



Abdominal Ultrasound  
Chapter 4

# THE KIDNEYS



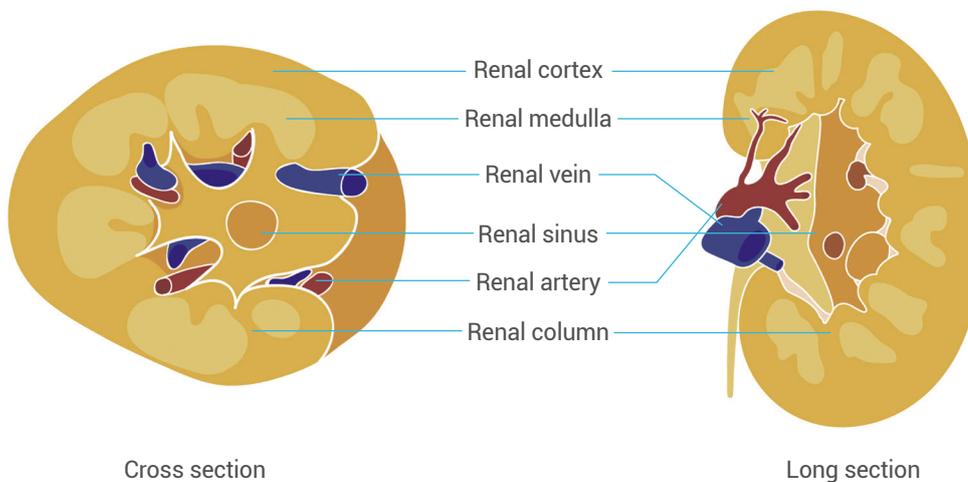
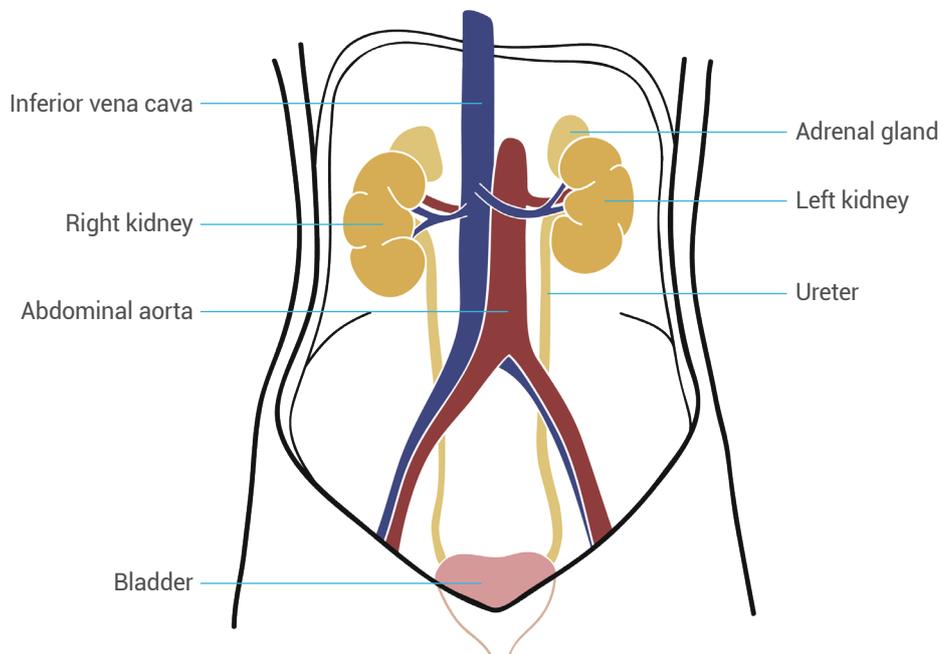
Niko Mayr

## The Kidneys

# MASTERING ULTRASOUND ANATOMY

The kidneys are normally found in the right and left epigastrium, with the right kidney dorsal to the right liver lobe and the left kidney caudal to the spleen and dorsal to the stomach. The kidneys are enveloped by fatty tissue and suspended by a fibrous sheath

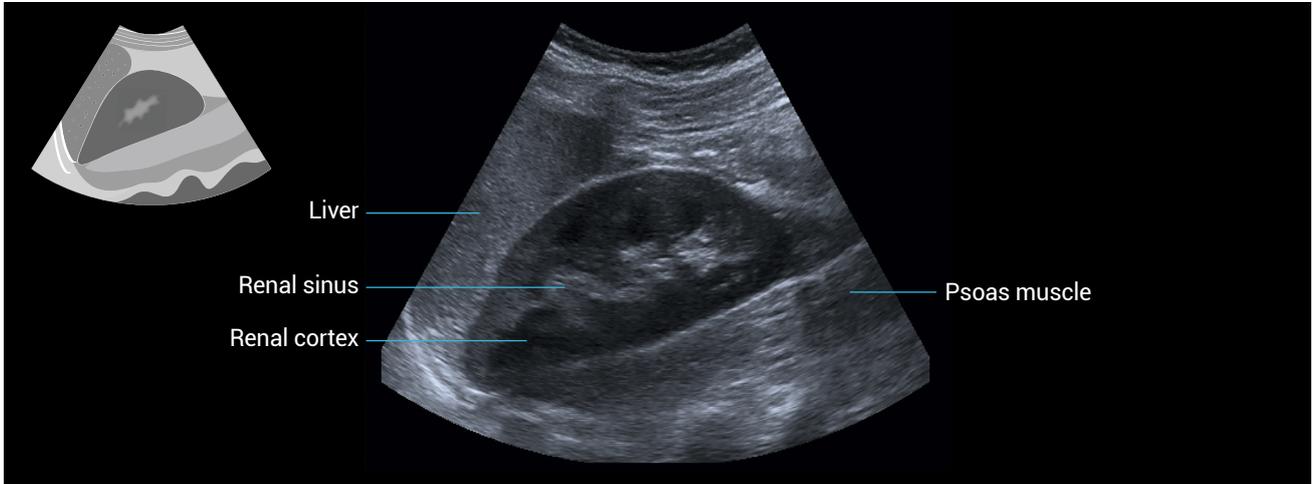
in the retroperitoneum. The retroperitoneum is bordered dorsally by the major psoas muscle and the quadratus lumborum muscle, and medially by the vertebral column.



The renal cortex and the renal columns are identical structures enveloping the renal medulla. The renal medulla shows less echogenicity than the renal cortex and columns.

