ Risk of rupture is heightened in pregnant women

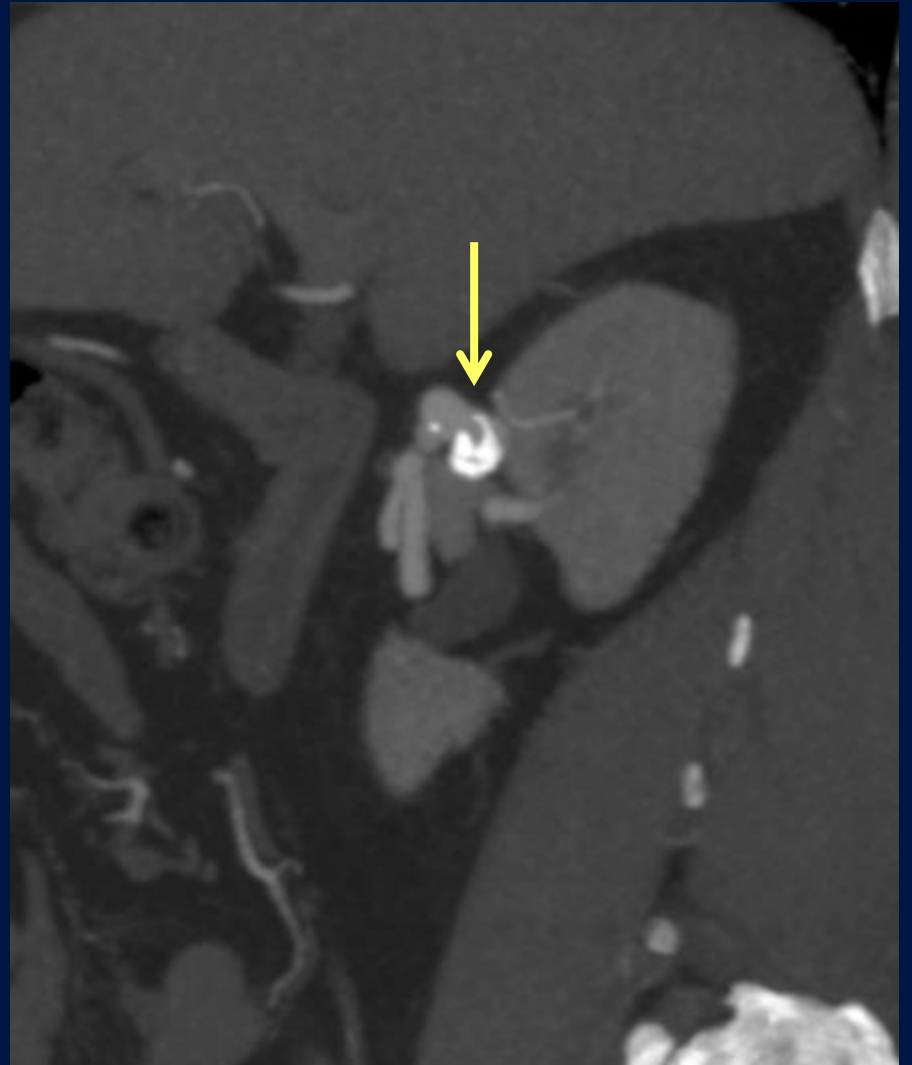
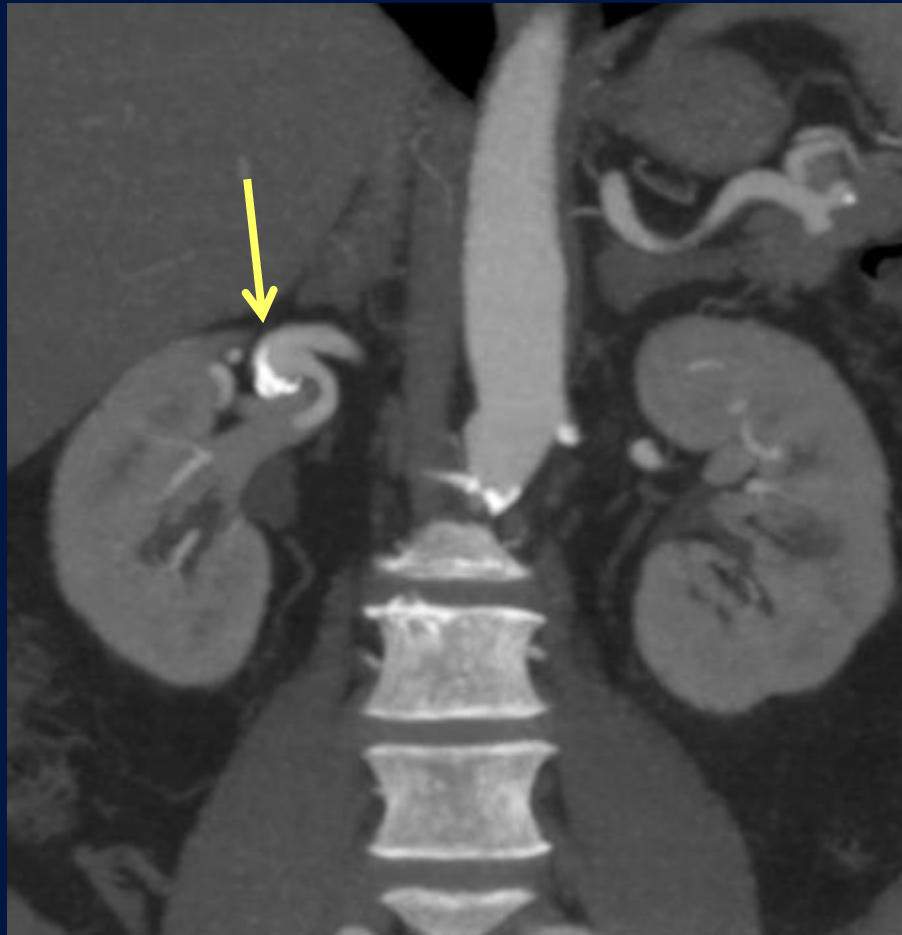
When to treat: “rule of 2 cm”, regardless of size in women of child-

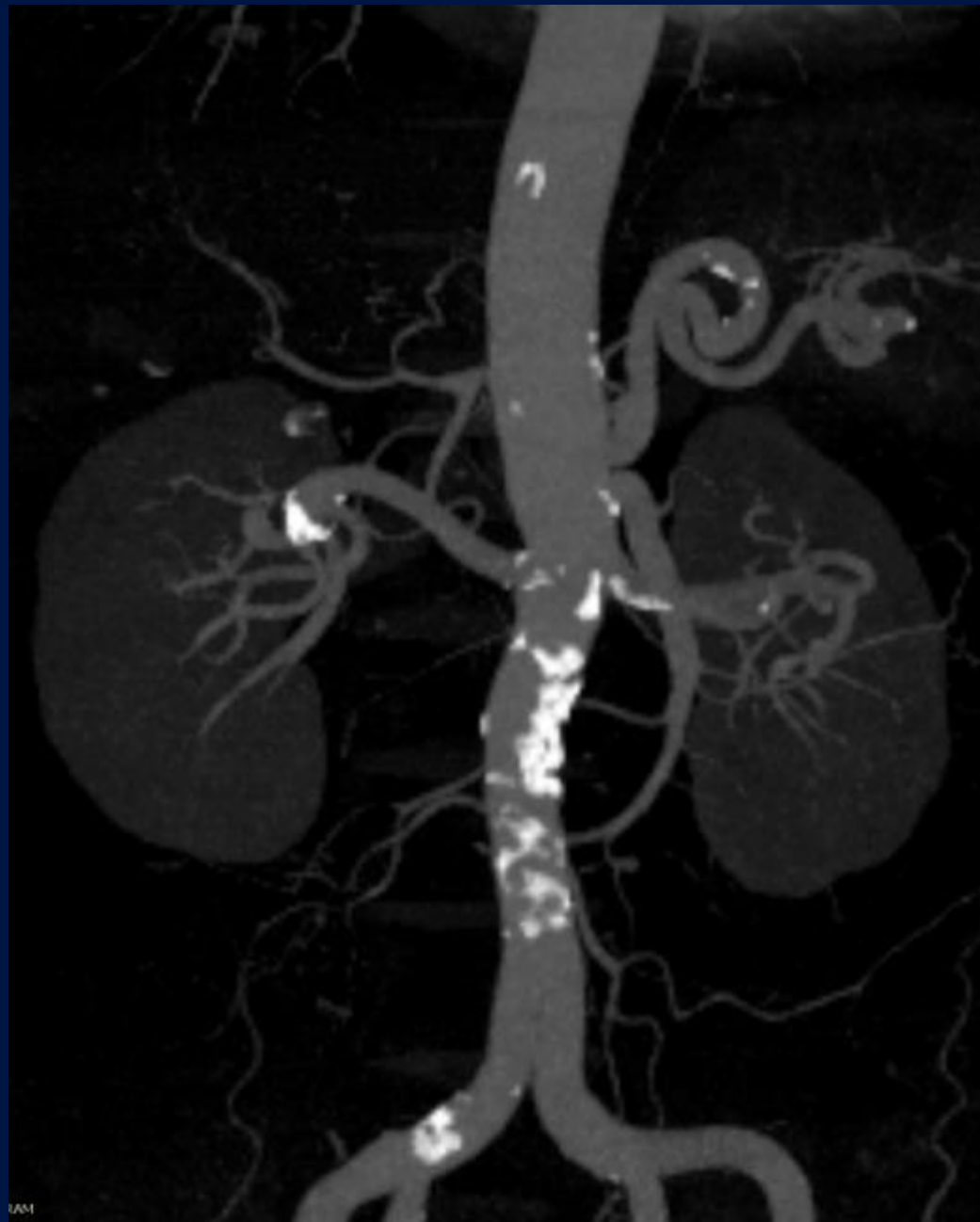
bearing potential, symptomatic patients, all pseudoaneurysms

