

Uroradiology For Medical Students

Lesson 6

Nuclear Renography – Part 2

American Urological Association

Nuclear Renography - Review

- Nuclear renography gives a very accurate representation of the function and drainage of the kidneys.
- 3 Classes of radionuclides
 - Filtered – shows perfusion and drainage
 - Excreted – shows tubular excretion
 - Cortical imaging – shows renal mass
- 3 Panels of nuclear renogram
 - Perfusion
 - Excretion / drainage
 - Analysis / curves

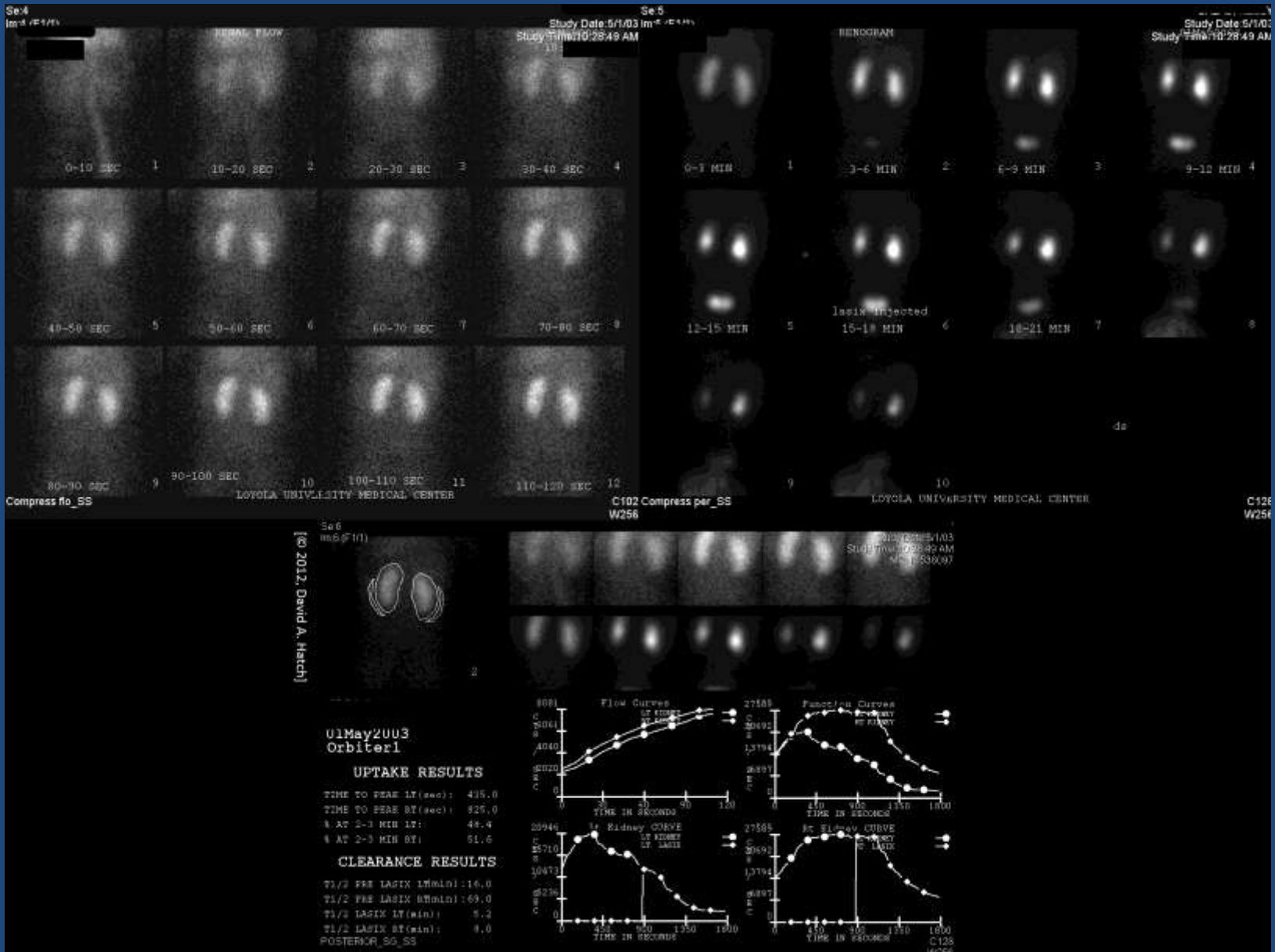
Objectives

- In this lesson we will sharpen your reading skills by showing you individual images from nuclear medicine studies. This means that we're not always going to give you a history. Don't panic. Just remember what you've learned about the three radionuclide classes and the three panels of a renogram.

Case History

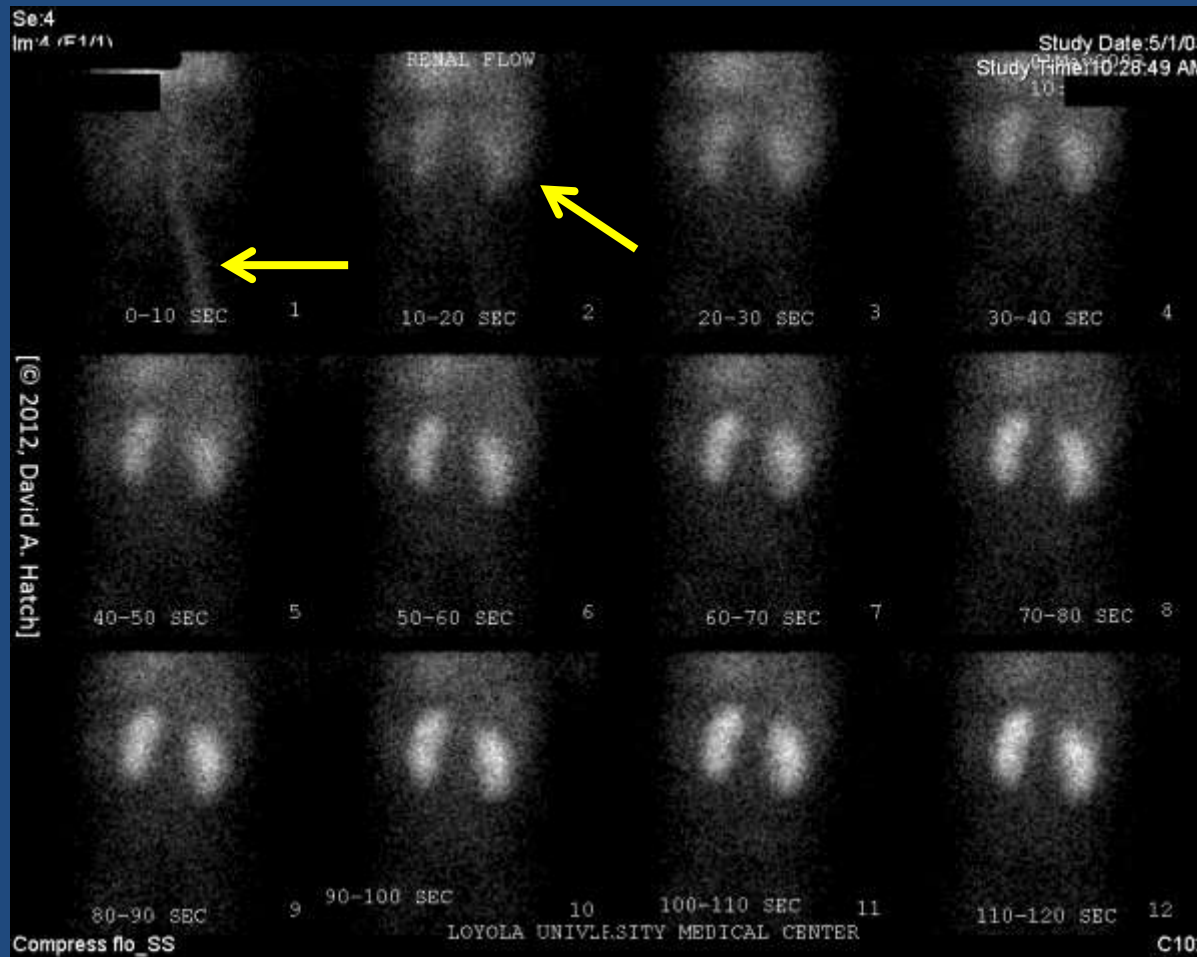
- A 6-week-old male with a history of prenatal hydronephrosis is sent to your clinic. But for the hydronephrosis, his history and exam are normal.
- A post-natal ultrasound showed Grade III hydronephrosis on the right.
- His pediatrician ordered a lasix renogram. Which radionuclide class should be used for the scan?
- A filtered radionuclide is used.

