

Uroradiology For Medical Students

Lesson 8

Computerized Tomography – 2

American Urological Association

Objectives

- In this lesson you will:
 - Gain more experience reading CT images
 - Learn how computer generated reconstructions can give useful perspectives on CT scans
- Plus
 - You will learn about three more conditions for which CT imaging is useful. Ready for your next patient?

Case History

- 17 year-old female is referred to you for evaluation of gross hematuria. The urine was the color of tomato juice, and there were no clots. This is the first episode of gross hematuria she has had. No fevers. No history of trauma. No history of bleeding problems (epistaxis, petechiae, bleeding gums, etc.).
- Past History: Developmental delay, seizures. No hypertension.

Exam

- Thin female with obvious developmental delay. P = 110, BP = 102/72
- Head and neck: macular, erythematous areas on her cheeks and nose.
- Abdomen: both kidneys are enlarged (right > left), but not tender.
- Genitalia: normal
- U/A: 30 – 50 RBCs, 3 – 5 WBCs, - nitrites, Protein-30 mg/dl

XY I41.2
Im:25 +C

DFOV 28.0cm
3TND

Describe the kidneys

DEC 2, 1994
512

R
1
3
9

L
1
4
2

R

L

kV 120
mA 220

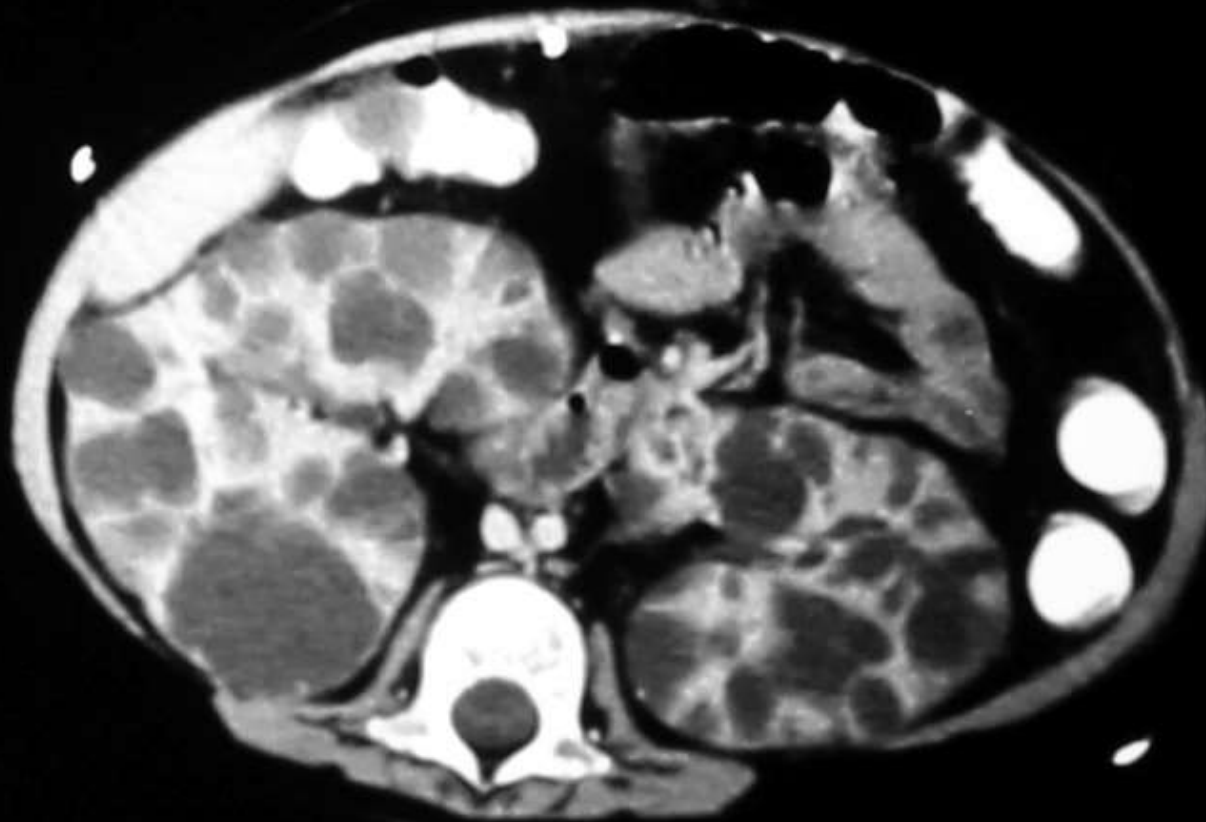
Large

5.0mm/1:1

Tilt 0.0

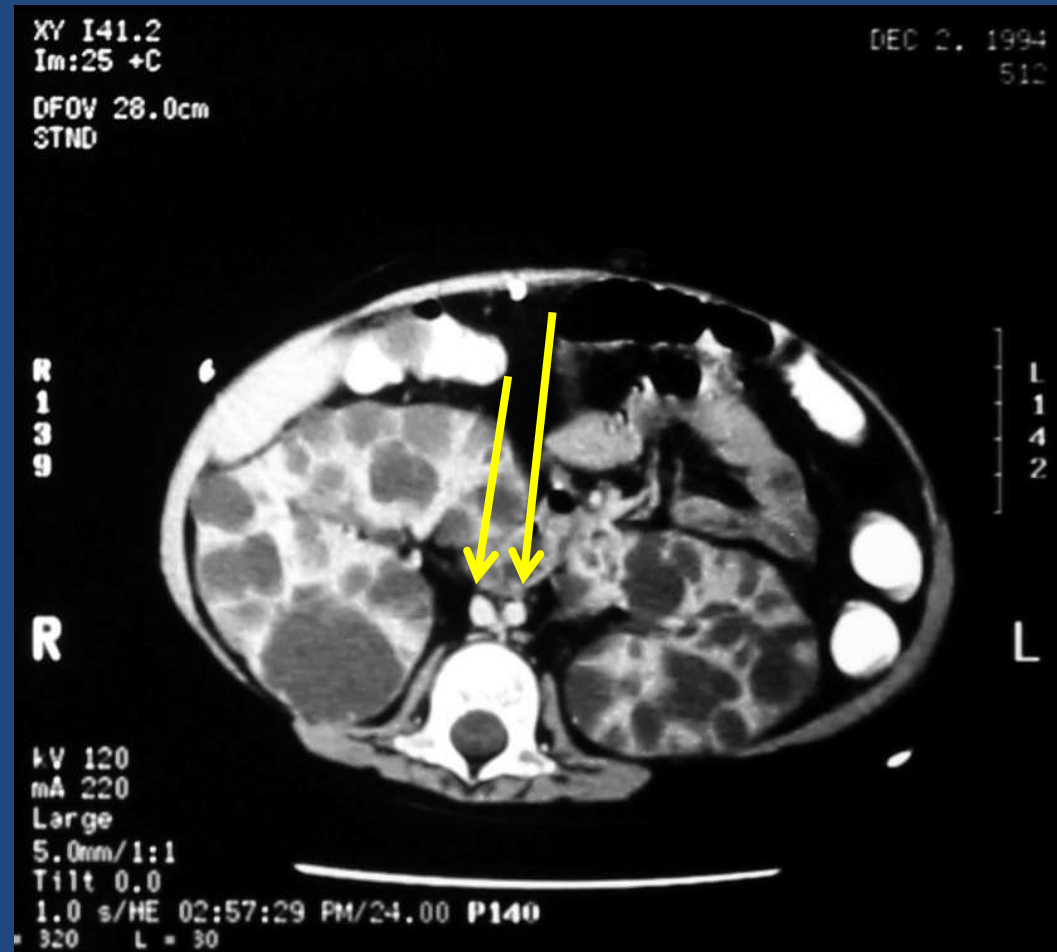
1.0 s/HE 02:57:29 PM/24.00 P140

* 320 L = 30



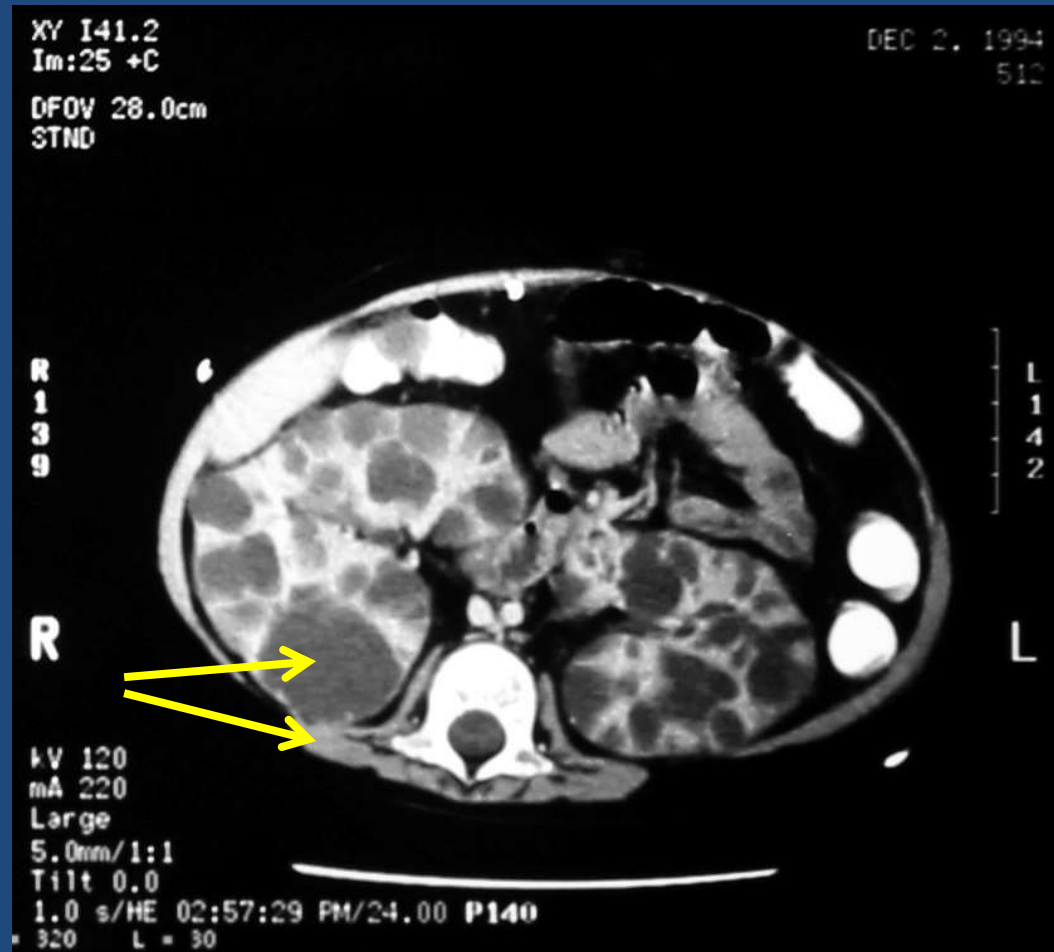
Describe the kidneys

- Contrast scan?
 - Yes, we see contrast in the iliac arteries just caudal to the aortic bifurcation.
 - No contrast is seen in the collecting system.
 - Both kidneys are very large. Note that the depth measurement of the right kidney is more than $\frac{1}{2}$ the depth of the entire body.



Describe the kidneys

- Renal parenchyma?
 - Some of the parenchyma shows contrast enhancement. Compare those enhancing regions with muscles of the back.
 - Other areas in both kidneys don't enhance at all; they are less radiodense than the adjacent muscle.
 - Use your densitometer to measure the Hounsfield number of those non-enhancing masses.



Describe the kidneys

- The CT technician reports that several areas of both kidneys measure -100 (the density of fat).
- Your diagnosis, doctor?
- These non-enhancing masses are benign tumors called angiomyolipomas. As the name implies, they contain fat, smooth muscle and vascular components. This patient has tuberous sclerosis.



Case Review Angiomyolipoma (AML)

- These tumors can be multifocal and bilateral (usually in patients with tuberous sclerosis) or solitary lesions.
- As they grow, the risk of spontaneous hemorrhage increases. This can be life threatening. Vascular embolization is recommended for AMLs > 4 cm.

Case History

- 55-year-old white male with hypertension
- Past history: nothing remarkable
- Family history: “kidney problems in 2 of my sisters, my dad and two of his siblings”
- Exam: P=84, BP=165/95
 - Abdomen: Large masses in both upper quadrants
- U/A: 0 RBCs, 0 WBCs, Protein >200 mg/dl
- BUN = 46 mg/dl, Creatinine = 4.6 mg/dl
- His referring physician sent a CT scan on disk.

Describe the kidneys

Size:

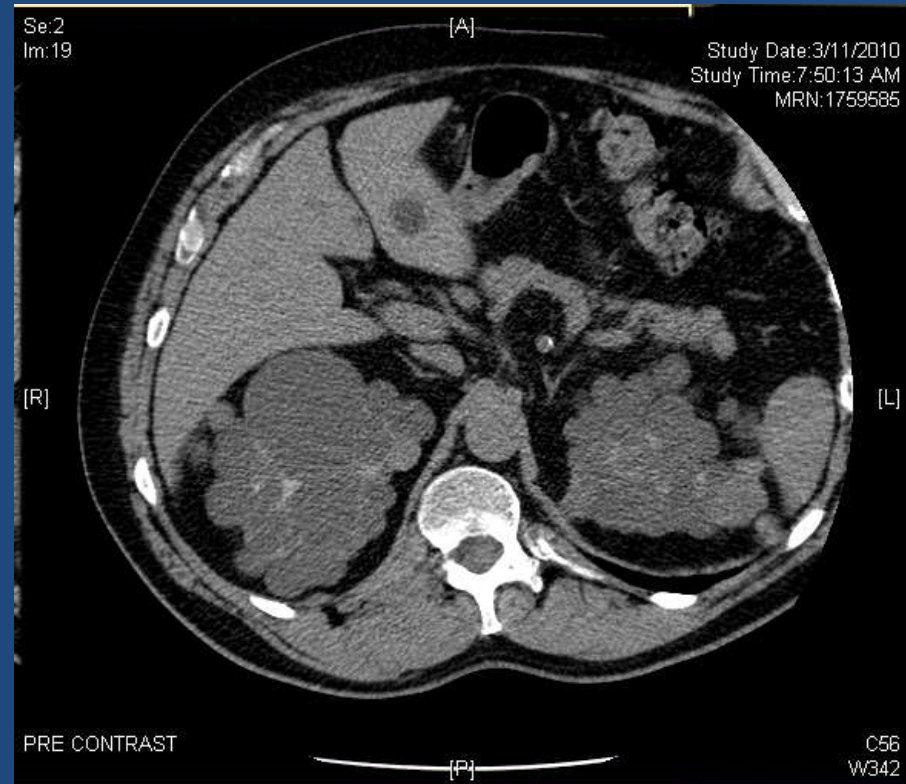
The kidneys are large, almost double normal size on the right.

What about the parenchyma?