Endovascular treatment options: covered stent placement for main

RA aneurysms, embolization with microcoils or glue for intrarenal aneurysms



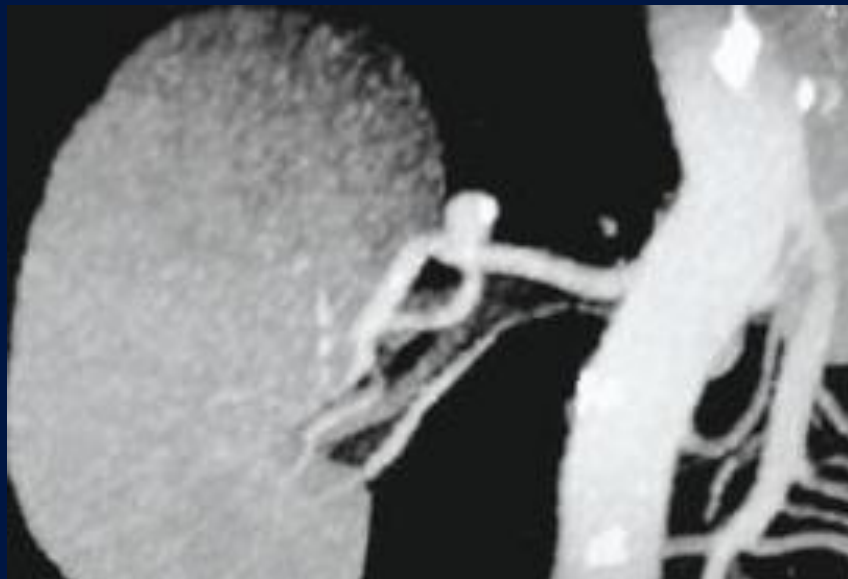






Traumatic RA
pseudoaneurysm
and AV fistula

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)

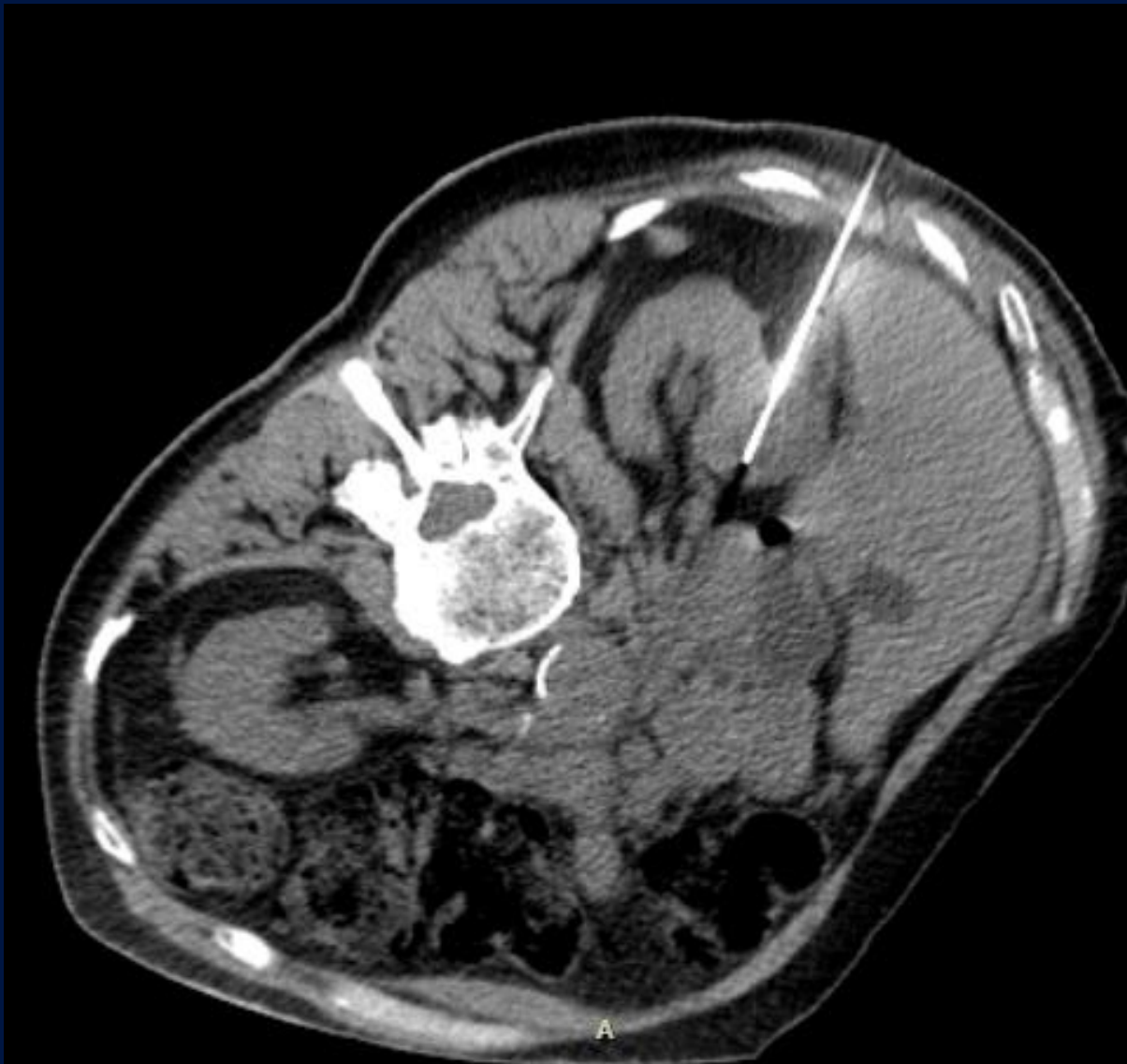


CT guided left renal
mass biopsy



Complications:

2. Bleeding/hematoma
3. Infection
4. Pneumothorax

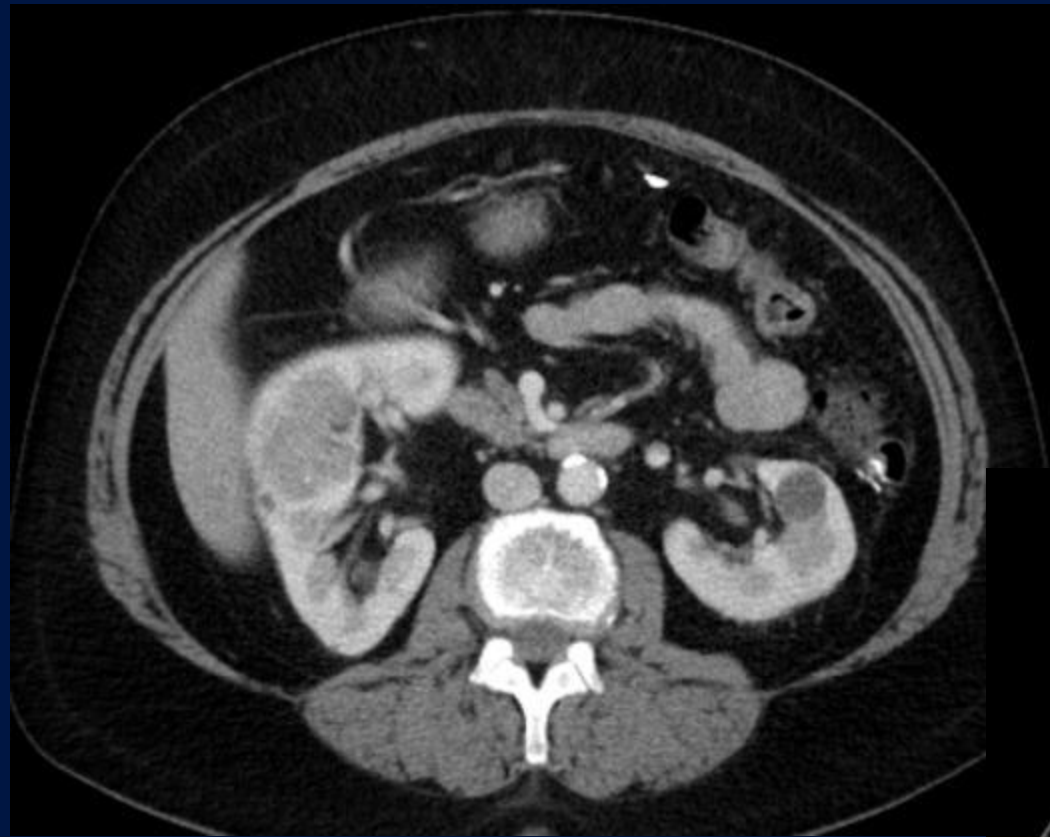


Renal Lesion
Core Biopsy

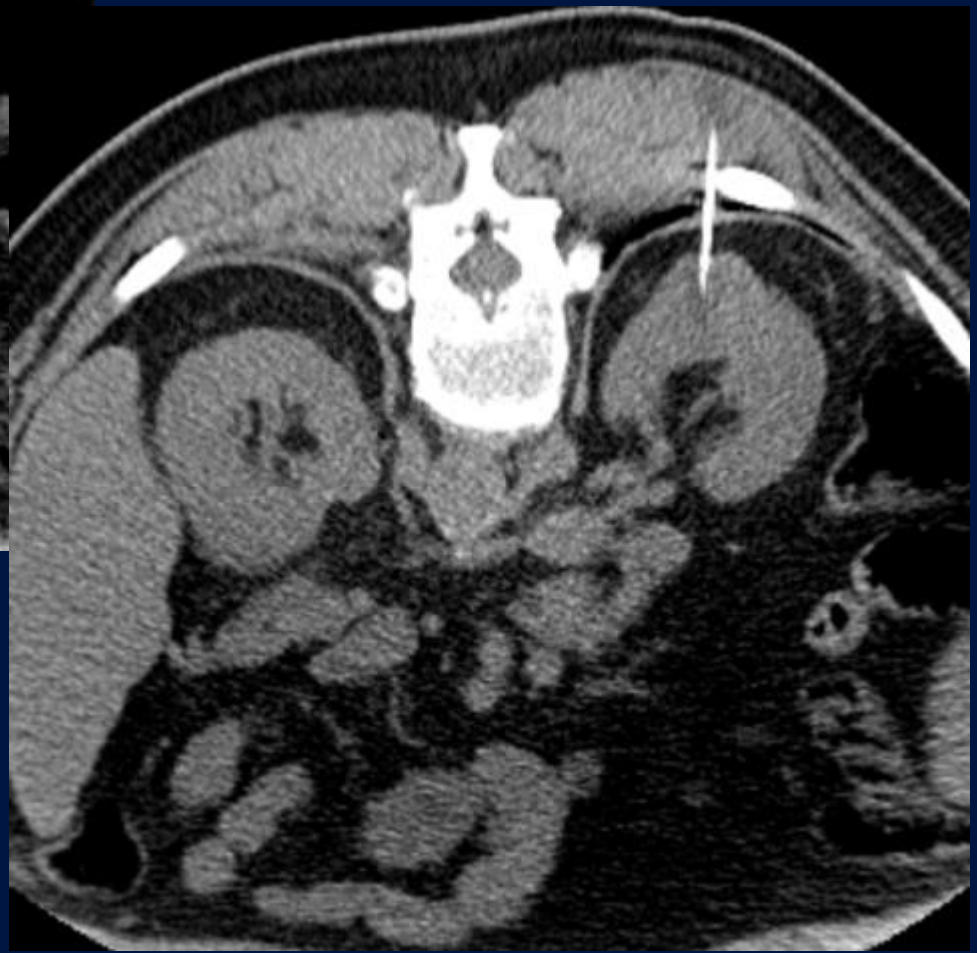
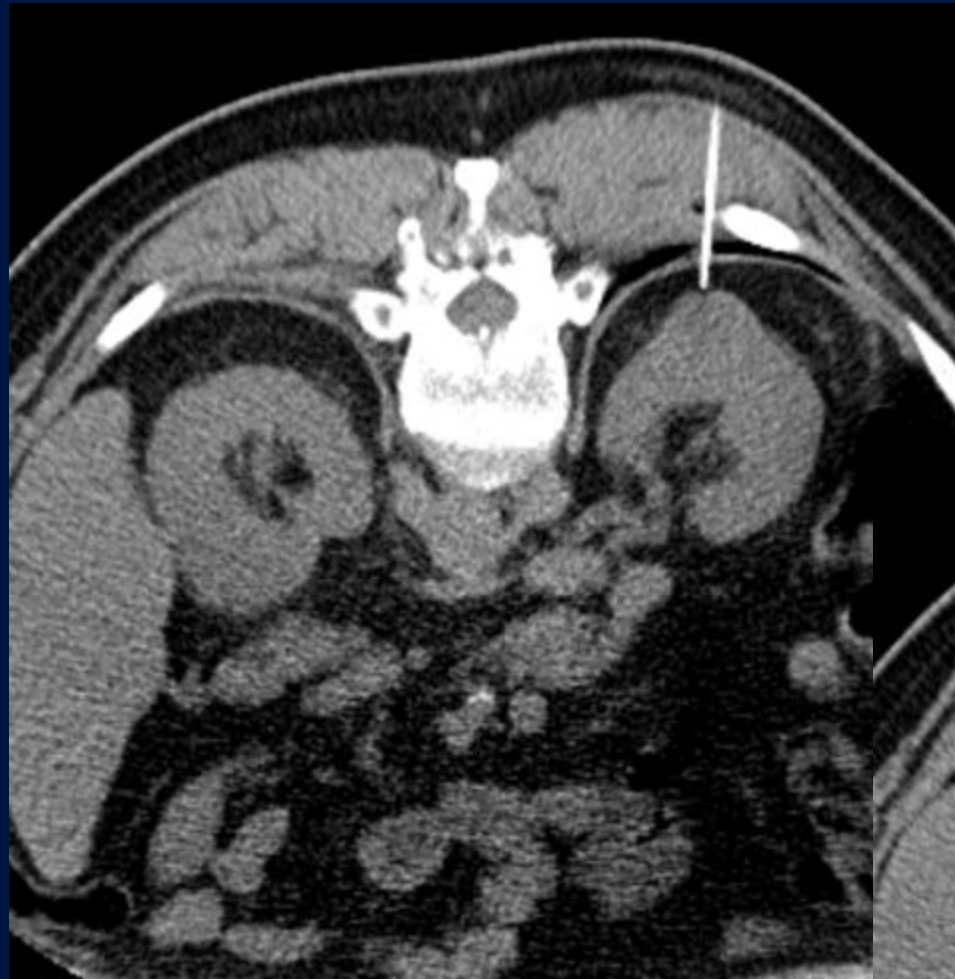
17 Gauge
Introducer,
Needle