Read this lasix renogram (filtered radionuclide)



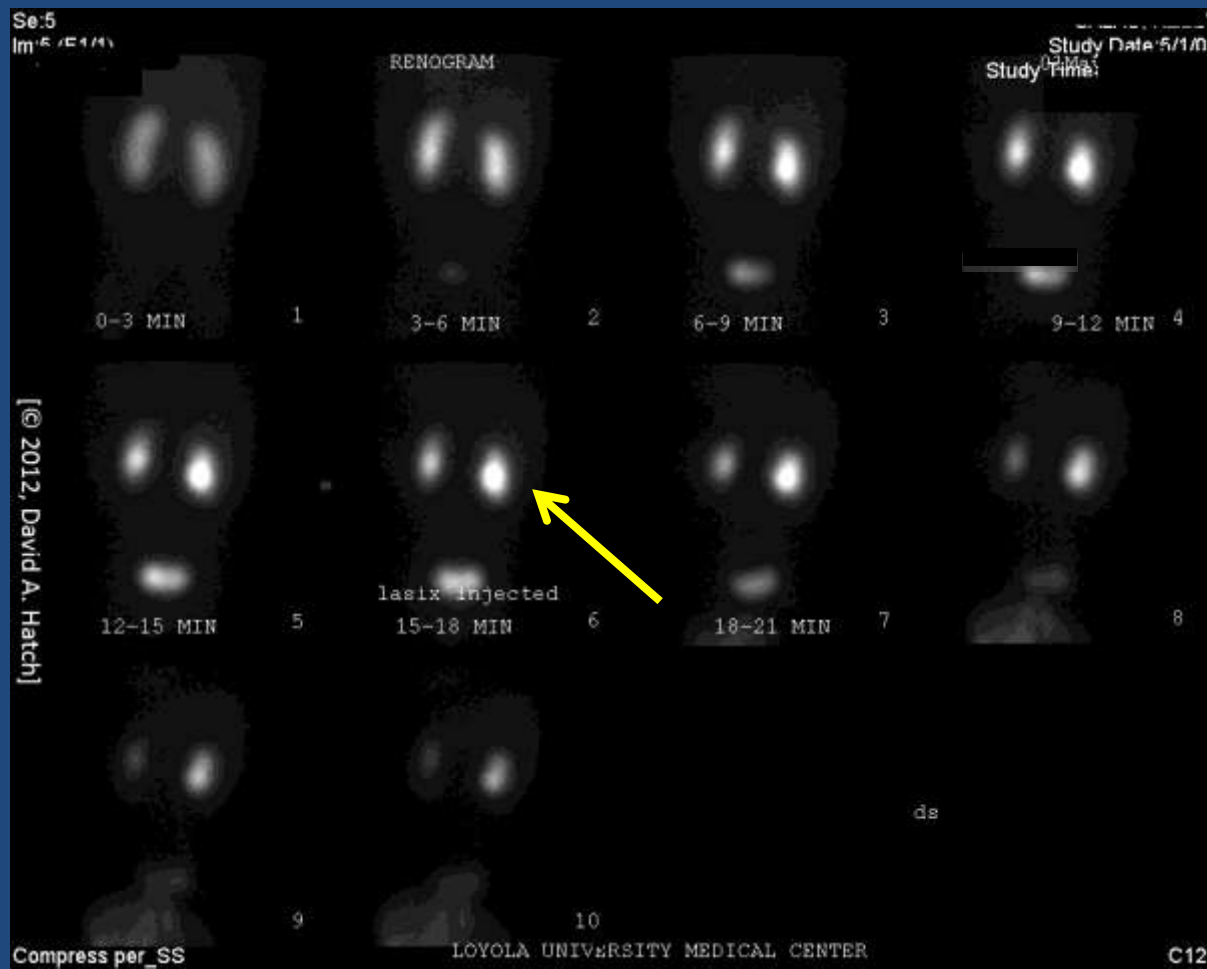
Your Interpretation, Doctor?

- Perfusion phase panel
 - Prompt and equal perfusion is seen in both kidneys within one frame of the great vessels.



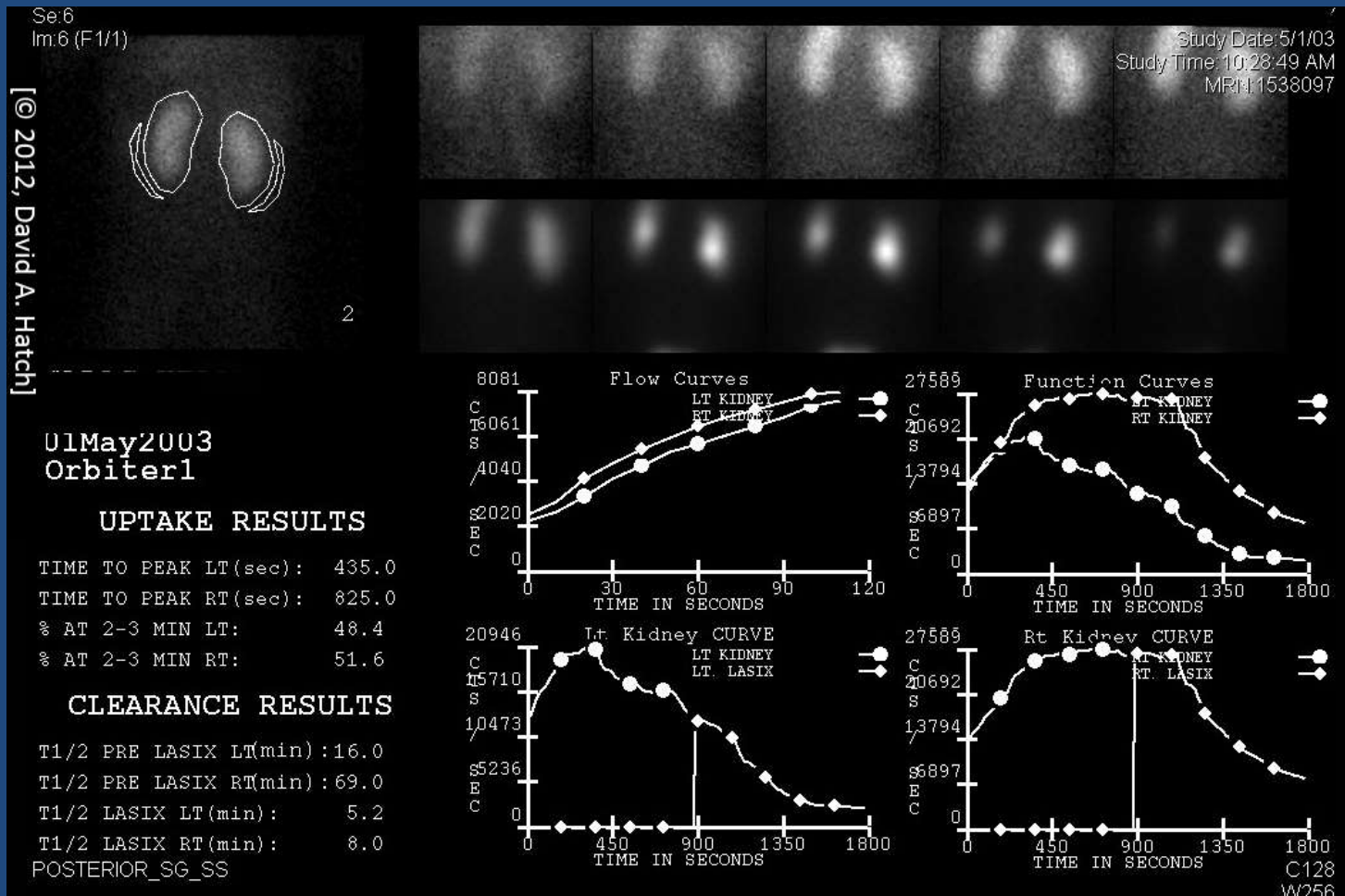
Your Interpretation, Doctor?

- Drainage phase panel
 - The left kidney drains faster, but the right kidney shows drainage, especially after lasix is given at 15 – 18 minutes (arrow).



Your Interpretation, Doctor?

- Curves / analysis
 - Half times: Right T $\frac{1}{2}$ = 9.0 min., Left T $\frac{1}{2}$ = 5.6 min.
 - The curves confirm slower, but normal drainage on the right.



Case Summary

- This boy has right hydronephrosis, but normal and equal perfusion to both kidneys.
- Although the right kidney drainage is slower than that of the left, it is still within the normal range.
- The nuclear scan shows that there is no significant obstruction on the right.

Case History

- A 6-year-old girl is referred for consultation after suffering several urinary tract infections. She has no other significant medical history.
- Exam: Healthy female. BP=92/64. Abdomen and genitalia are completely normal.
- An ultrasound showed right duplication with a ureterocele.
- VCUG showed duplication on the right with reflux into the lower pole ureter. You can learn more about reflux, duplication and ureterocele in AUA lessons 1 & 2- Ultrasound and 3 & 4-Cystography. Let's review her anatomy. Watch carefully. This is a bit complicated.