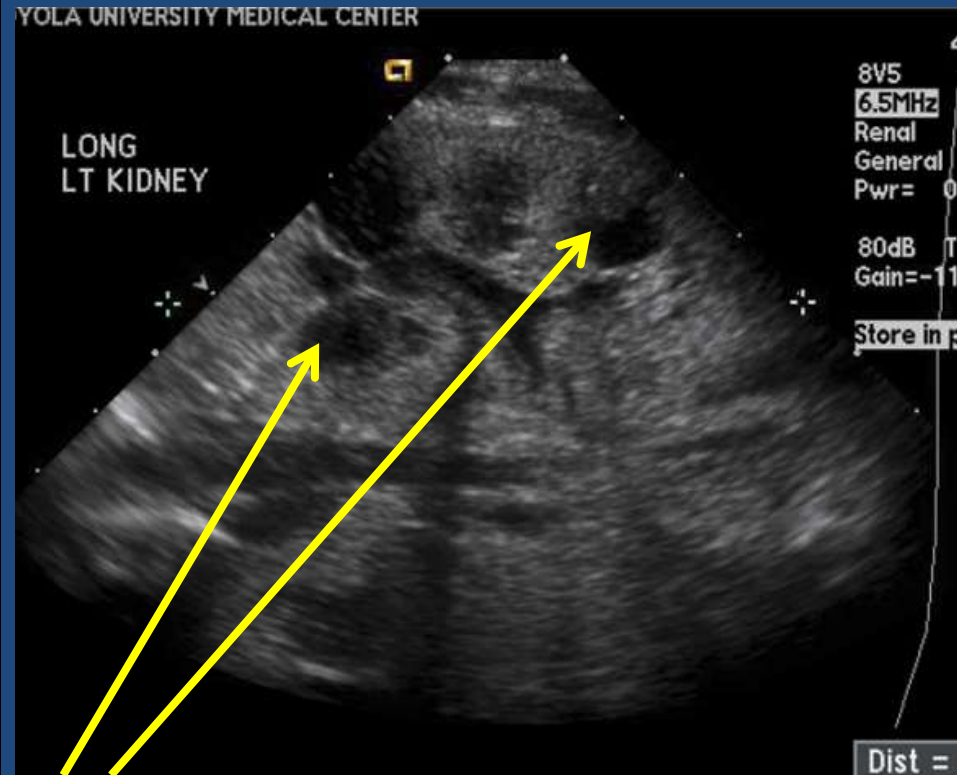
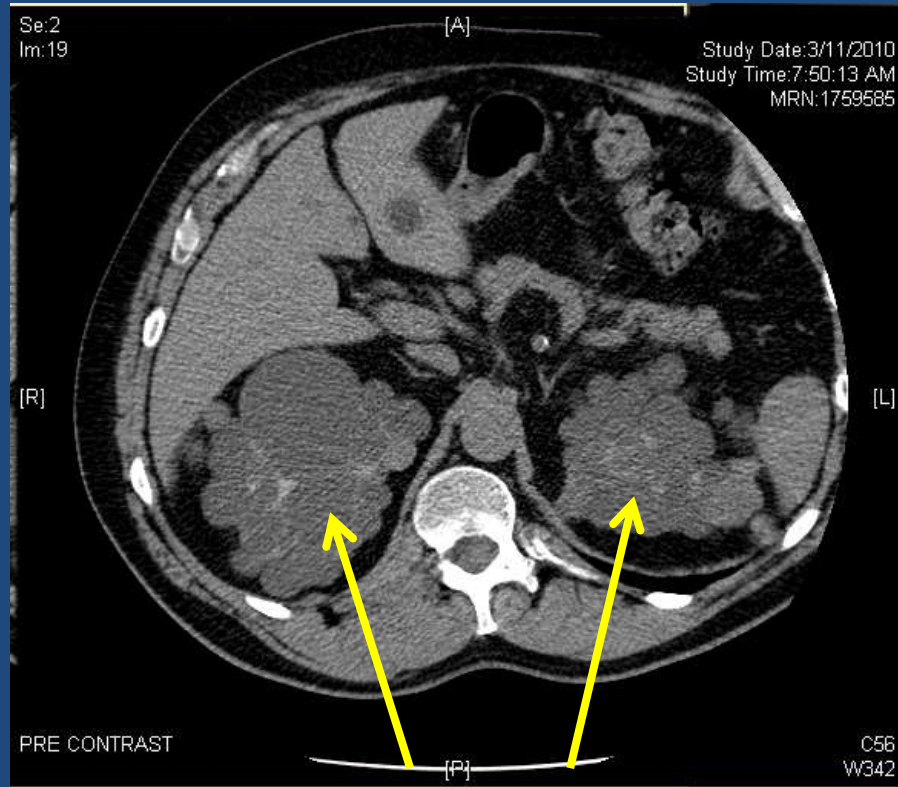
The kidneys have many cysts of varying size that have replaced normal parenchyma.