## Anatomy

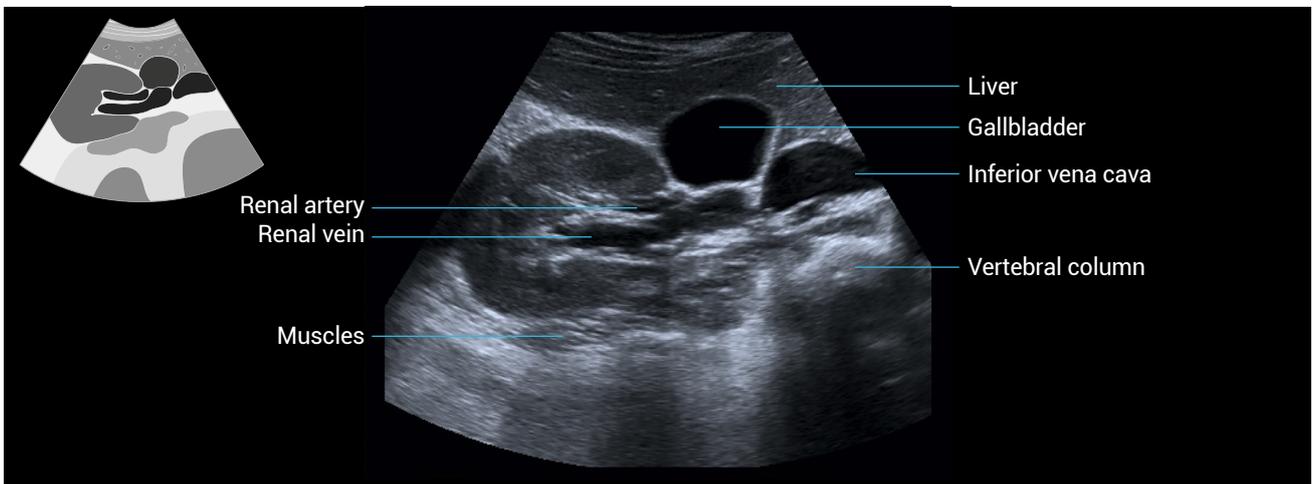
Within the kidney, the highest echogenicity can be seen in the renal sinus due to the presence of fat tissue.



## Vessels

The renal vessels are best viewed in cross-section.

The renal veins tend to have a higher caliber but a thinner wall than the renal arteries.



## The Kidneys

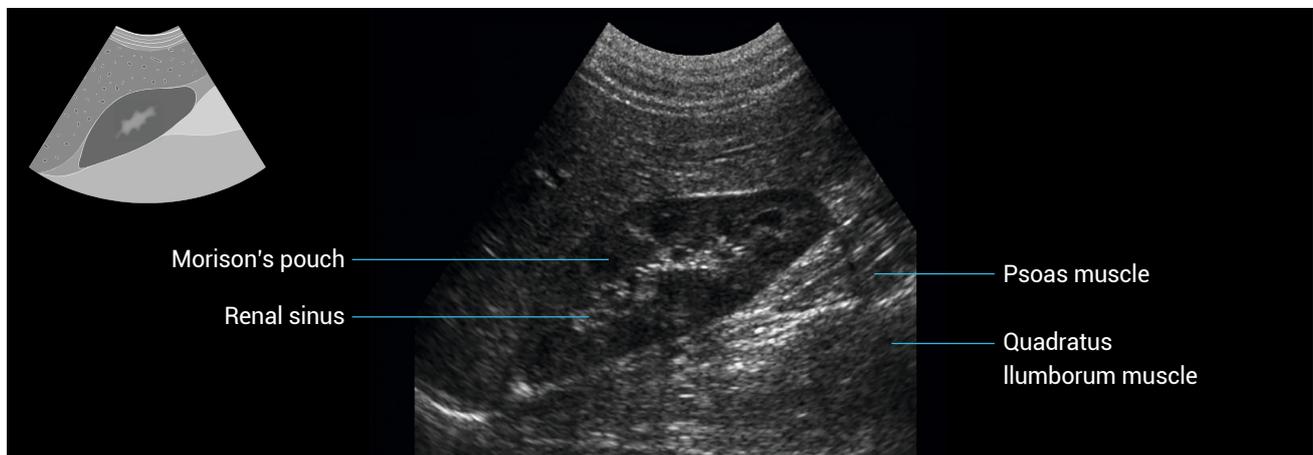
# RECOGNIZING THE LANDMARKS

### Right kidney—longitudinal

The image below shows a long section of the right kidney.

The right liver lobe borders the right kidney cranially and ventrally.

The thin echogenic line between the liver and the kidney is the peritoneal sheath duplicature called the Morison's pouch. It is the lowest part of the peritoneal cavity in the upper abdomen. As such, free peritoneal fluid can collect here and been seen on an ultrasound image.

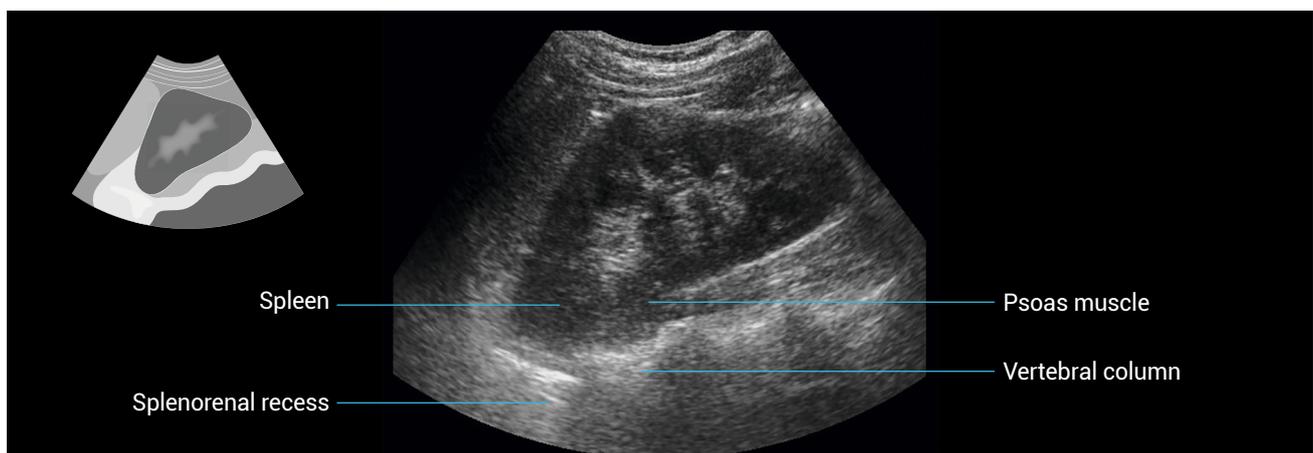


### Left kidney—longitudinal

The image below shows the left kidney in long section.