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Renal
Ultrasound

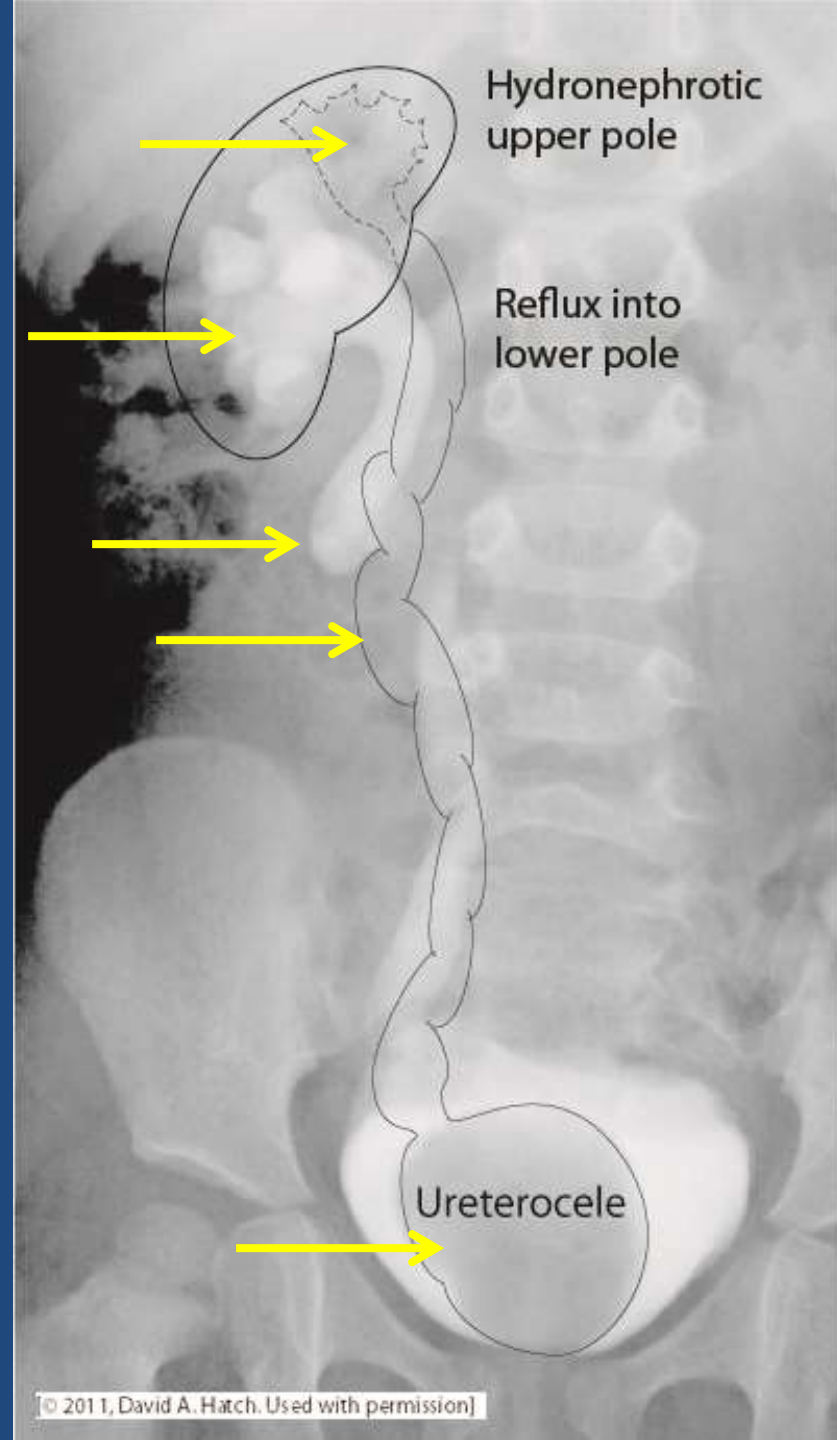
VCUG



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Right Kidney

- This voiding cystourethrogram shows reflux into the lower pole ureter.
- The upper pole collecting system doesn't appear on this study because there is no reflux into the upper pole ureter or the ureterocele. No contrast enters the upper pole system.

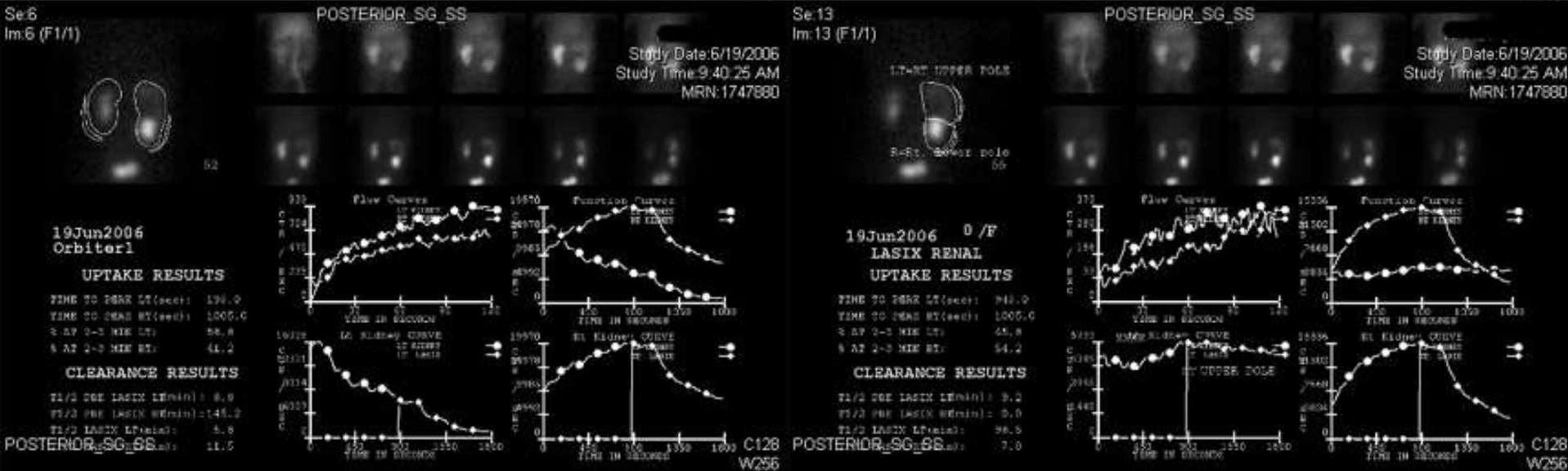
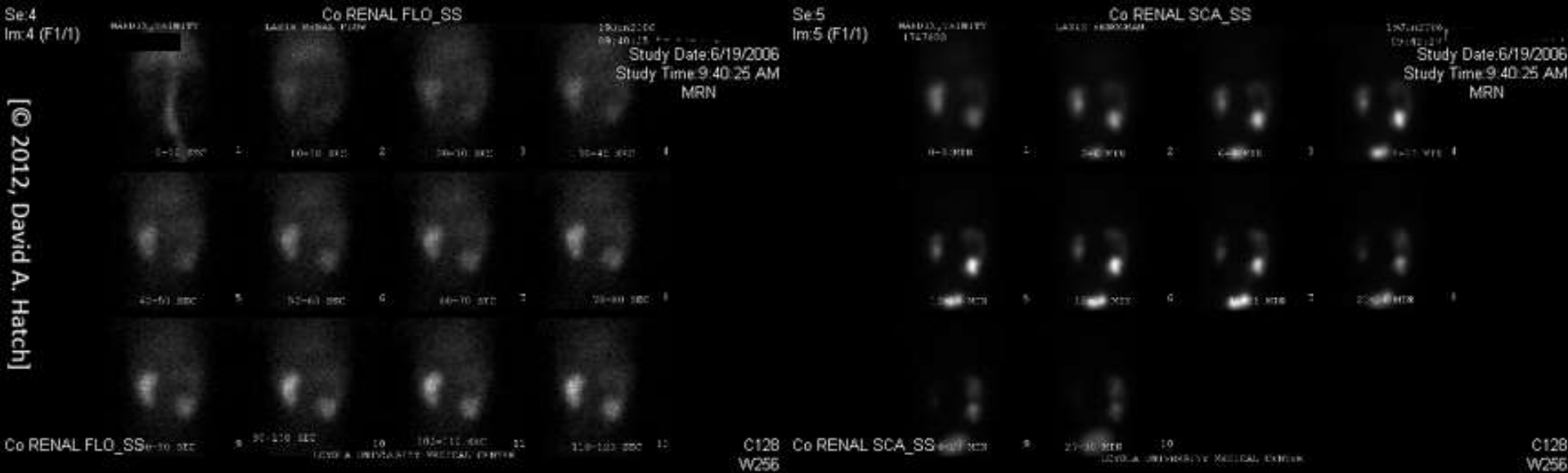


The best management of this patient depends on the function of the upper pole of the right kidney. If the upper pole of the right kidney has significant function, surgery to relieve the obstruction would be appropriate. However, if the upper pole has minimal or no function, the patient may better be served by removing the upper pole and its ureter. A nuclear renal scan can determine how much function the right upper pole has.