How do you know these are cysts?

They are round with uniform radiodensity consistent with water. Remember, cysts are sonolucent on ultrasound, but of interdediate radiodensity on CT (Hounsfield # 0).



Compare the appearance of cystic kidneys on your patient's CT scan with an ultrasound of his younger sister.



Note that the cystic areas are sonolucent (ultrasound), but moderately radiodense on CT scan.

We don't see much parenchyma. No wonder his creatinine is elevated. Two of his five siblings also have this condition. Your diagnosis?

Polycystic Kidney Disease

- This hereditary (autosomal dominant) condition causes cysts to form, gradually replacing functional parenchyma. About one half of those with the disease will go on to renal failure. Unlike multi-cystic dysplastic kidney disease, polycystic disease affects both kidneys, usually causing symptoms in the fourth to fifth decade.

Case History

- The 36-year-old cousin of your previous patient comes to your office asking if she can donate a kidney to him.
- Past history: negative (genetic test negative for polycystic kidneys)
 - Exam: healthy female
 - P=76, BP=104/68
 - Abdomen, chest, heart, etc. all normal
- Before surgery we need to know if her renal vessels are suitable for donation. CT can help.

3-D CT Angiography

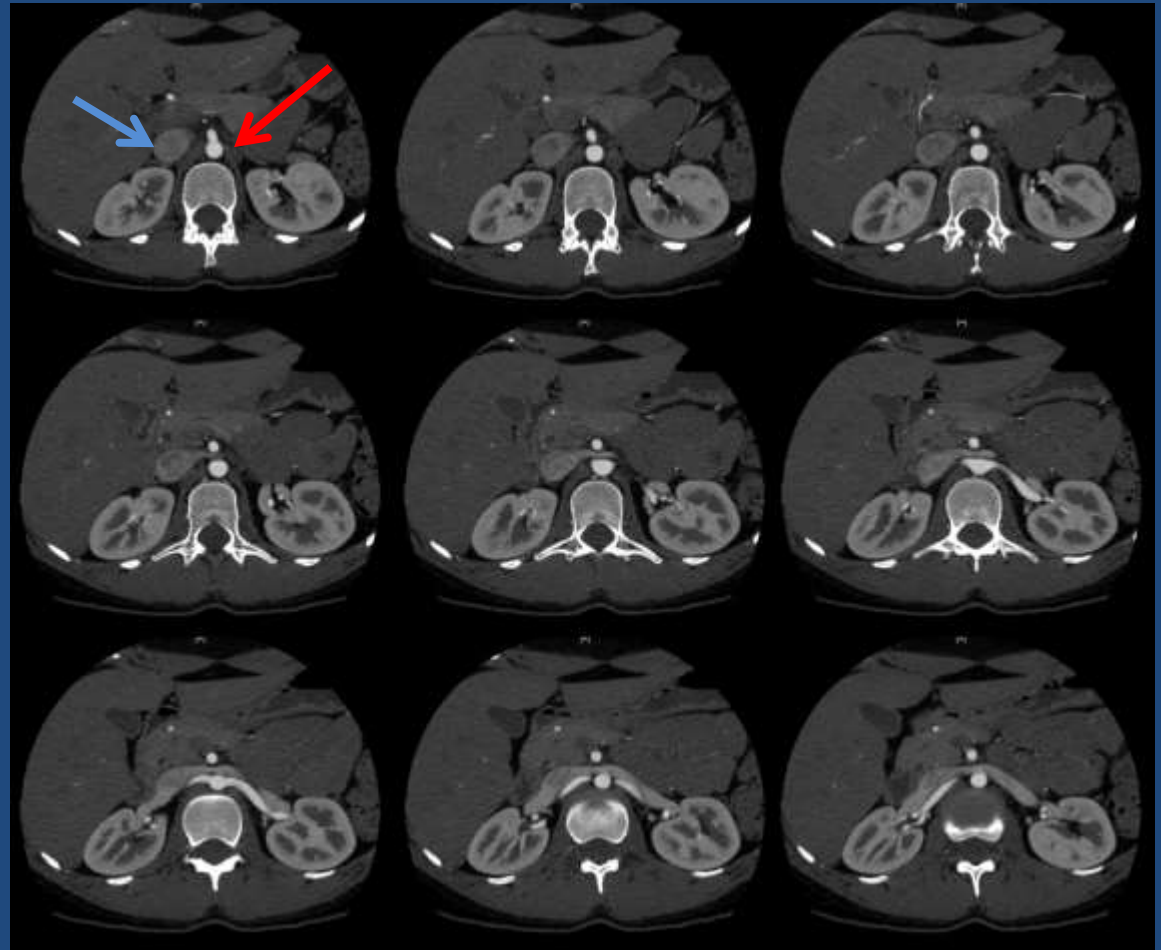
- In order to show the vessels, images are taken with intravenous contrast in early phase, and the slices are very thin (3 mm). In addition, the images are focused on the vessels; they don't show the entire abdomen.
- Once the scan is complete, the computer constructs images from various perspectives. Let's start with axial images.