The spleen borders the left kidney cranially (left in the picture).

The splenorenal recess (also called the Koller pouch) is a peritoneum duplicature on the left side between the spleen and the left kidney.



## The Kidneys

# HOW DO I DO IT?

### Suggested algorithm for the ultrasound of the biliary system

1. Right kidney long section
2. Right kidney transverse section
3. Left kidney long section
4. Left kidney transverse section
5. Landmarks: renal sinus, renal cortex, Morison's pouch, Koller pouch (all in long section), renal hilum (transverse section)



**Important:**  
*Always follow the same sequence!*

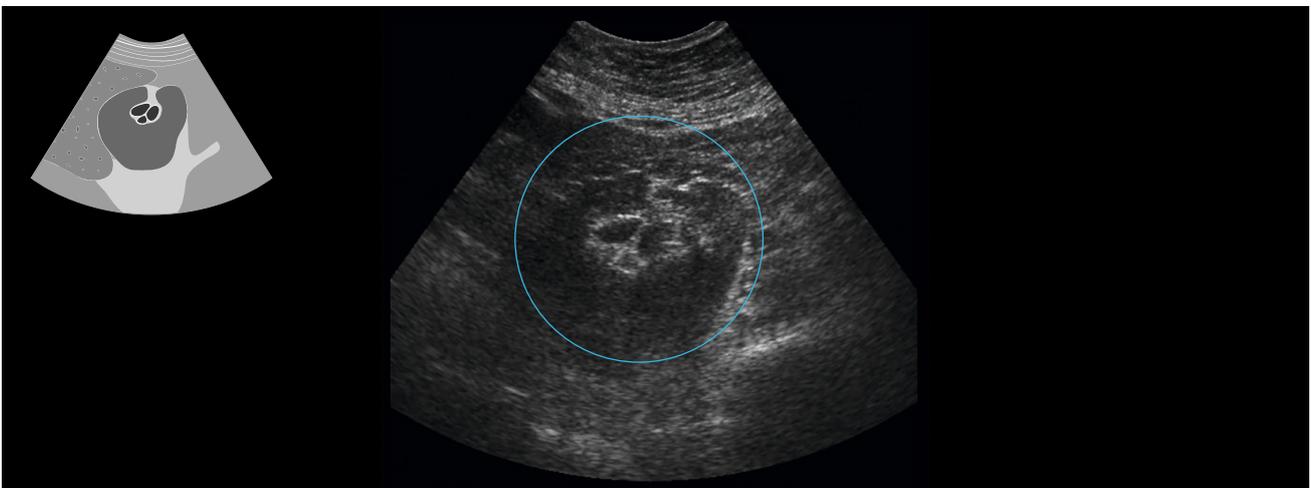
## The Kidneys

# INTERPRETING ANOMALIES

### *Abnormal renal rotation*

Abnormal renal rotation (renal malrotation) refers to an anatomical variation in the position of the kidneys, in particular to the anomalous orientation of the renal hilum.

It may occur unilaterally or bilaterally. It is almost always an asymptomatic incidental finding.

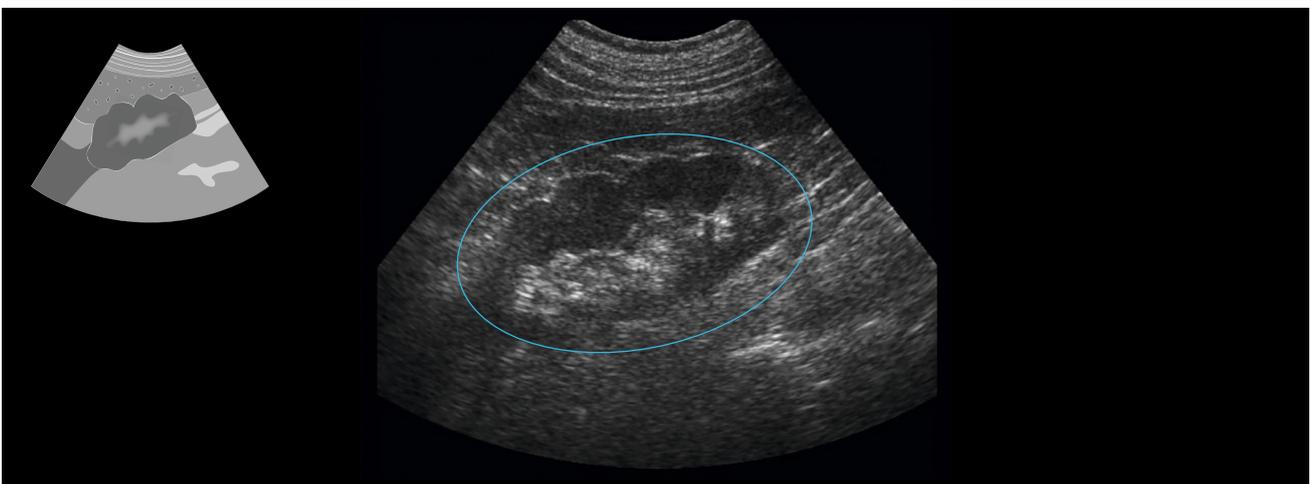


### *Persistent fetal lobulation*

Persistent fetal lobulation is a normal variant occasionally observed in adult kidneys.

lobules that fuse as they develop and grow  
Persistent fetal lobulation occurs when there is incomplete fusion of the developing renal lobules.

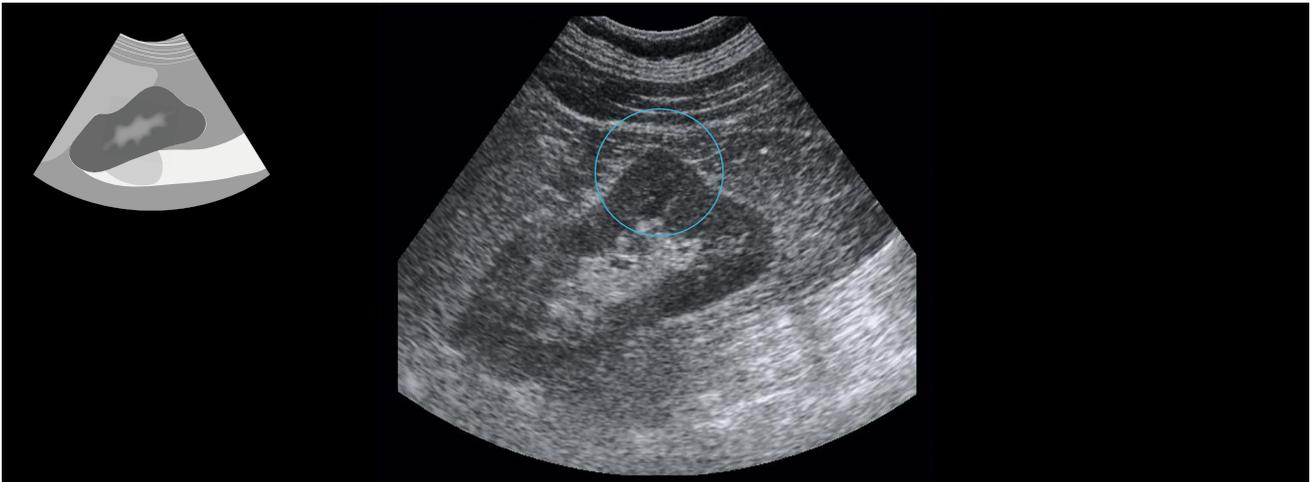
Embryologically, the kidneys originate as distinct