Ureterocele / Duplication

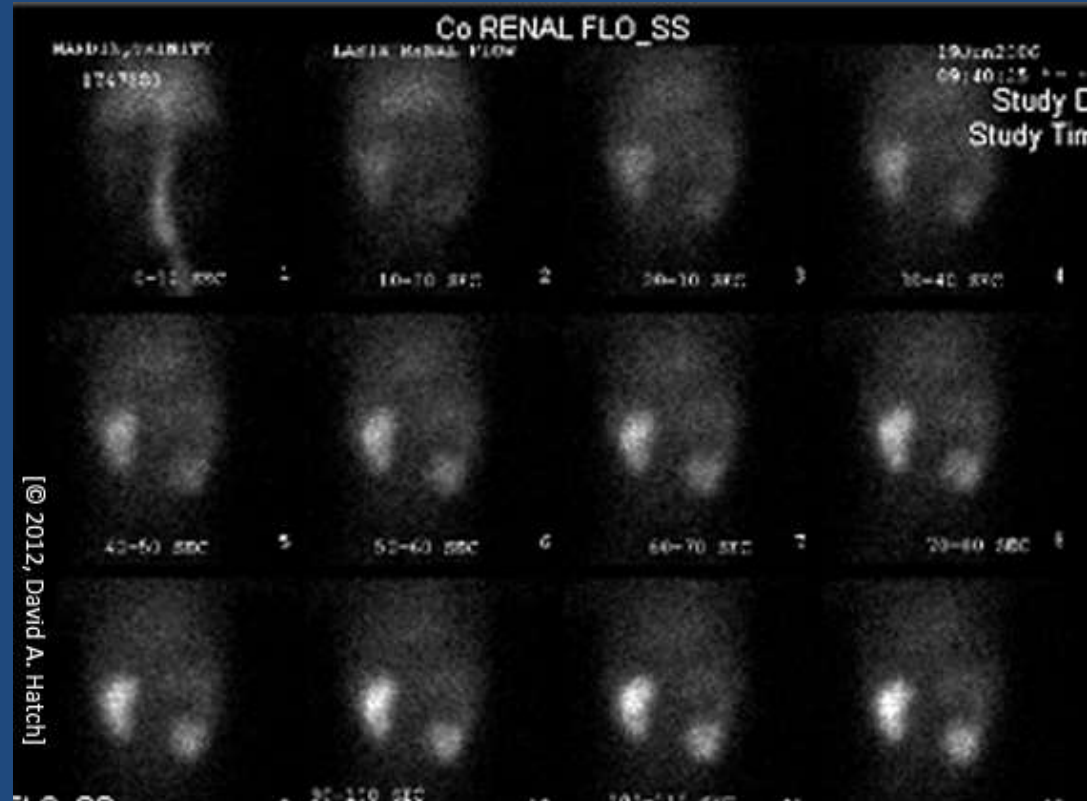
- What radionuclide would you use to demonstrate function of the upper pole?
 - Filtered radionuclide
 - Excreted radionuclide
 - Cortical imaging radionuclide
- Both filtered and excreted radionuclides demonstrate renal function. Actually, any of the three radionuclides could be used in this patient.

For this renal scan we chose a filtered radionuclide (DTPA)



Read the scan

- Perfusion
 - Both kidneys show uptake.
 - The left kidney appears normal.
 - The right kidney appears to be smaller and more caudal in location than the left.
 - Uptake is delayed and lower on the right than the left.



Drainage / function panel

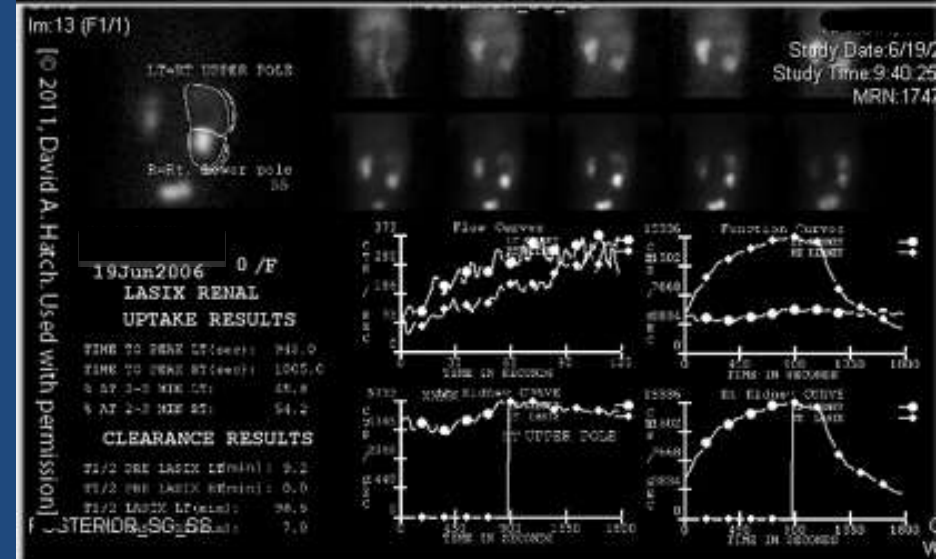
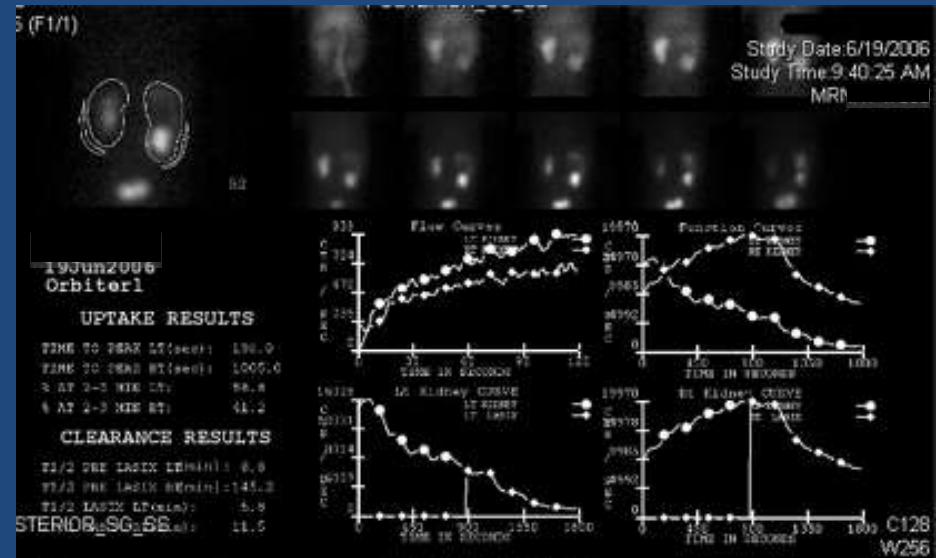
Both kidneys show uptake.
The right kidney is smaller and it has less function than the left.
Drainage of right upper pole is difficult to assess because there is little renal function.



Curves / Analysis Panel

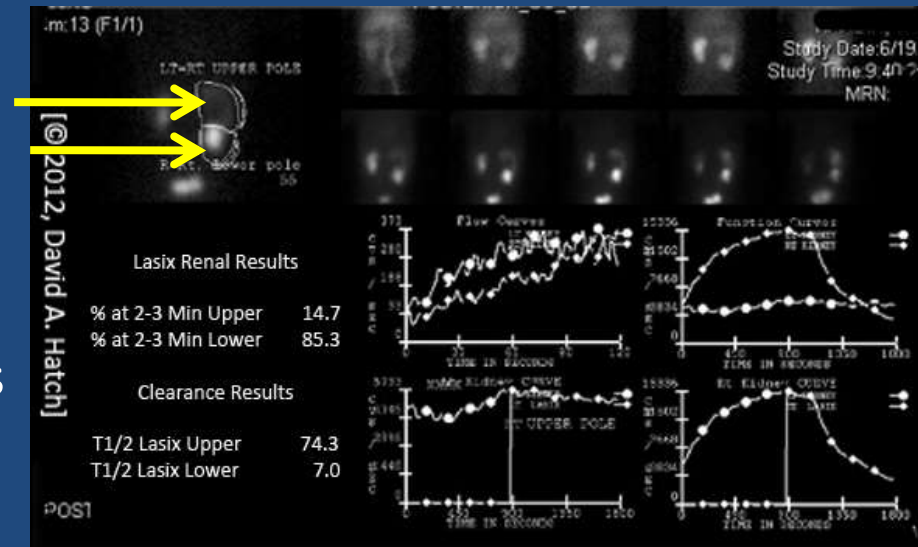
This scan is more complicated than the ones we have read because there are two separate collecting systems in the right kidney. In order to define the function of both collecting systems the area of interest must be defined.