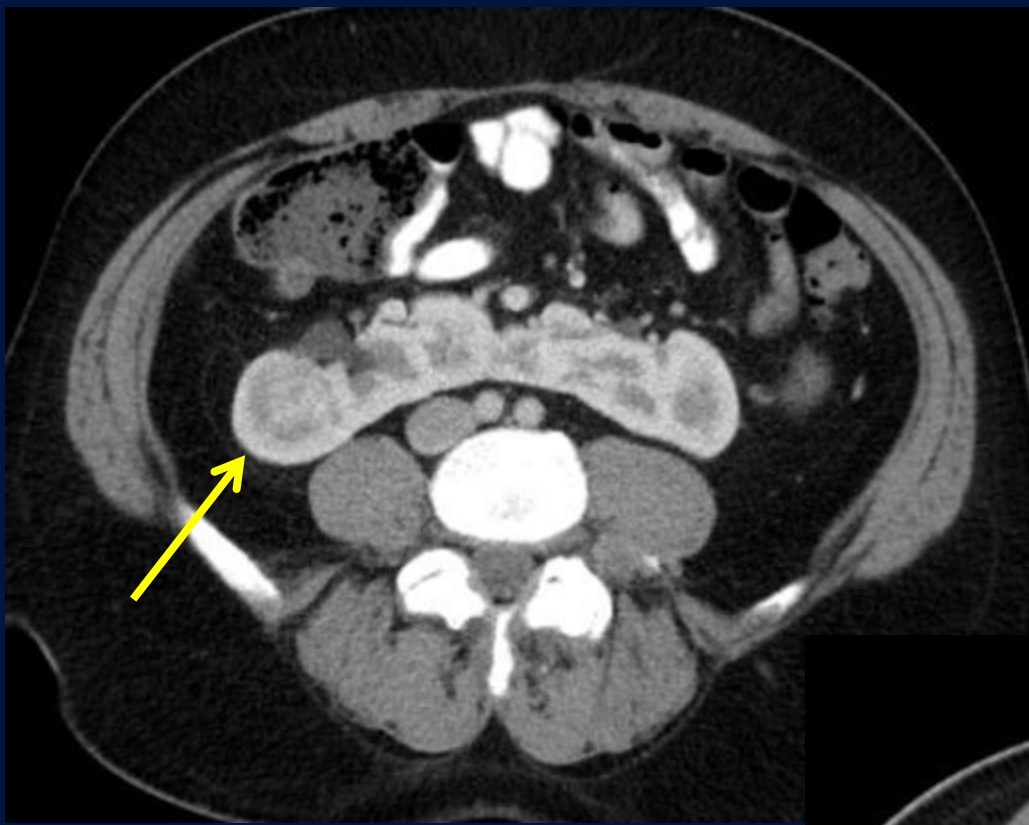
18 Gauge Gun











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



Kidney tumor RFA

LeVein Needle
Electrode
(Boston Scientific)



Percutaneous Nephrostomy

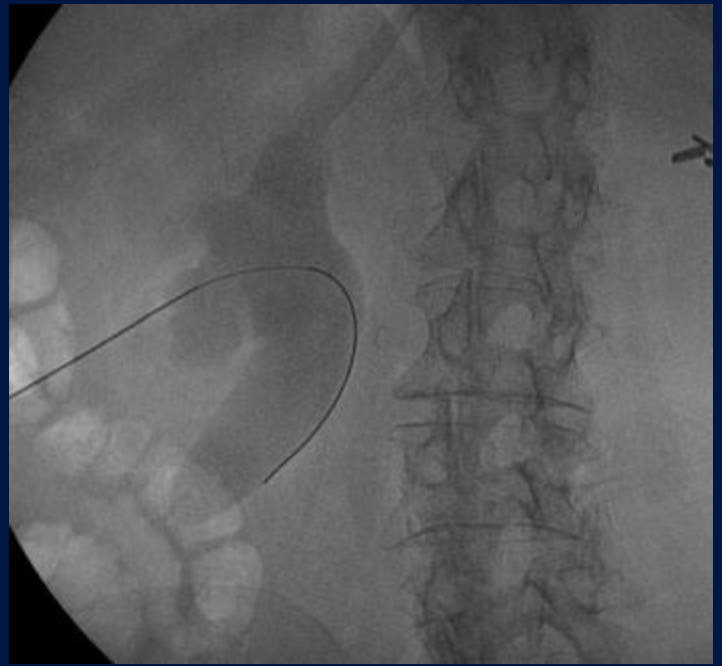
➤ US/Fluoroscopy guided or CT guided (in obese patients)

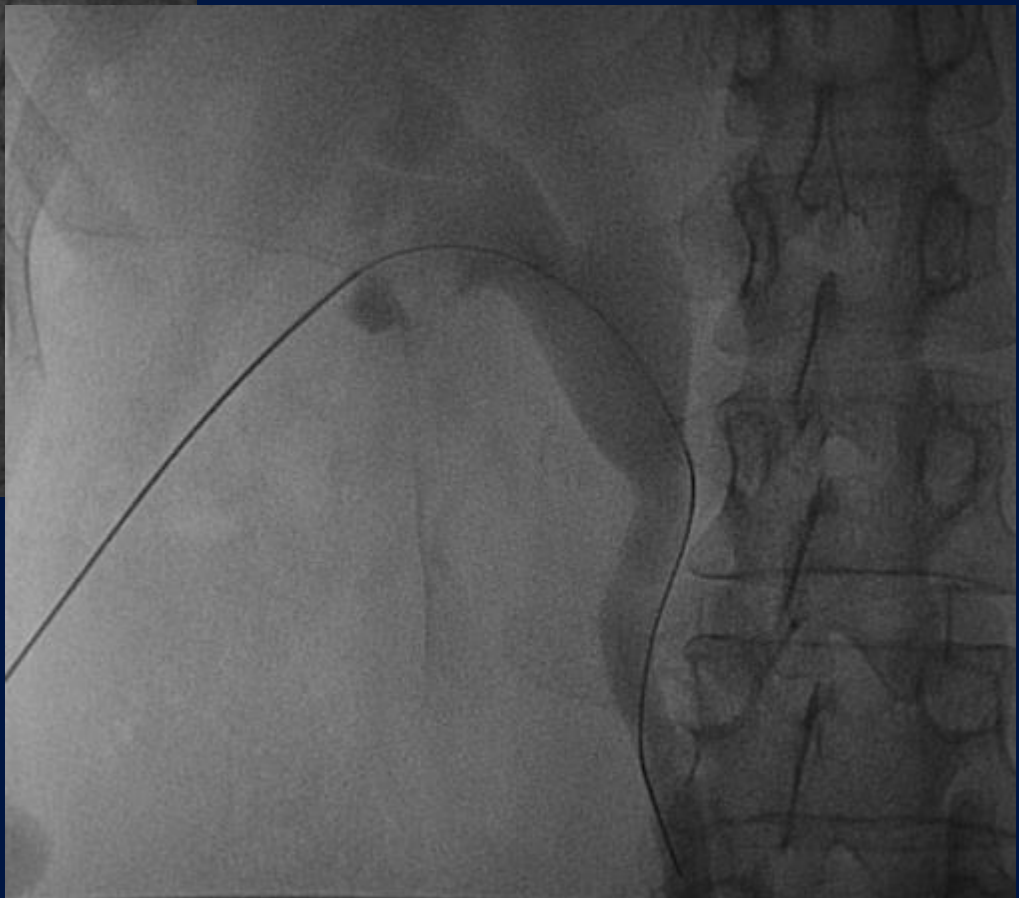
Indications:

- ❑ 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

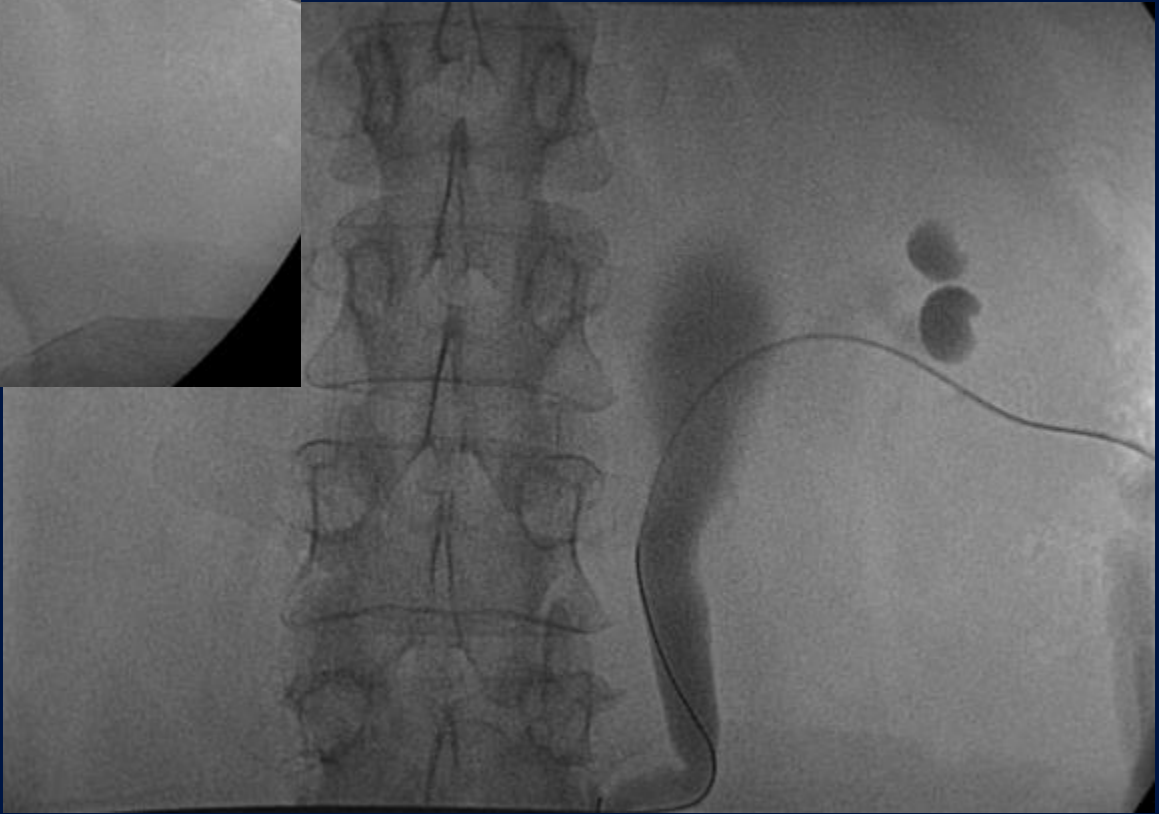


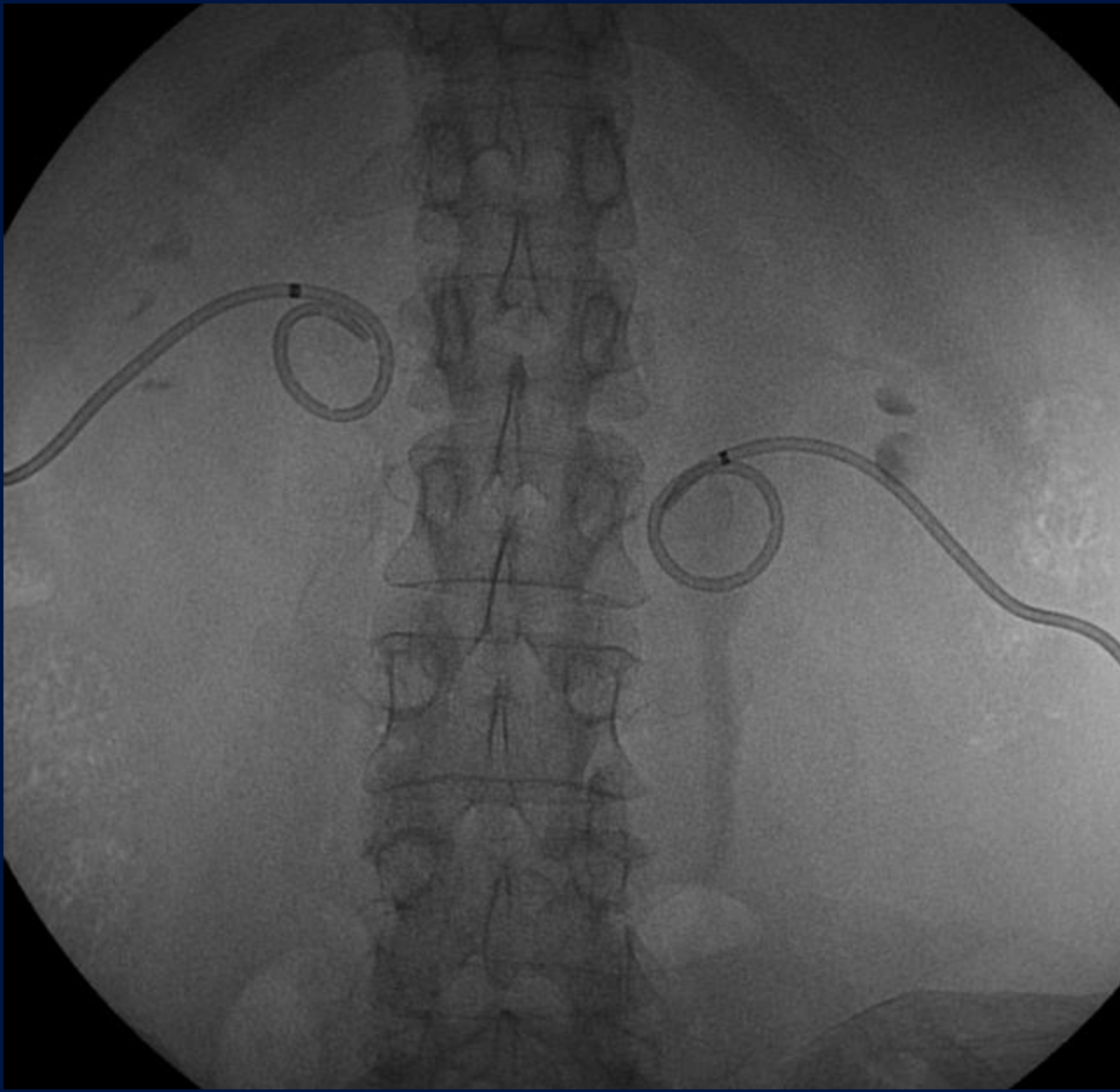






8 French nephrostomy



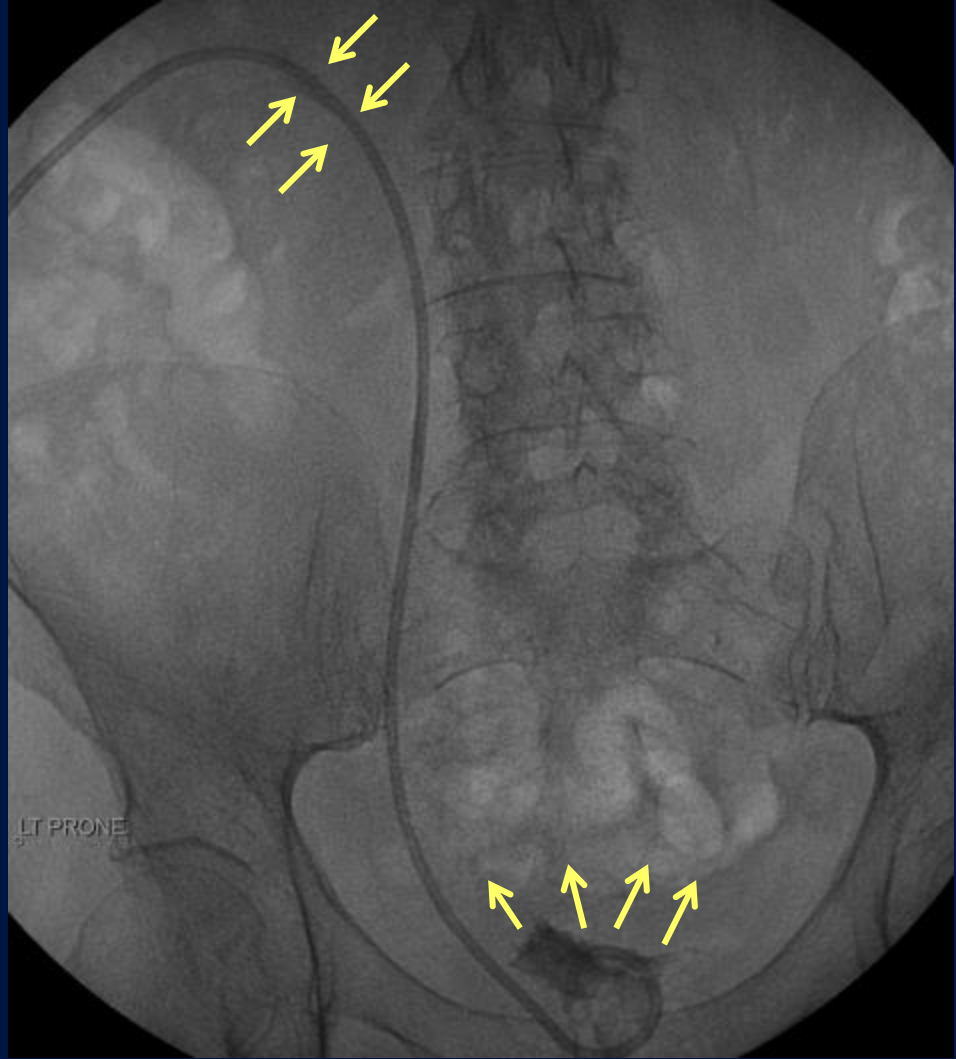