## Dromedary hump

Dromedary humps are prominent focal bulges found on the lateral border of the left kidney. They are normal variants of the renal contour, caused by the splenic impression onto the superolateral left kidney.

Dromedary humps are important because they may mimic a renal mass, and as such they are considered to be a type of renal pseudotumor.

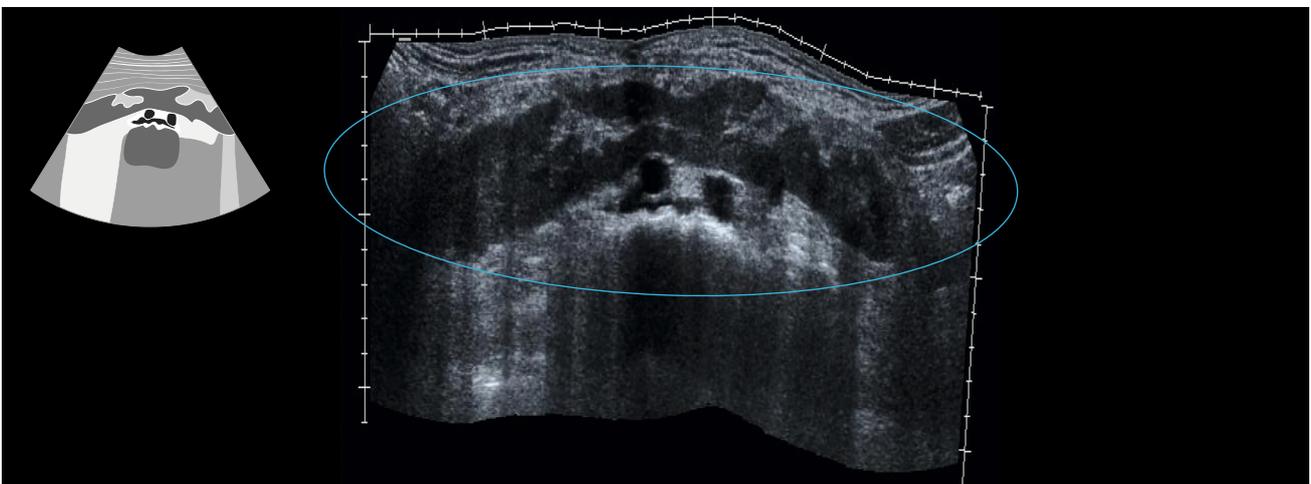


## Horseshoe kidney

Horseshoe kidneys are the most common type of renal fusion anomaly.

They render the kidneys susceptible to trauma and represent an independent risk factor for the development of renal calculi and transitional cell carcinoma of the renal pelvis.

During development, the kidneys normally ascend to take their place in the abdomen below the adrenal glands. A horseshoe kidney occurs when ascent into the abdomen is restricted by the inferior mesenteric artery, which hooks over the isthmus. Hence horseshoe kidneys are low lying.



## The Kidneys

# DIAGNOSING HYDRONEPHROSIS

### Hydronephrosis

Hydronephrosis is defined as dilatation of the urinary collecting system of the kidney (the calyces, the infundibula, and the pelvis).

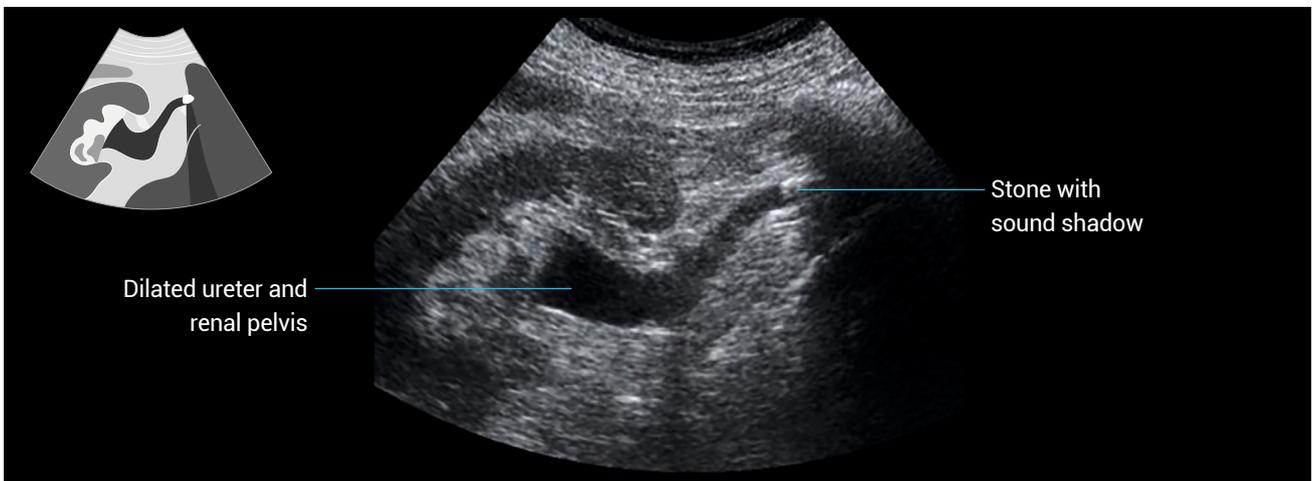
Hydroureteronephrosis is the term used when the dilatation also involves the ureter.