The upper panel shows function as analyzed by considering each kidney as a whole. The lower panel shows function compared between the right upper pole and lower pole. Notice the difference in the area of interest between the two panels.



Let's concentrate on the right kidney

In this panel, one area of interest is drawn around the right upper pole and another around the right lower pole. The lower pole region shows good uptake and somewhat slow, but appropriate drainage. The peak of the curve is somewhat prolonged compared to other scans, but the kidney drains over 50% of its activity before the end of the study. The upper pole region shows minimal function (14.7% of the total).

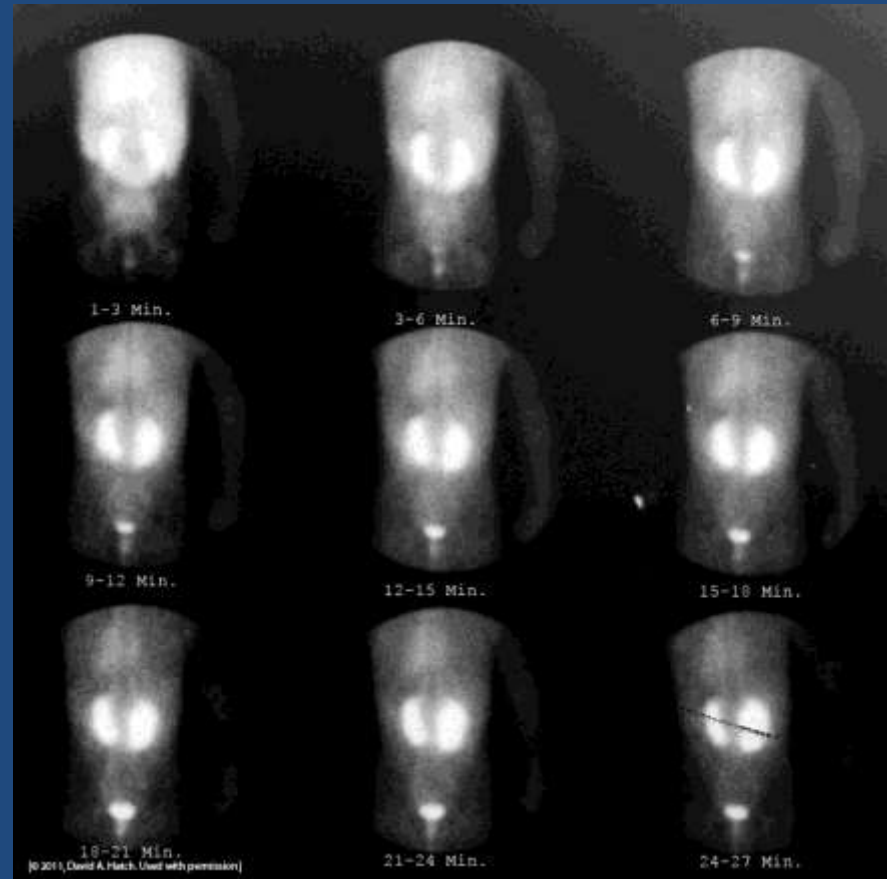


Case Summary

The nuclear renogram shows that the upper pole of the right kidney has minimal function. Neither ultrasound nor cystography could give you that important information. You perform an upper pole partial nephrectomy. She has no further urine infections, and health insurance companies now are willing to cover the child. Her parents are so grateful that they offer to sponsor you on a medical mission to Viet Nam.

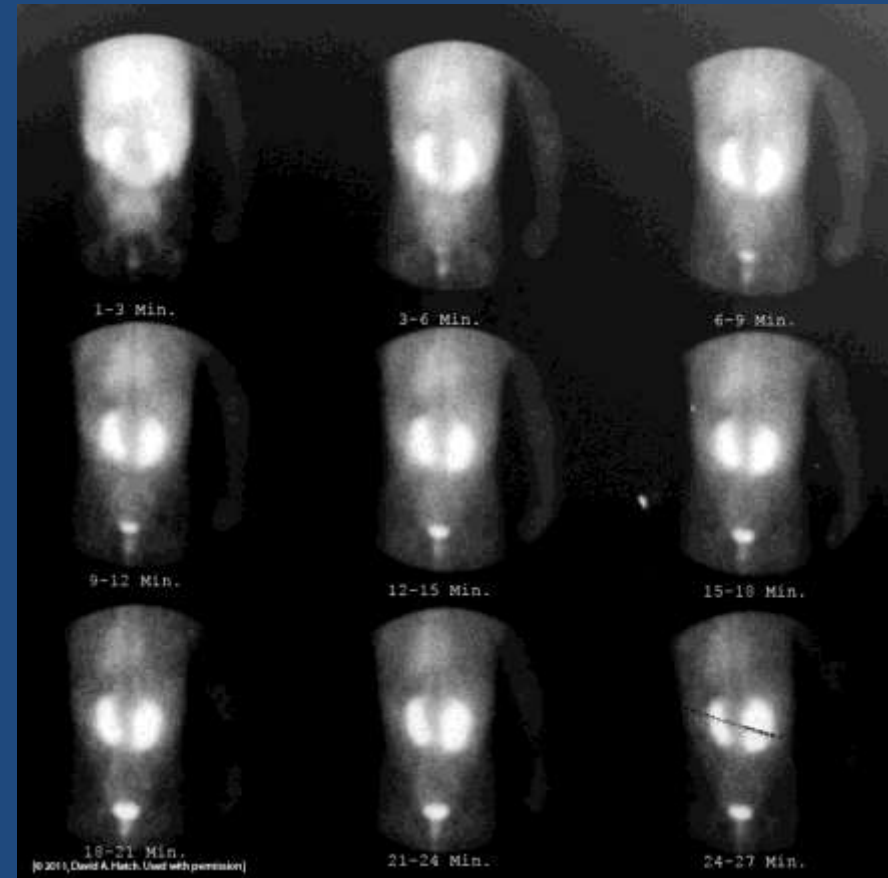
DTPA Scan

An 8-year-old boy had cramping pain in the region of the umbilicus. His pediatrician ordered an ultrasound which showed bilateral grade III hydronephrosis. This DTPA renal scan was ordered.



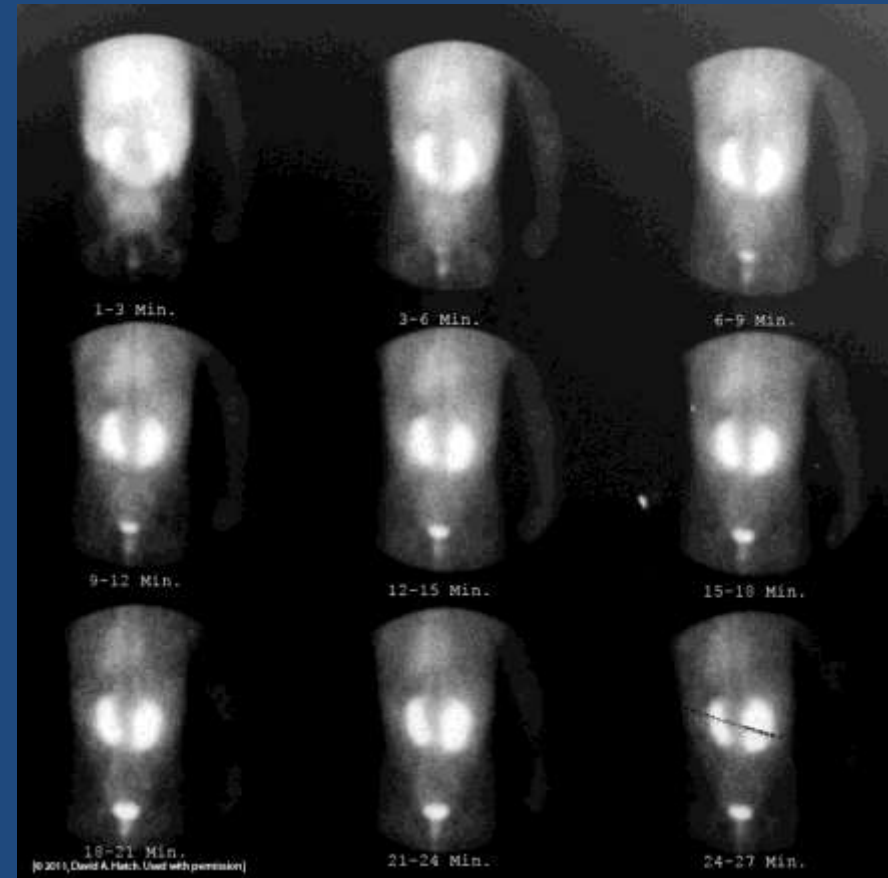
Read the Scan

- Which panel are you looking at?
 - Perfusion
 - Function / drainage ←
 - Notice that the time intervals are 3 minutes so this must be the function/drainage panel. What else do you notice about this scan?