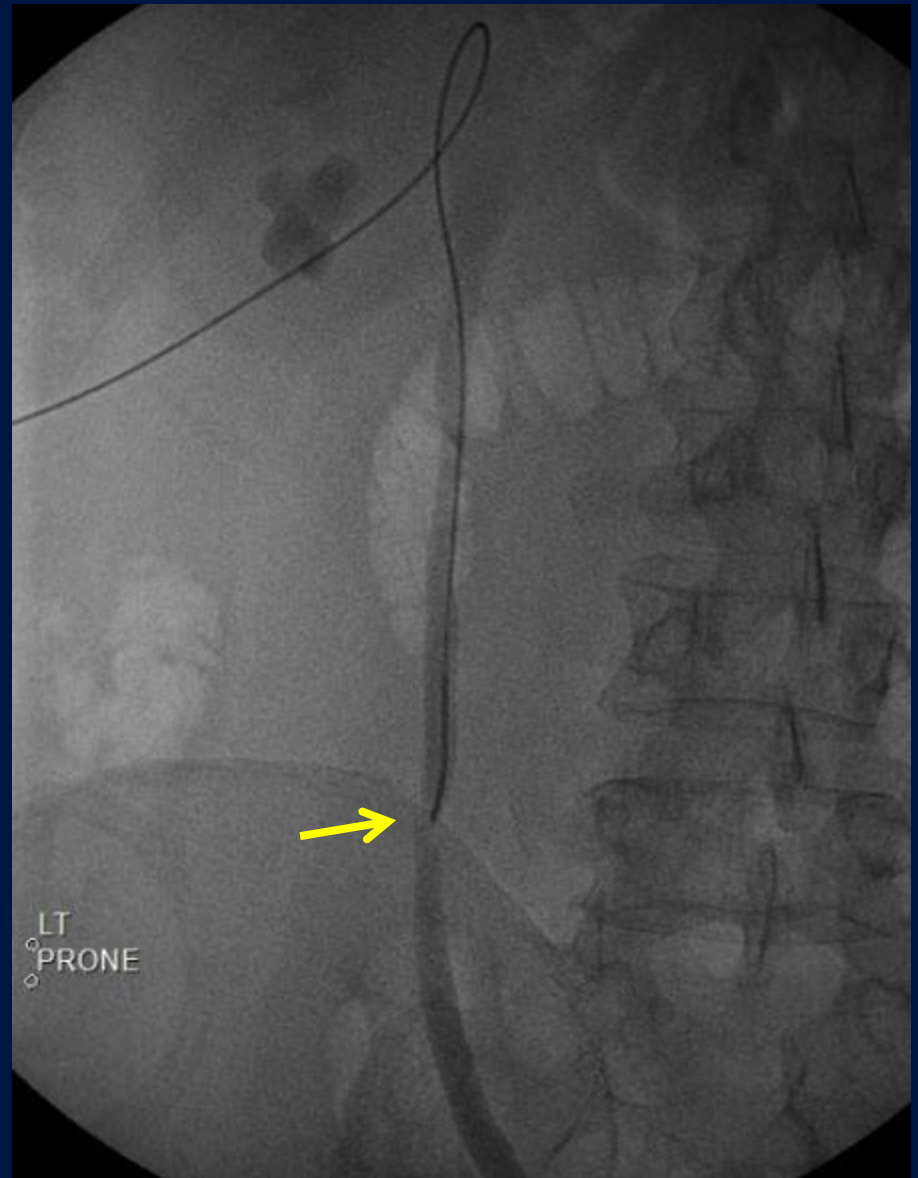
US and Fluoroscopic Guided Percutaneous Nephrostomy

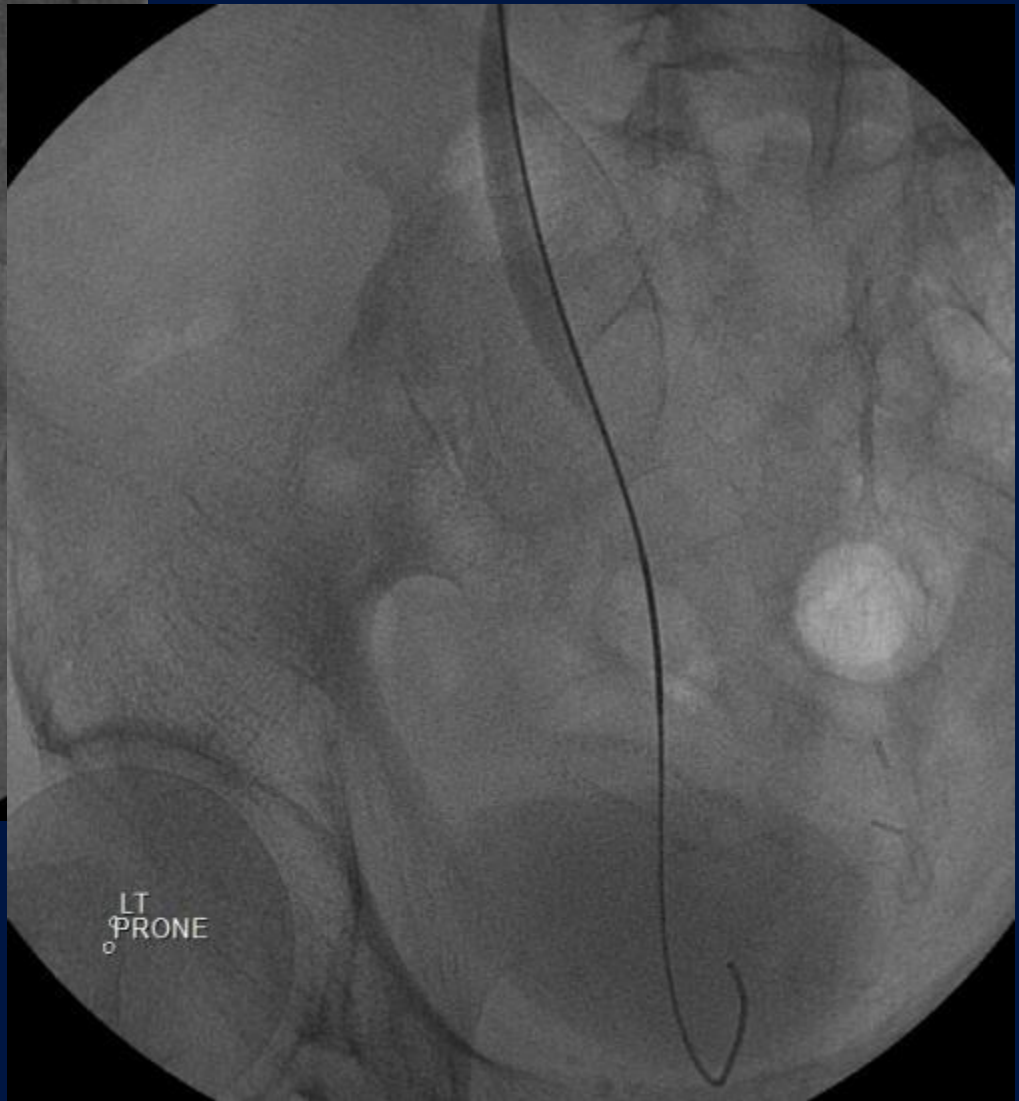
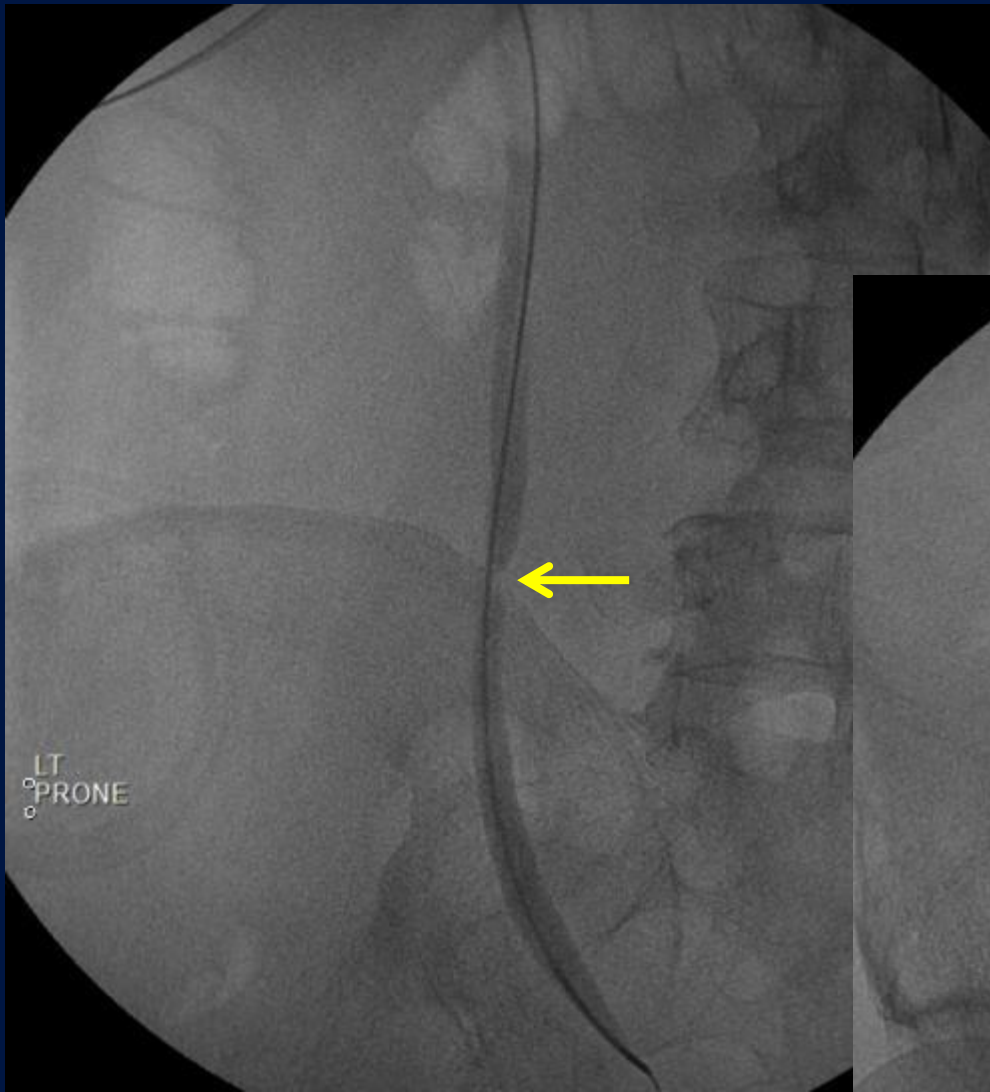