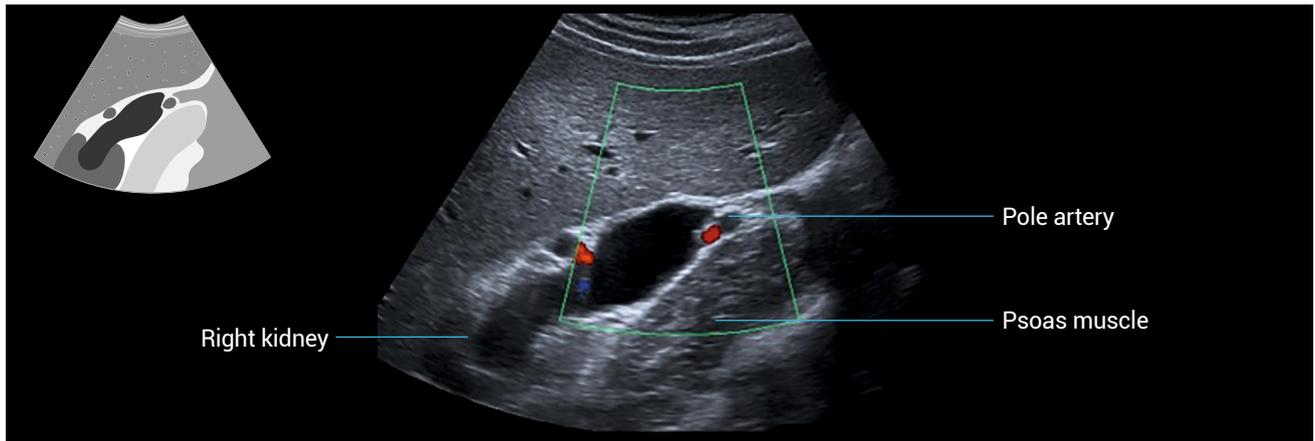


### Stones / ureteropelvic junction (UPJ) obstruction

Following the identification of hydronephrosis, appropriate further investigations must be undertaken to establish an underlying cause. Potential etiologies include urolithiasis, UPJ

obstruction, malignancy (such as cervical cancer), and retroperitoneal fibrosis.





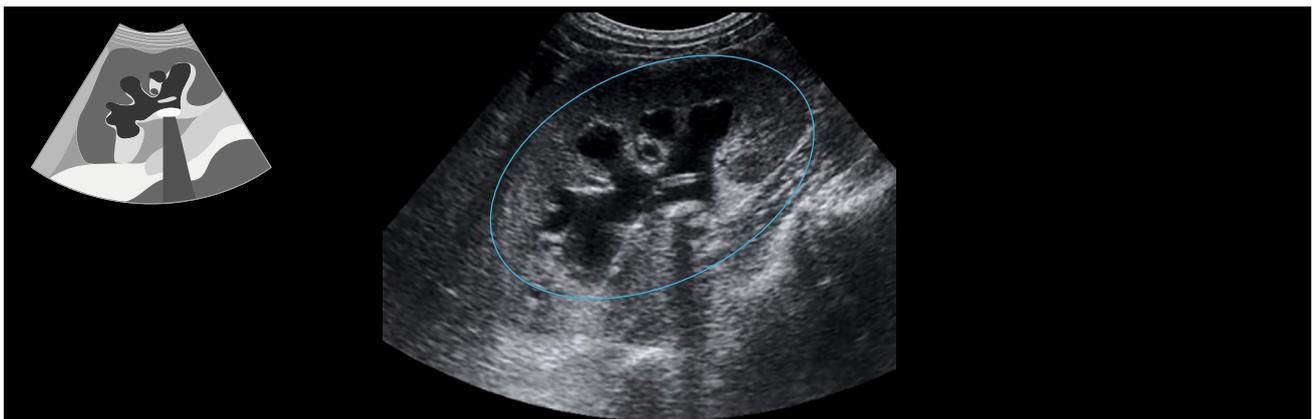
### Grade 1 hydronephrosis

The renal pelvis is dilated more than 5 mm and echo-free fluid can be seen in the calix and infundibula. The renal parenchyma is normal.



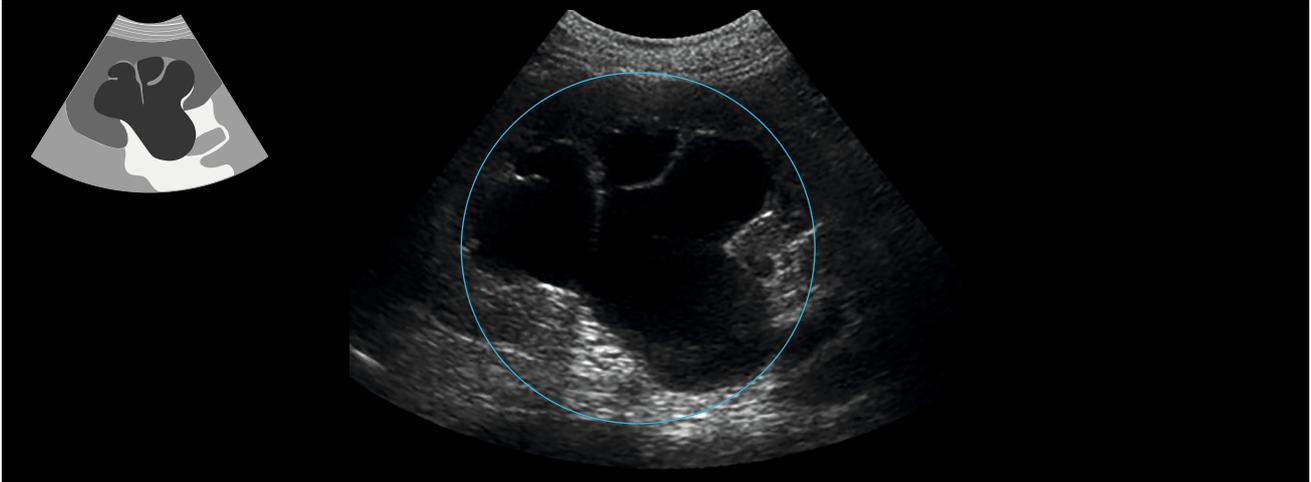
### Grade 2 hydronephrosis

The renal pelvis, the calices, and the infundibula are dilated. The renal parenchyma is normal.