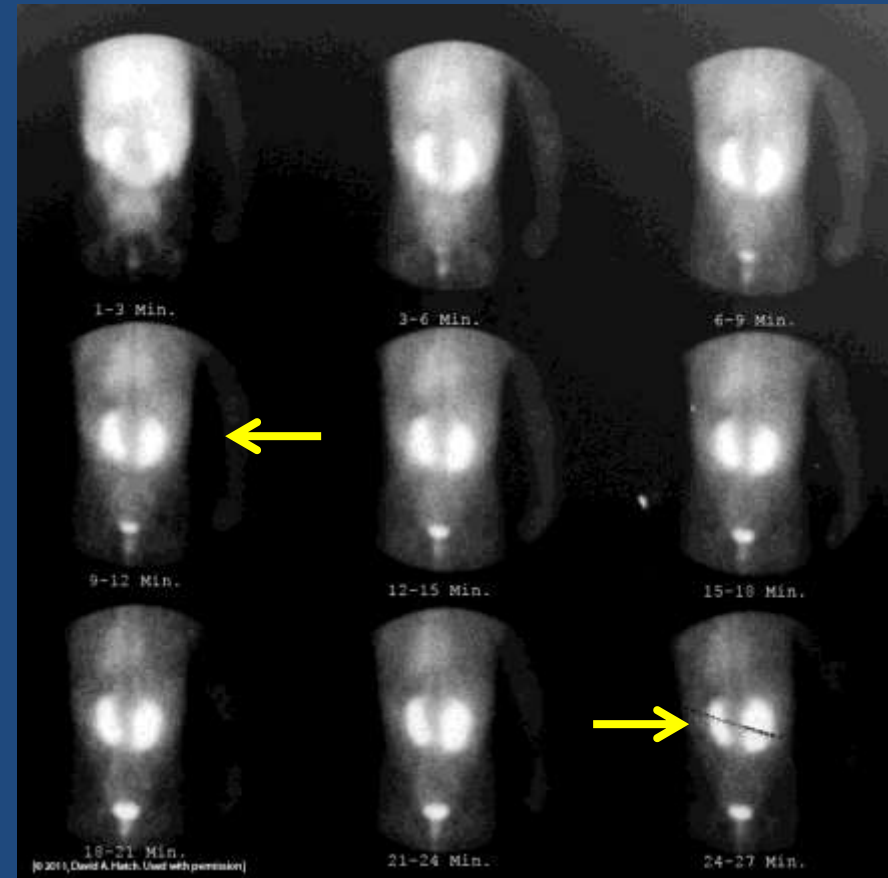
Read the Scan

- Without seeing the curves, can you say anything about the drainage?
 - The kidneys just keep getting brighter throughout the scan. Even without seeing the curves/analysis panel you can tell that these kidneys aren't draining normally.



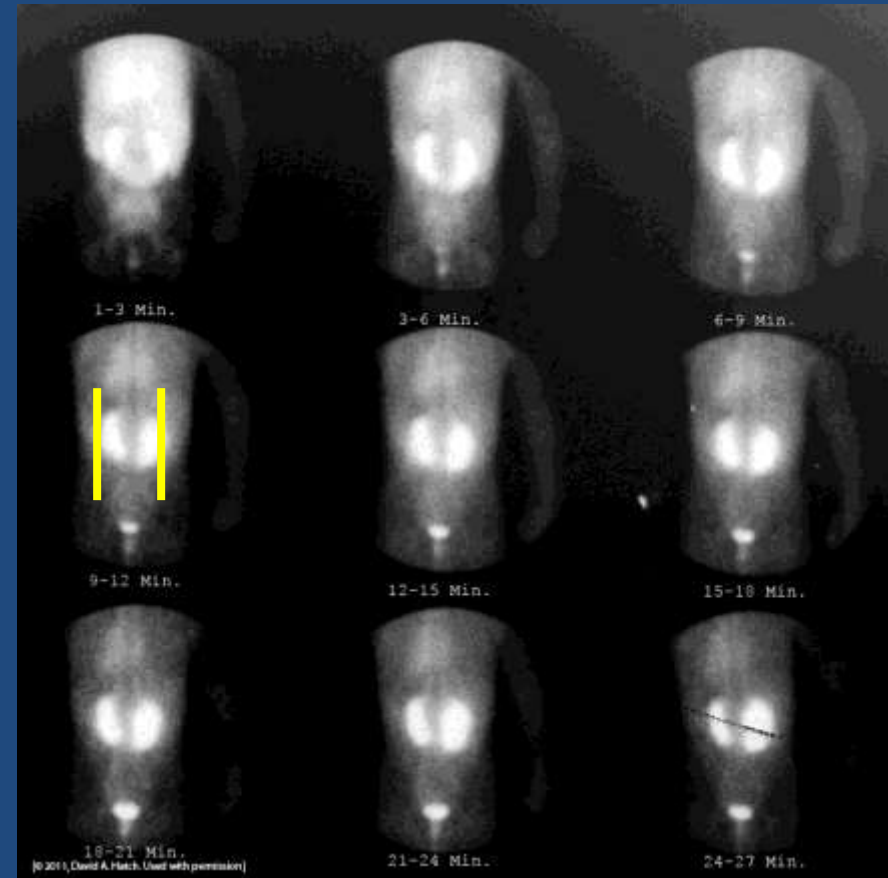
Read the Scan

- Do the kidneys drain at all?
 - Compare the 4th image with the last image. Both kidneys are slightly smaller and not quite as bright on the last image, so they both show some drainage.



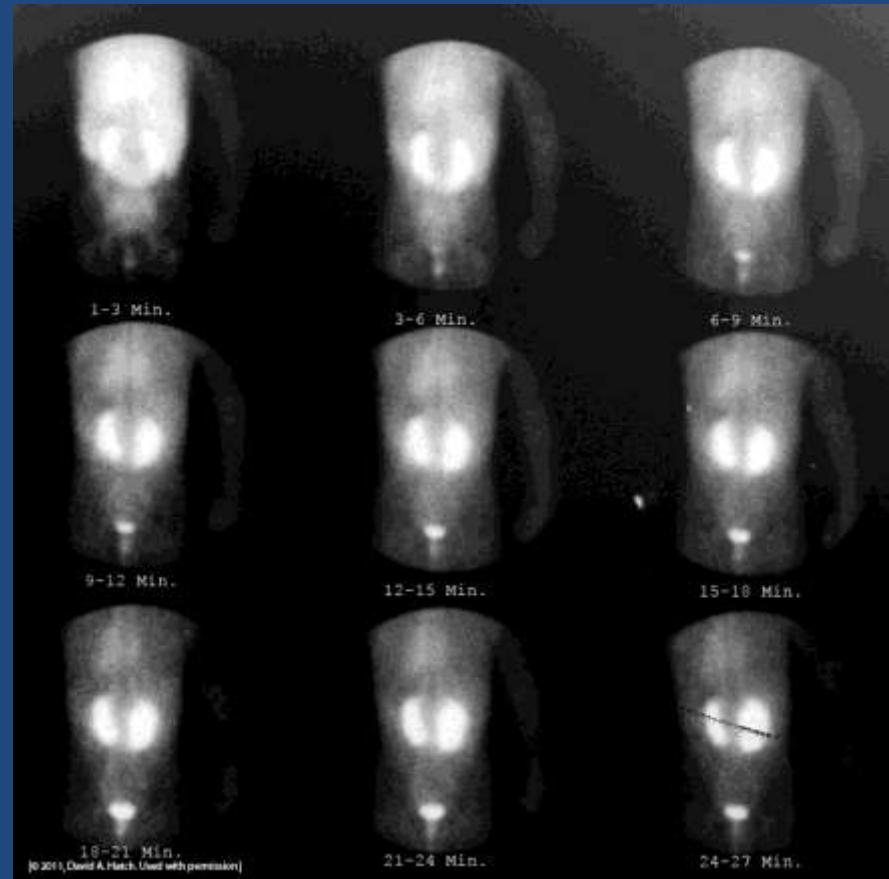
Read the Scan

- What is unusual about these two kidneys?
 - Notice anything unusual about their position?
 - What about the axis of each kidney?