Complications:

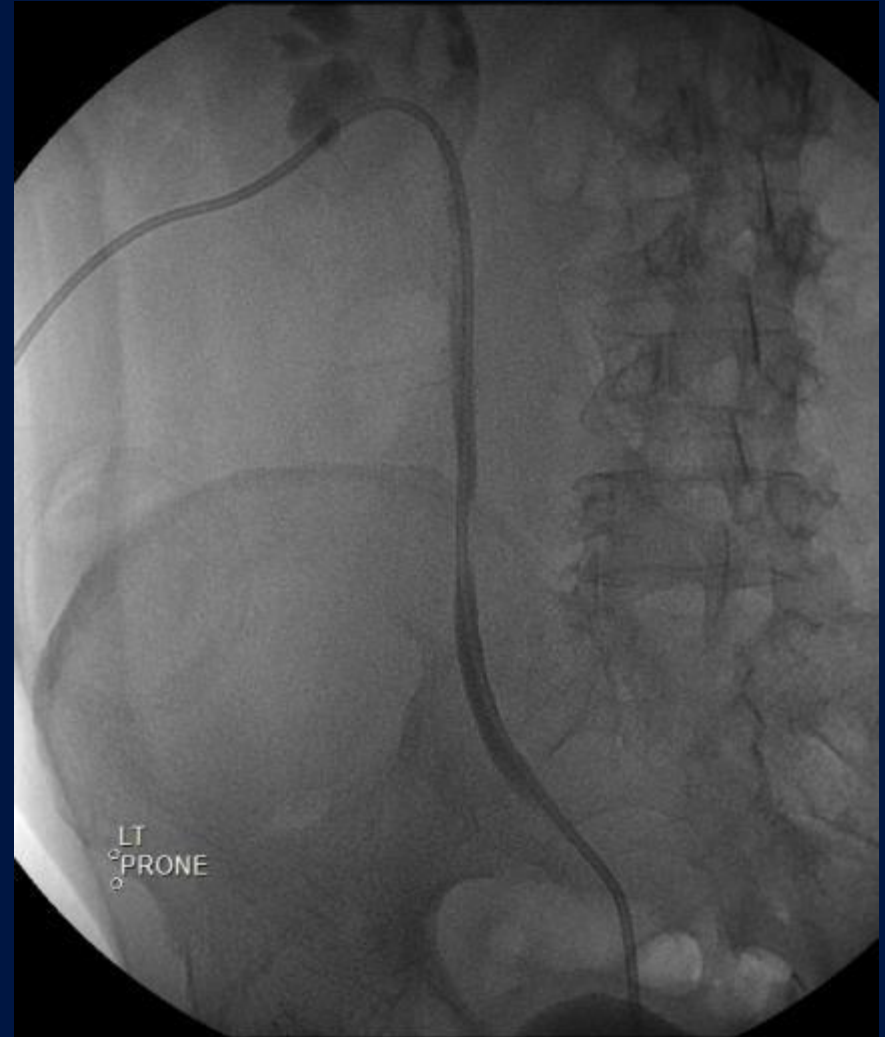
2. Perirenal/retroperitoneal hematoma
3. Clot within the collecting system
4. AV fistula, pseudoaneurysm
5. Infection (including sepsis)