Here's your potential kidney donor's scan.

This is an early phase CT. Find the aorta.
Note that the aorta is highly radiodense.

Find the vena cava.
Note how close it is to the right kidney. The right renal vein is shorter than the left.

Look at the lower image frames.

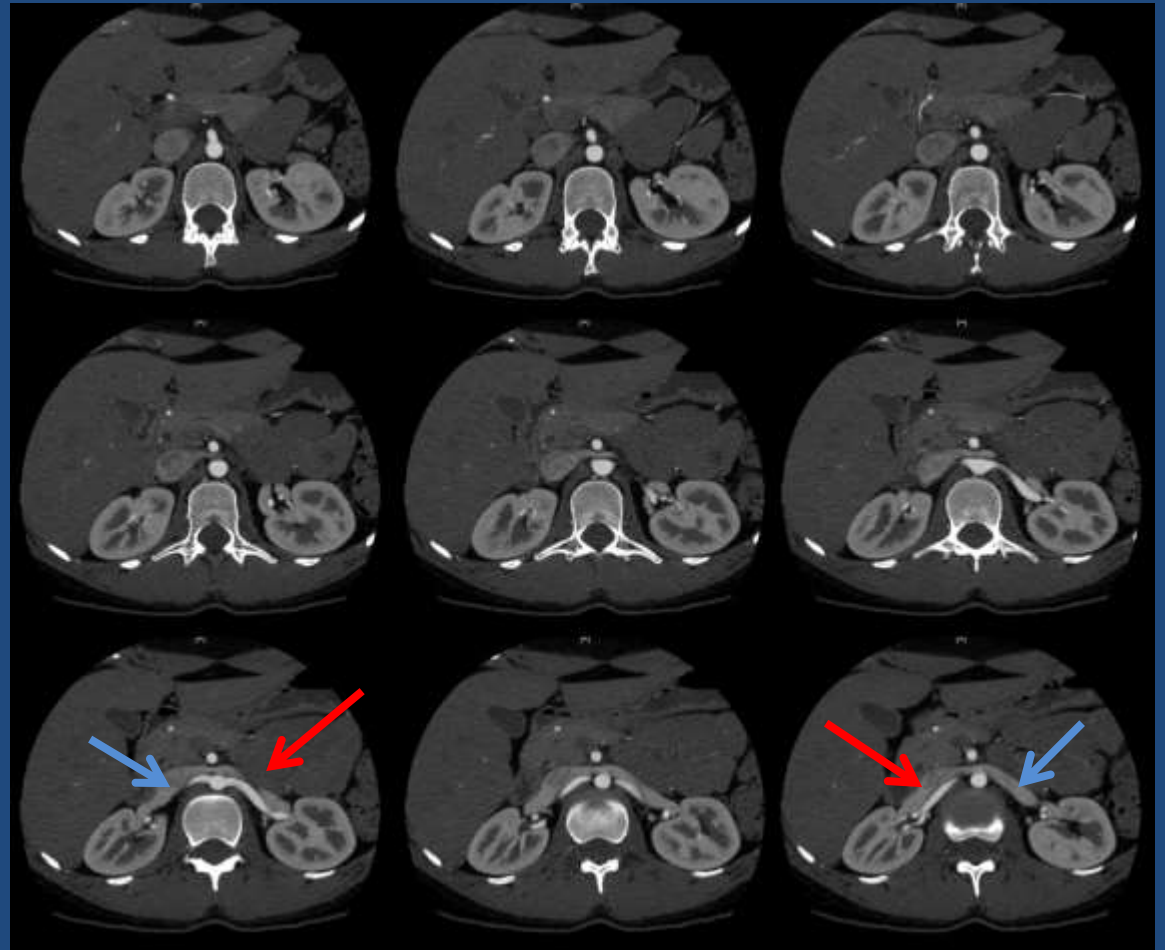


Kidney donor's 3-D CT scan

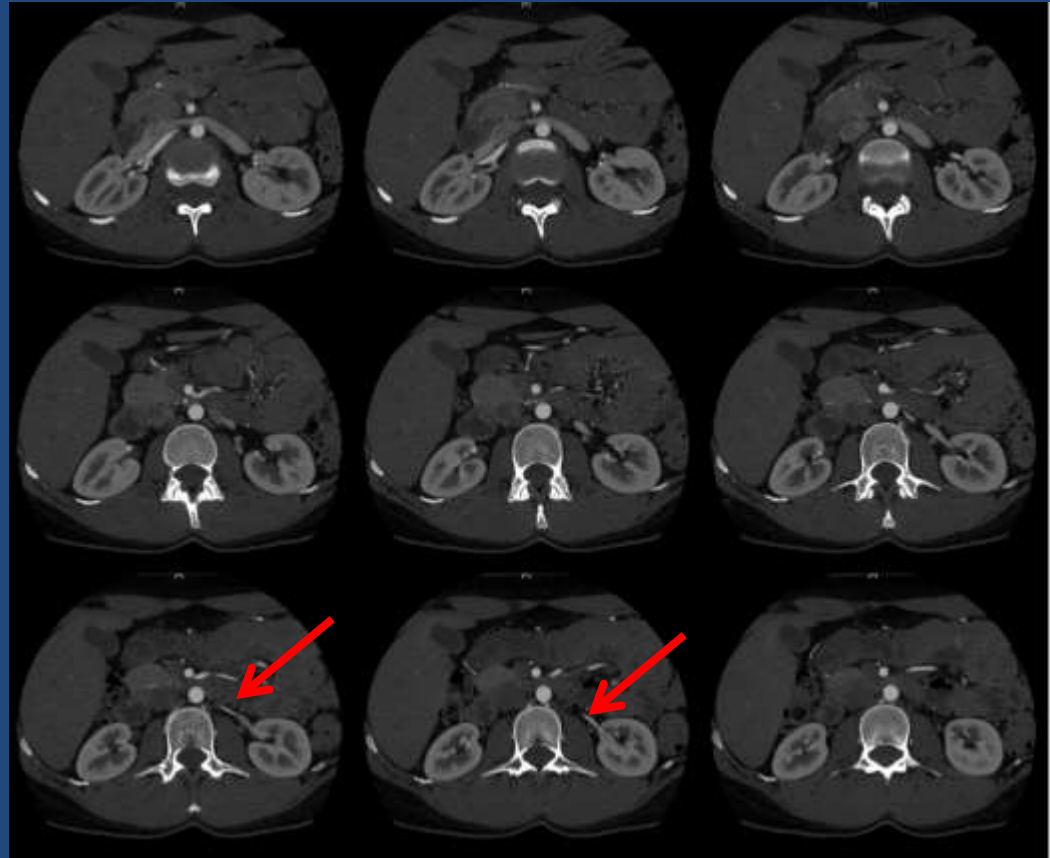
Follow the image frames from cephalad down until you see branching vessels.

Renal artery

Renal vein



- Follow the images down.
- See any other vessels?
- There is a second renal artery on the left.
Although it's possible to transplant a kidney with two arteries, using a kidney with one artery is simpler because only one arterial anastomosis is needed.