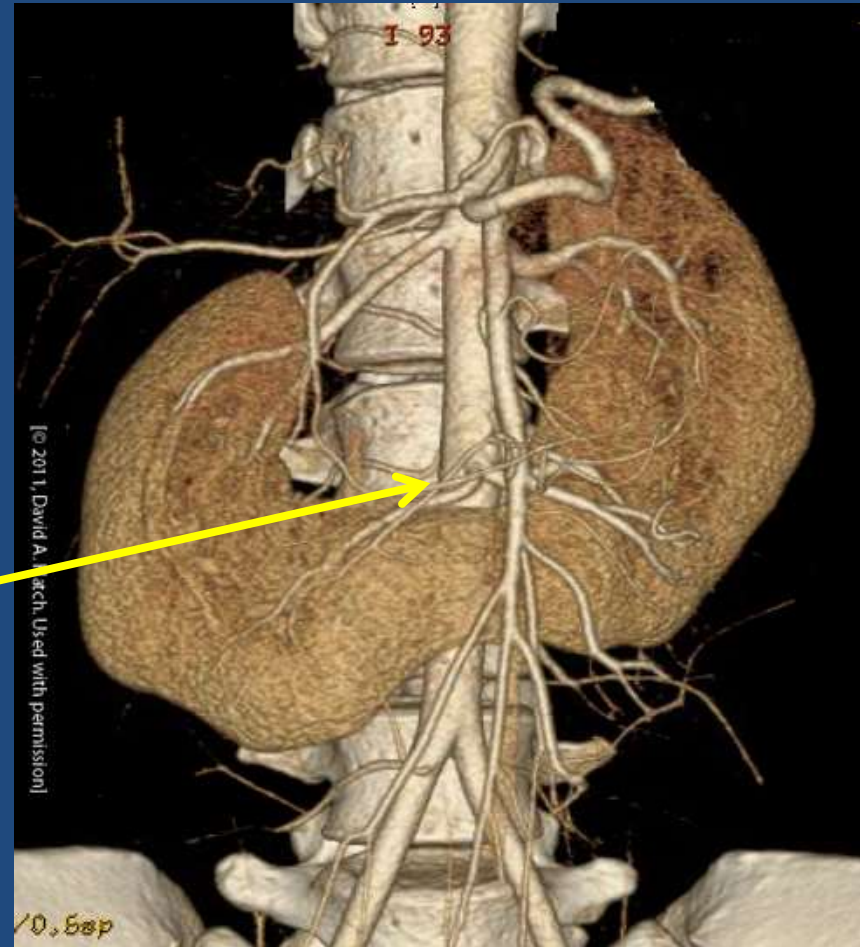
Your interpretation, Doctor?

- The kidneys seem to be slightly displaced inferiorly. They are closer to the bifurcation of the aorta than is normal.
- The axis of both kidneys is abnormal (upper pole is lateral to the lower pole).
- There are two conditions that can make the kidney axis abnormal. Remember?



Fusion Anomaly

- This boy has a horseshoe kidney (fusion at the lower poles).
- The kidneys lie inferior to the normal position because the isthmus between the lower poles blocks the kidneys from ascending when it reaches the inferior mesenteric artery.
- The lower poles are fused. This keeps them from falling laterally, parallel to the psoas muscles.

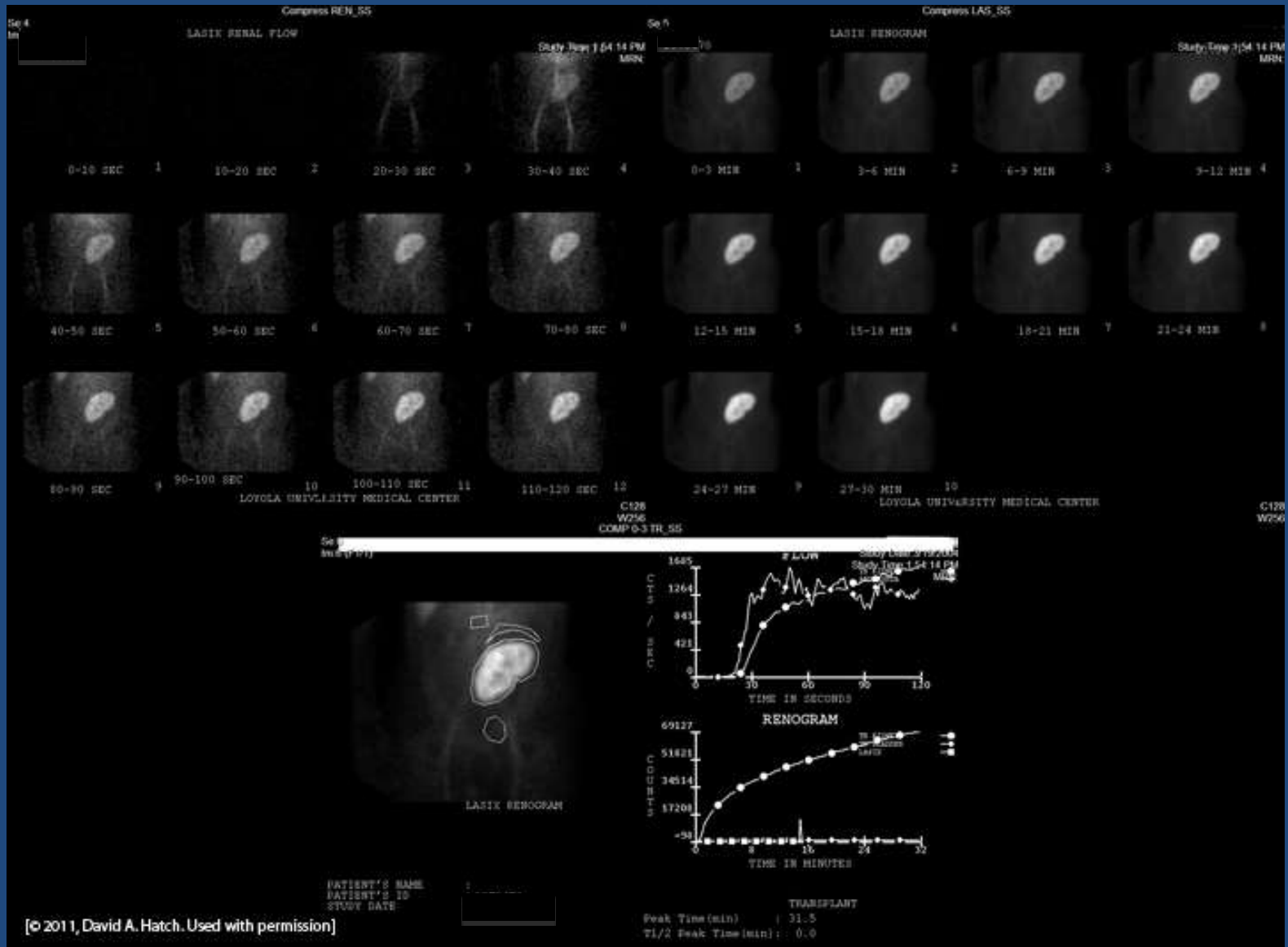


3-D CAT Scan

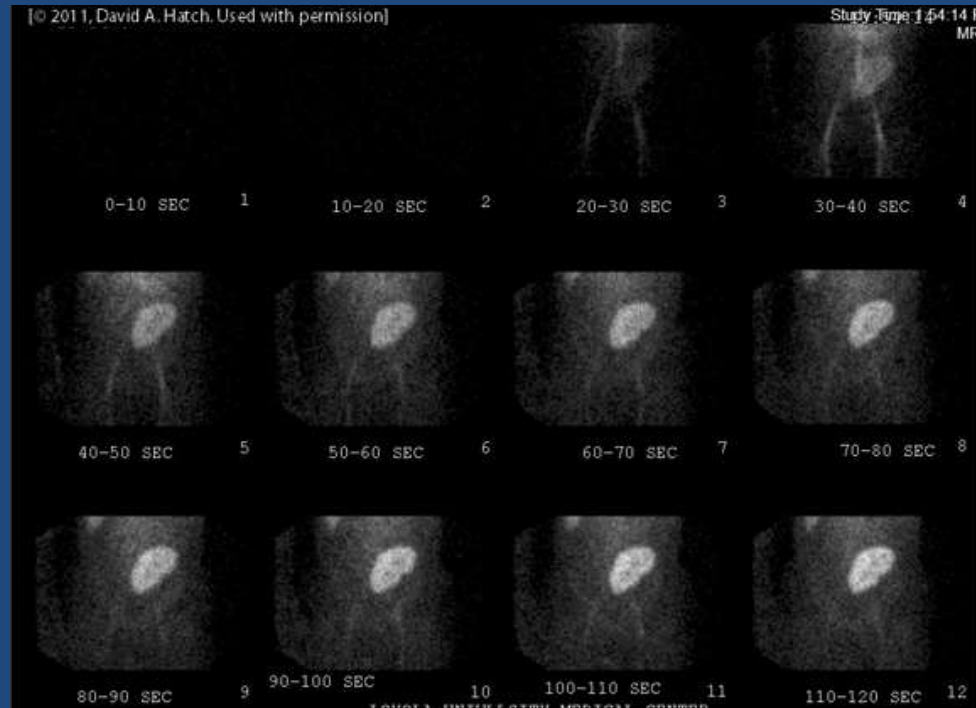
Case Without a History

- You're getting so good at reading nuclear renograms that you need a challenge. We're going to ask you to read a scan without giving you any medical history except:
 - This 45 year old female has minimal urine output.
 - An ultrasound showed no hydronephrosis.
 - A nuclear renogram was obtained to assess the patient's renal function.
- What radionuclide would you use to measure kidney function in a patient with anuria?