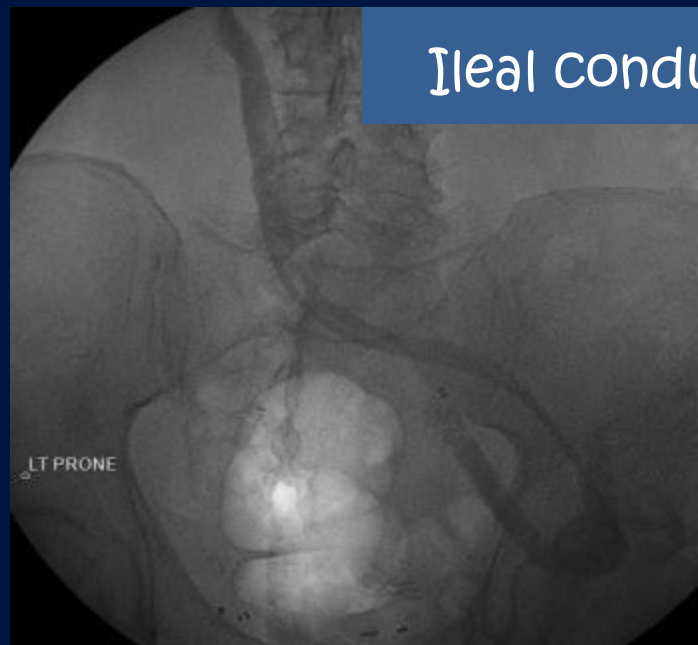


Hobbs Catheter (8 Fr)
Insertion through the
mid ureteric stenosis

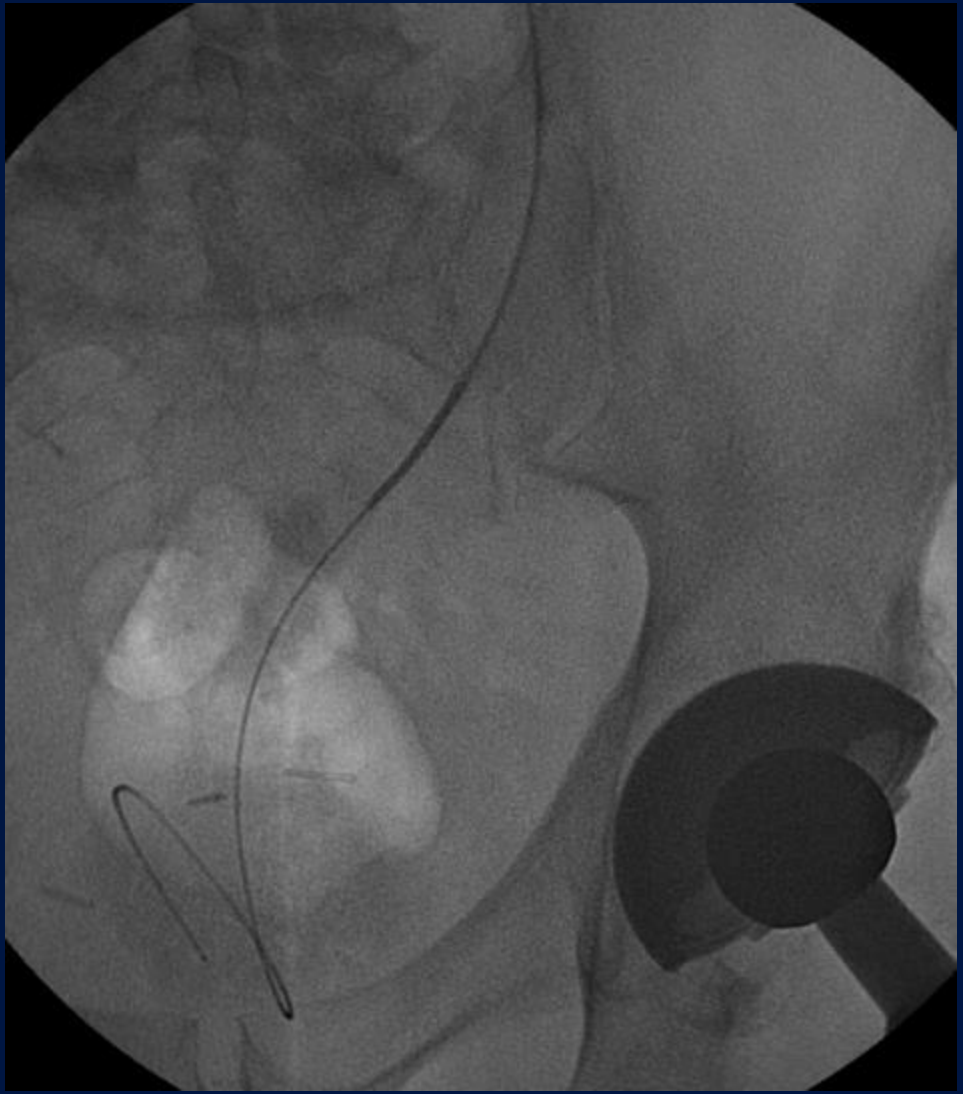


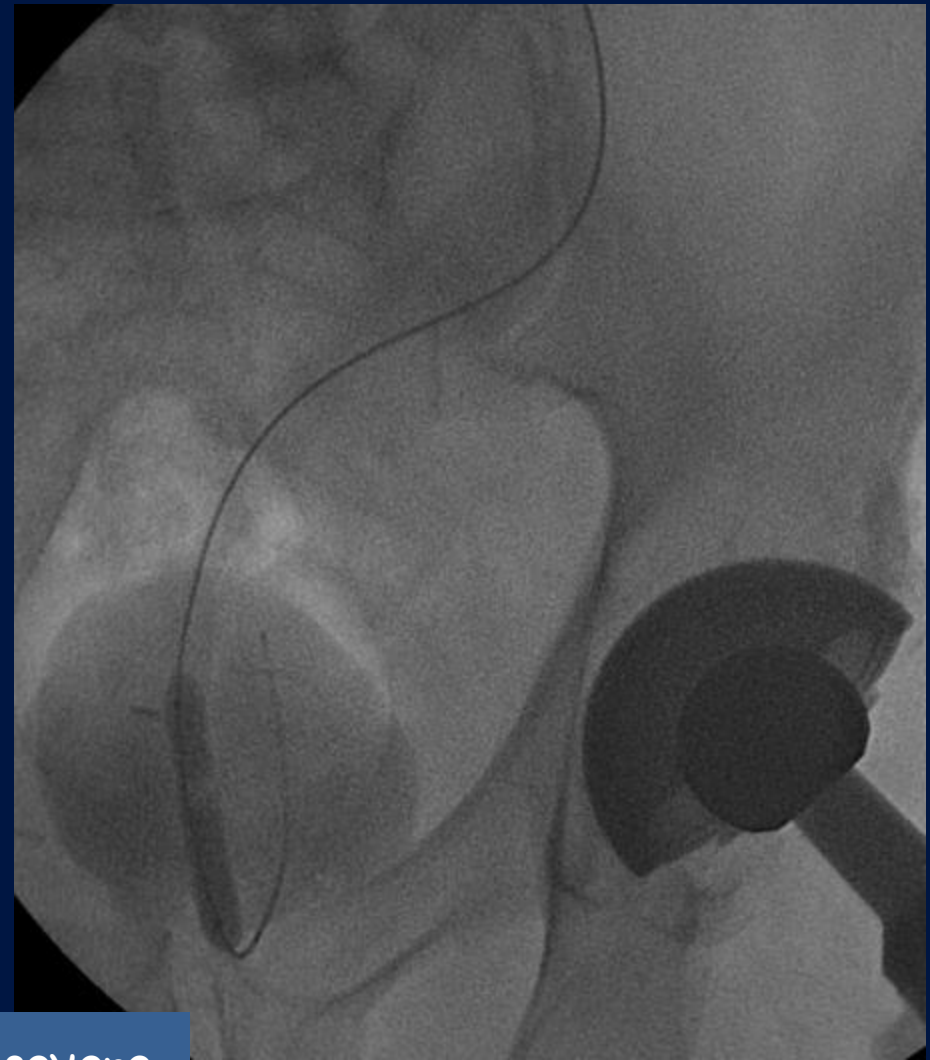
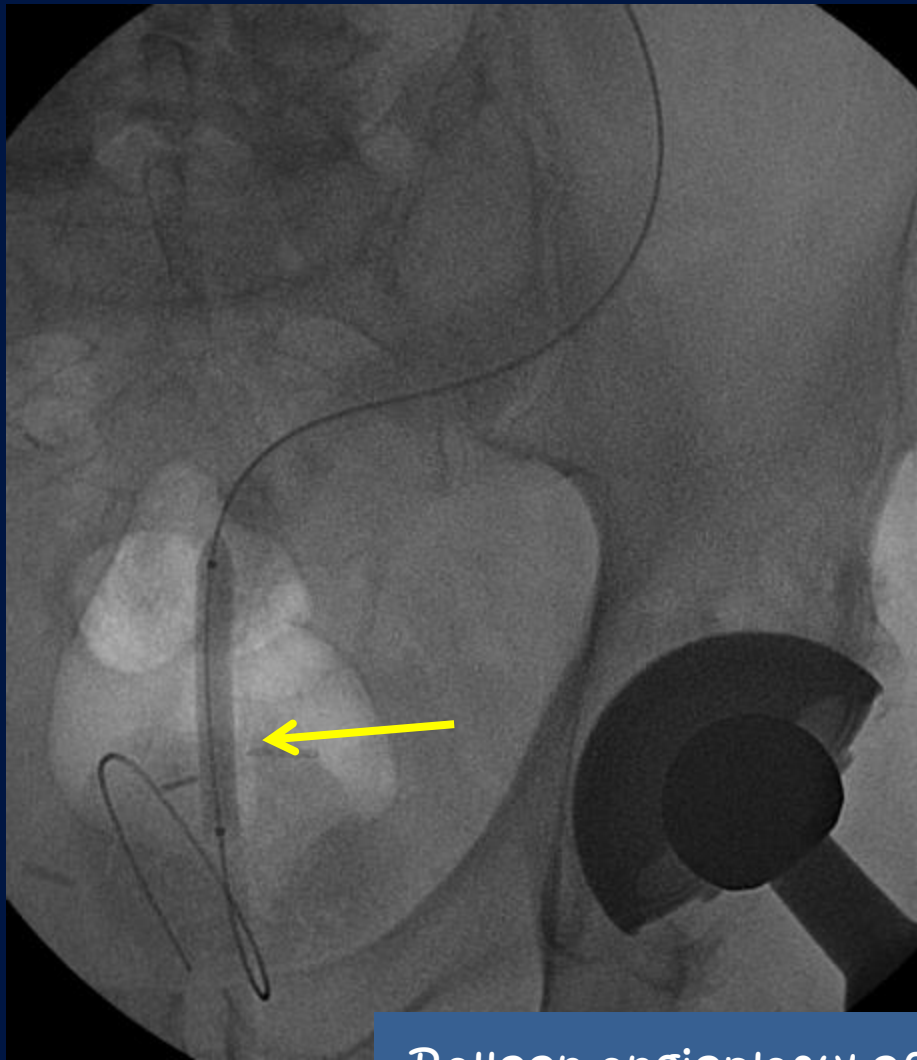


Bilateral 8 French
Hobbs catheters



Ileal conduit





Balloon angioplasty of severe stenosis of the distal ureter