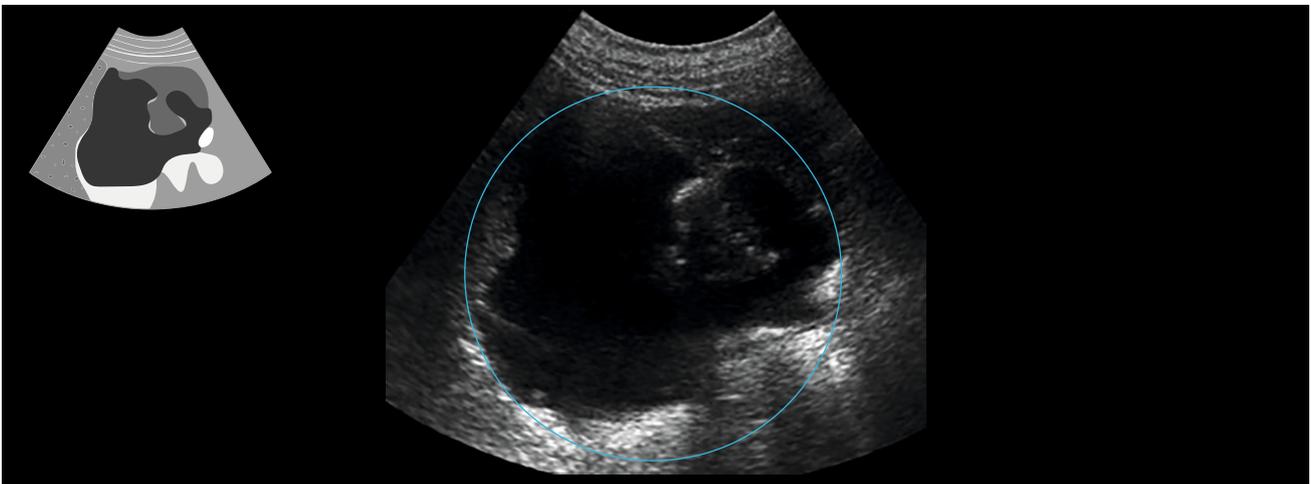
### Grade 3 hydronephrosis

The renal pelvis, the infundibula, and the calices are dilated and the renal sinus is totally occupied by dilated structures. The renal parenchyma is narrowed.



### Grade 4 hydronephrosis

Significant dilatation of renal pelvis, calices, and infundibula is observed. The renal parenchyma is considerably narrowed until it can no longer be seen, resulting in a sacculated kidney.



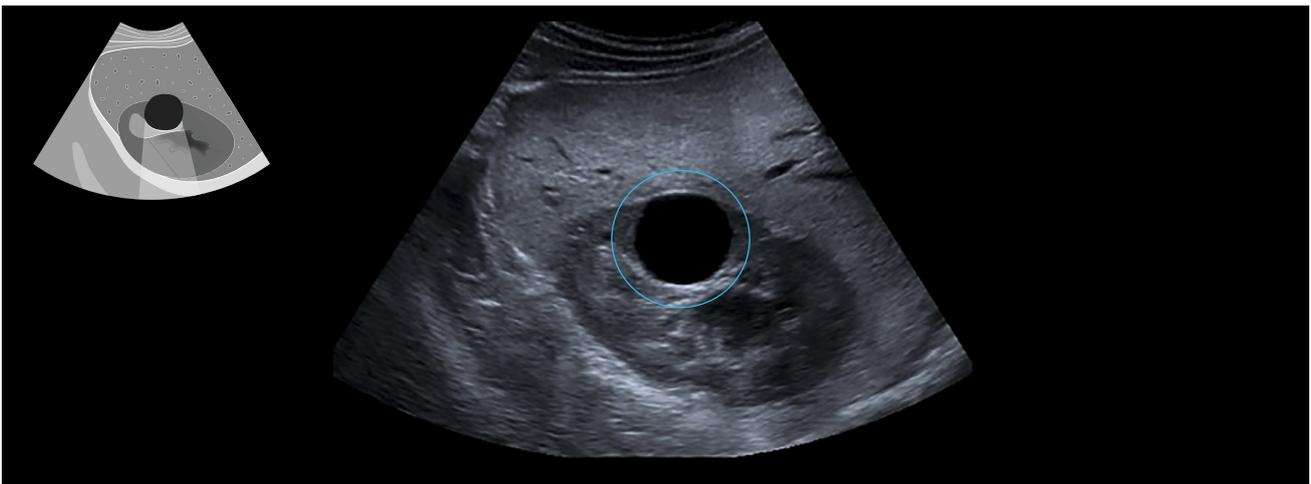
## The Kidneys

# DIFFERENTIATING CYSTIC KIDNEY LESIONS

### *Cortical cysts or parapelvic cysts*

These uncomplicated cysts differ only in their location within the kidney. Uncomplicated renal cysts show the following ultrasound criteria:

- Well-marginated anechoic lesion with thin walls.
- A few thin septa may be present.
- The back wall should be visible.
- Posterior acoustic enhancement may be present, although this finding is nonspecific and may not be seen with smaller cysts.
- A small amount of intracystic hemorrhage / debris may be present, and may require further evaluation.