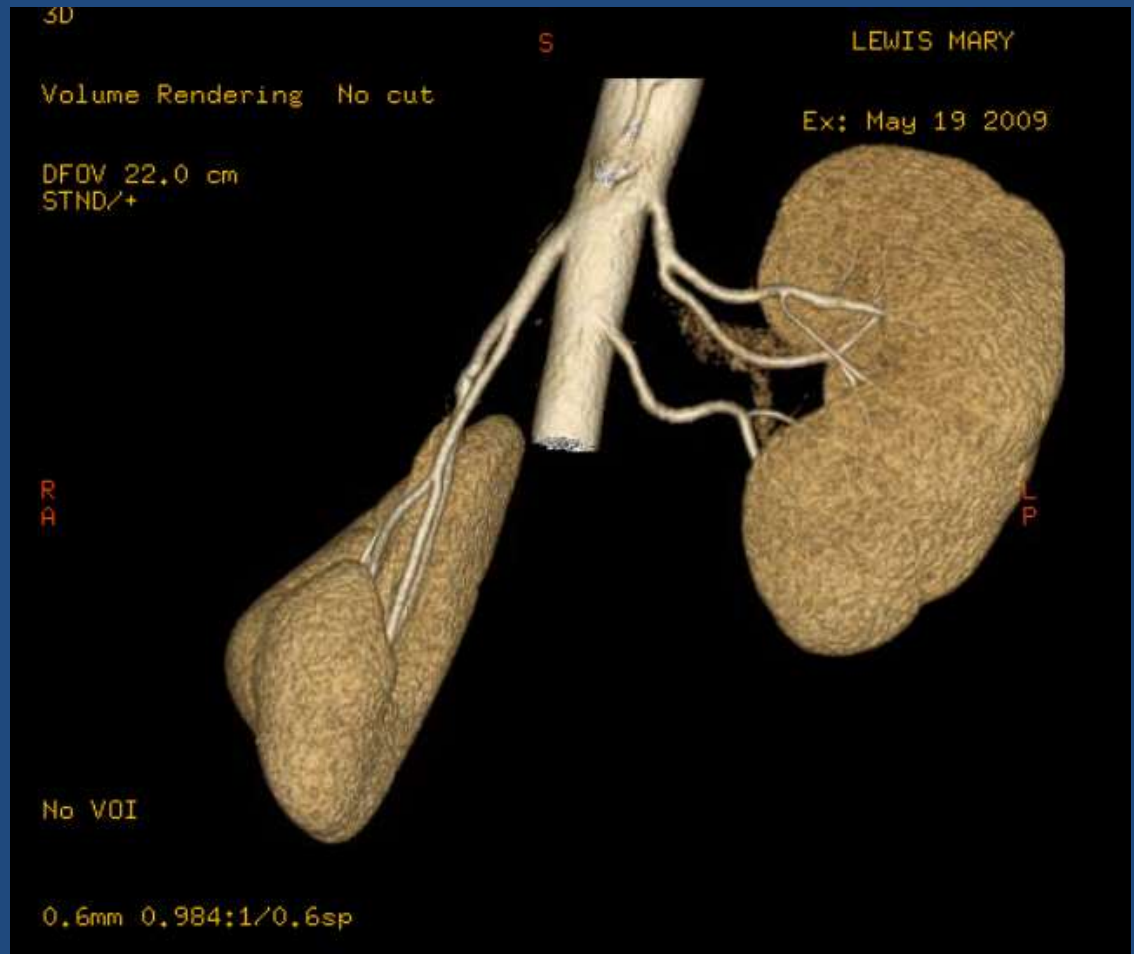
CT Reconstruction in 2D

Once the scanning is complete, the computer can reconstruct images in various planes and perspectives. Note how easy it is to see the lower pole artery on this 2-D image that visually isolates the left kidney.



CT Reconstruction in 3D

This 3-D reconstruction gives another perspective. Remember that a renal artery supplies only one area of the kidney. If the lower pole artery isn't reconnected to an artery at transplantation, the lower pole of the kidney will be lost due to ischemia.



Case Review

- You remove the right kidney. The transplanted kidney functions perfectly. The man is freed from dialysis. The grateful family plants a tree in your name at a local arboretum.
- 3-D CT is an effective imaging technique to demonstrate vascular anatomy, useful for:
 - Donor nephrectomy
 - Partial nephrectomy
 - Renal artery stenosis

CT Scan Summary

- Autosomal dominant polycystic kidney disease causes gradual replacement of normal renal parenchyma with cysts of varying size. Symptoms usually start in the 4th to 5th decade. Renal failure occurs in about half of affected patients.
- 3-D CT effectively demonstrates vascular anatomy in organ donors, patients undergoing partial nephrectomy and those with renal artery stenosis.

CT Scan Summary

- Angiomyolipoma is a benign neoplasm occurring singly or with multifocal tumors. Multifocal AML occurs in patients with tuberous sclerosis. AML is accurately detected on CT by measuring the radiodensity (Hounsfield number -100 consistent with fat). AMLs > 4cm are at risk for spontaneous hemorrhage and are effectively managed with embolization.