Tubular Function (Hipuran) Renal Scan



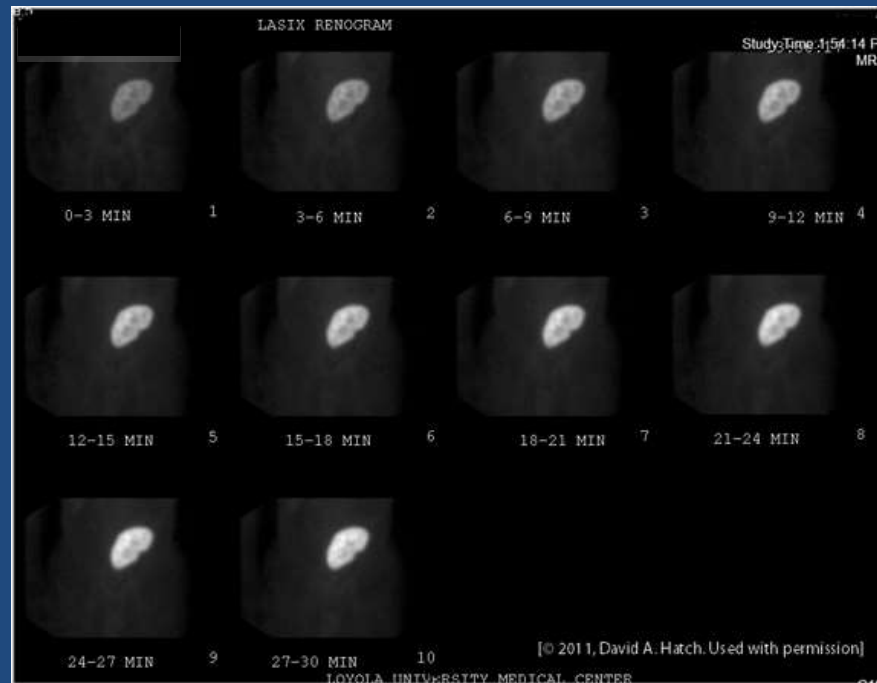
Your interpretation, Doctor?



- Perfusion:

There is only one kidney, and it shows prompt uptake. Where is the other kidney? Why is the kidney so far caudal (see the bifurcation of the great vessels)?

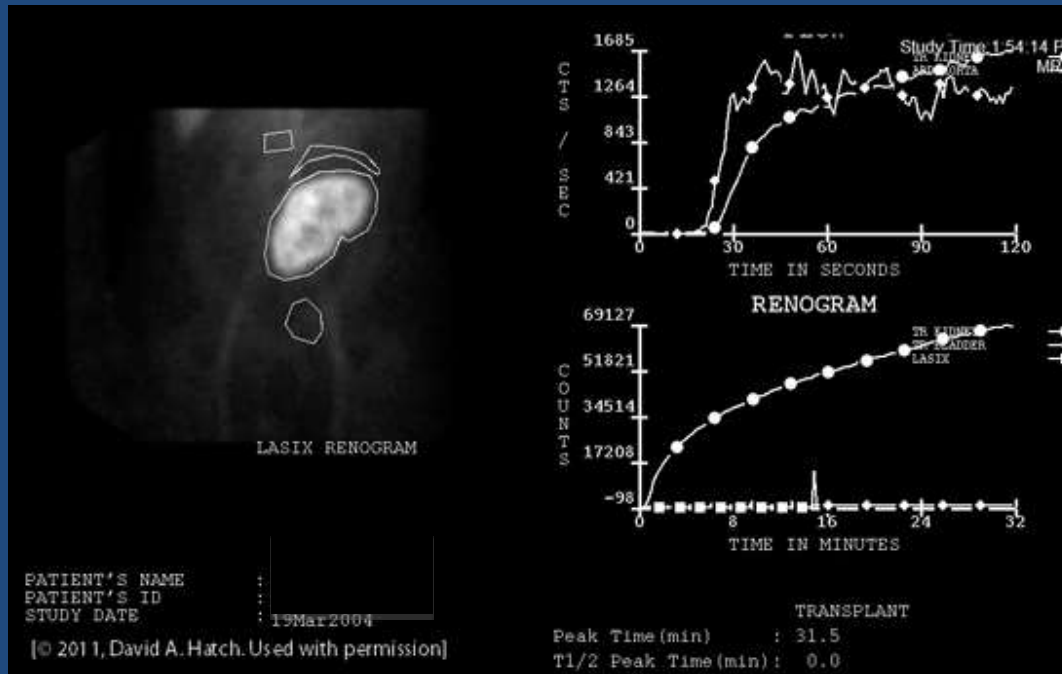
Your interpretation, Doctor?



- Drainage/excretion:

The solitary kidney takes up the radionuclide, but it doesn't excrete it. If there were an obstruction we would expect to see accumulation of radionuclide in a large renal pelvis.

Interpretation

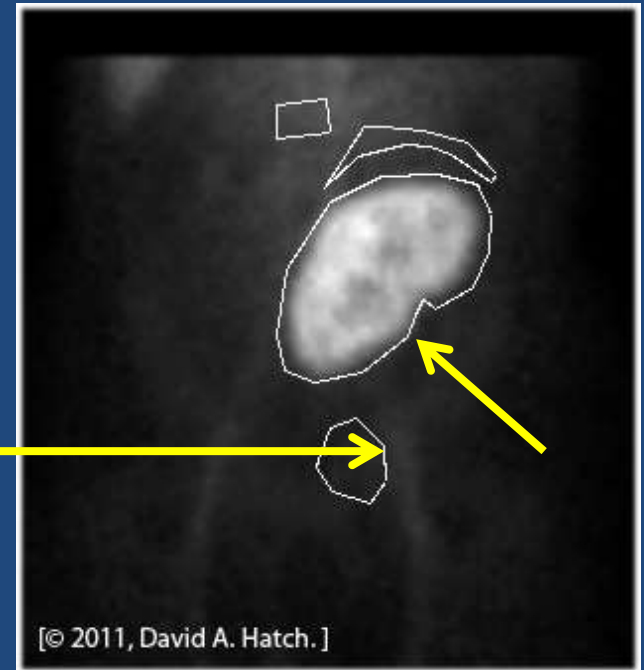


- Curves

Good perfusion, but no excretion (the radionuclide stays in the renal parenchyma; we don't see any in the bladder).

Interpretation

- How many kidneys?
 - One
- Where is the kidney?
 - Over the right iliac artery
- Orientation of the kidney?
 - Hilum is on the right (lateral)
- Kidney is well perfused, but shows no excretion. Why?
 - Acute tubular necrosis (ATN)



Case Summary

- This patient just received a cadaver kidney transplant
- The kidney has acute tubular necrosis (ATN)
 - That explains perfusion without tubular function
 - About 25% of cadaver kidney transplants have ATN
- The transplant is a left kidney placed in the right side of the pelvis
 - That explains why the hilum of the kidney faces laterally. Some transplant surgeons prefer to place a left kidney transplant on the recipient's right so that the renal pelvis will be anterior.

Nuclear Renography Summary

- Nuclear renography gives the most accurate representation of renal function of any imaging technique.
- 3 radionuclide classes
 - Filtered – Shows perfusion, drainage and function
 - Excreted – Shows tubular function
 - Cortical imaging – Shows scarring and renal mass

Nuclear Renography Summary

- 3 panels of a nuclear renogram
 - Perfusion
 - Drainage/function
 - Curves/analysis
- $T_{1/2}$ is the time at which half of the radionuclide has drained. Normal $t_{1/2} < 12$ minutes. $T_{1/2} > 20$ indicates obstruction.

- Congratulations! You've completed the nuclear renogram tutorials. You can learn more about other urologic imaging techniques on the AUA website [www.auanet.org].