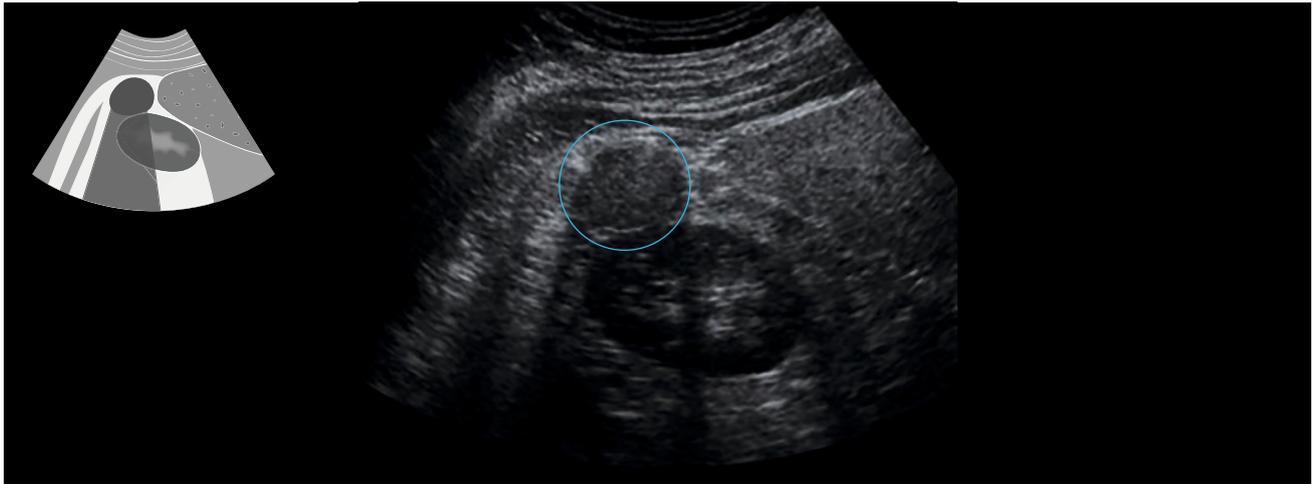


## Complex renal cysts

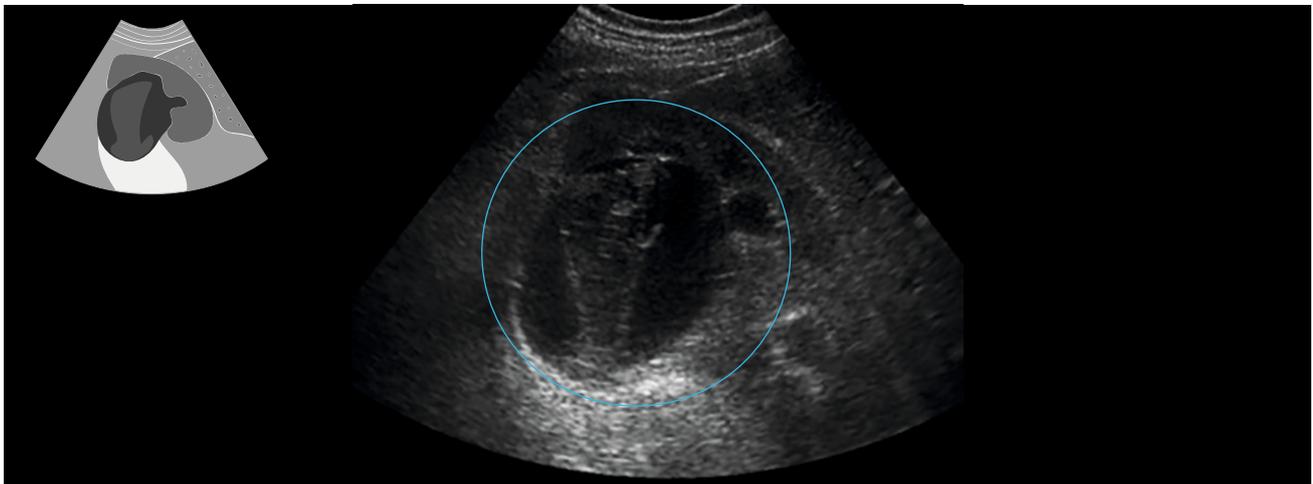
Complex renal cysts are cystic lesions with thickened or irregular walls or septa. These cysts are suspicious for renal cell carcinoma and warrant further workup.

Vascularity of the septa on color or spectral Doppler is particularly suspicious for renal cell carcinoma.

Contrast-enhanced ultrasound may be useful to show vascularity of the septa or nodular protuberances in a renal cyst, and can help differentiate a benign cyst from an indeterminate cyst or a malignant-appearing cyst.



Proteinaceous cyst



Hemorrhagic cyst

The complex renal cyst illustrated below was examined with contrast-enhanced ultrasound and the papillary structure in the lumen showed perfusion, indicating the presence of a malignant cystic tumor (most probably renal cell carcinoma).

The following criteria, which strongly suggest a malignant neoplasm, can be observed:

- Thickening of the wall with poorly defined borders.
- The intraluminal papillary structure showing perfusion.



Malignant cystic tumor

## The Kidneys

# PINPOINTING SOLID KIDNEY TUMORS

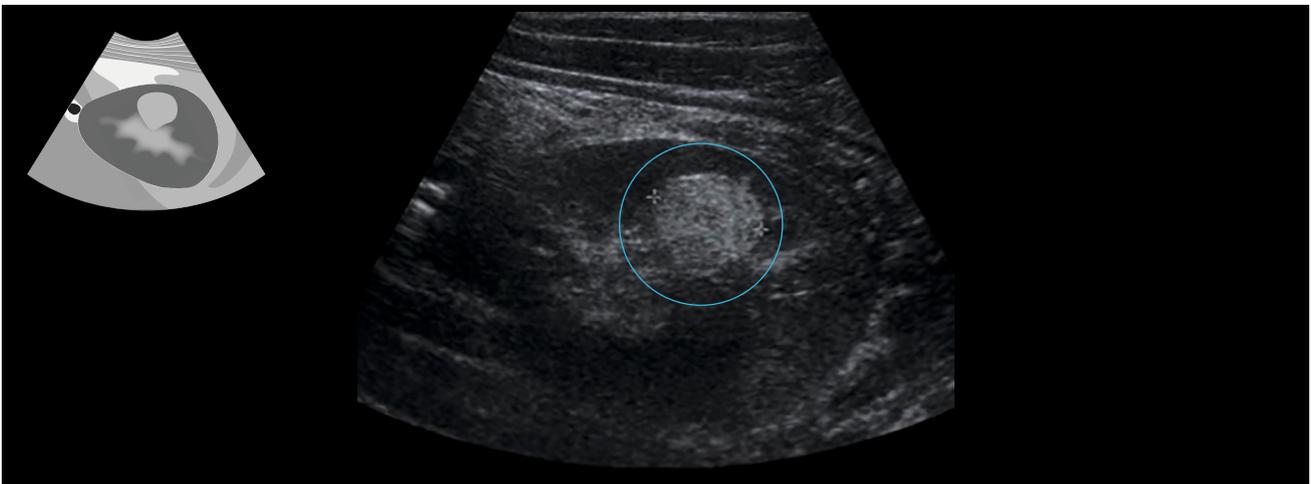
### Angiomyolipomas

Renal angiomyolipomas are a type of benign renal neoplasm composed of vascular smooth muscle and fat elements.

They are typically identified in adults, and affect females approximately four times more often than males.

Angiomyolipomas usually have characteristic appearances. The majority (80%) of angiomyolipomas are sporadic.

They can spontaneously haemorrhage, which can be fatal.



### Oncocytoma

Renal oncocytoma is a relatively benign renal tumor. The epidemiology, presentation, imaging, and even histology of these tumors can be so similar to renal cell carcinoma that it is difficult to distinguish

between the two preoperatively. This similarity represents the main clinical importance of this type of lesion.



## Renal cell carcinoma

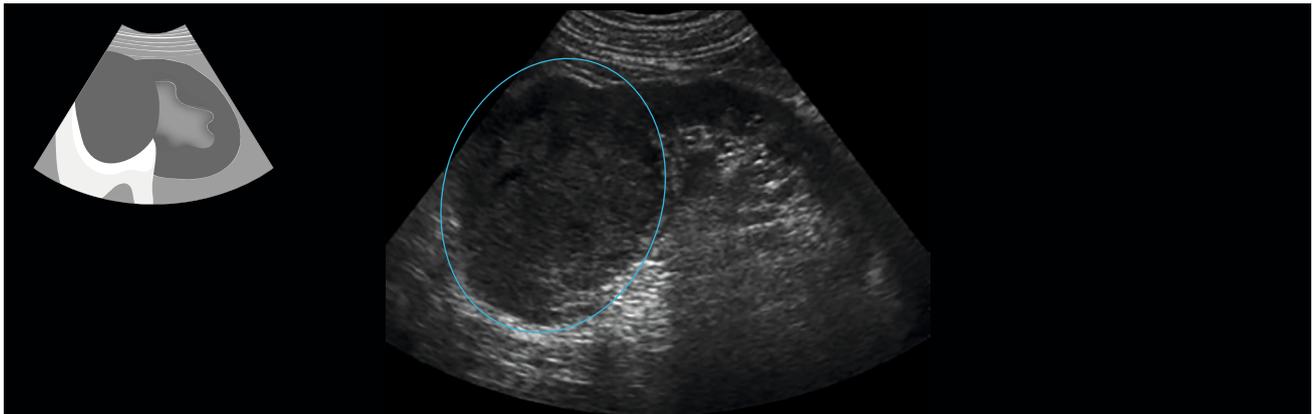
Renal cell carcinomas may appear solid or partially cystic, and may be hyperechogenic, isoechogenic, or hypoechogenic to the surrounding renal parenchyma.

The tumor pseudo capsule can sometimes be visualized with ultrasound as a hypoechoic halo.

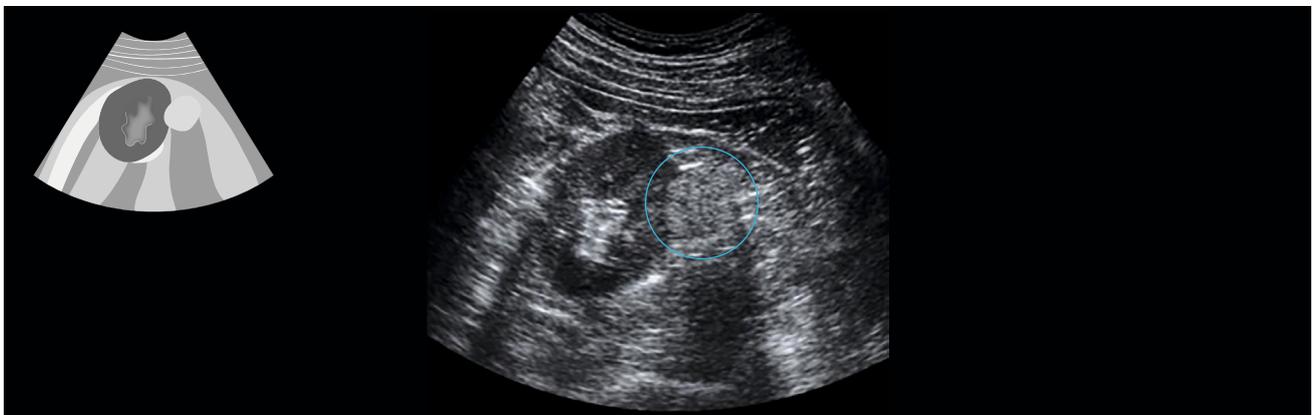
Although this is a relatively specific sign, it is not

particularly sensitive (~ 20%). Use of harmonic scanning has been reported to increase sensitivity up to 85%.

Contrast-enhanced ultrasound has demonstrated the lesion to be heterogeneously hypervascular in the arterial phase with early washout in the delayed phase.



Renal cell carcinoma—isoechoic



Renal cell carcinoma—hyperechogenic



Renal cell carcinoma—cystic

## The Kidneys

# IDENTIFYING PERIRENAL PATHOLOGIES

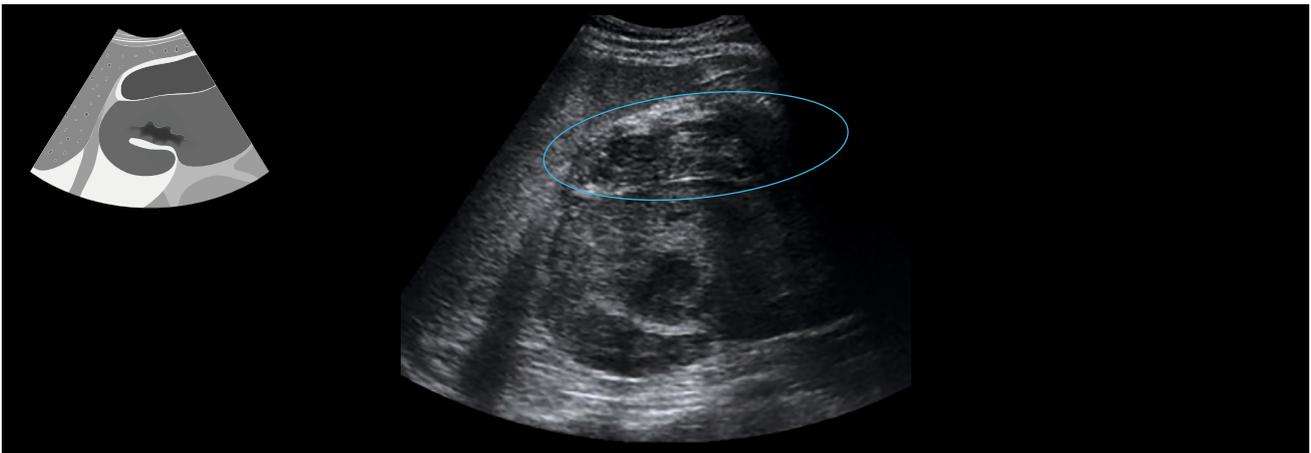
### Hematoma

Hematomas can occur after bleeding of subcapsular or capsular vessels of the kidney. Since the fascia of Gerota is durable, the bleeding is mostly contained in the retroperitoneal cavity and will not enter the peritoneal cavity, though it can extend caudally into the lower pelvis and into the mediastinum through the esophageal hiatus, if a high blood volume is present.

Bleeding most often occurs after extracorporeal lithotripsy, blunt abdominal trauma or biopsy. Metastatic bleeding or ruptured angiomyolipoma can also lead to hemorrhage. When the perirenal

hematoma gets organized over time, the body resorbs the clots and liquefies the coagulated parts of the hematoma, leaving only the fluid components. The remaining fluid can be seen weeks after the bleeding event and will be resorbed over a longer period of time.

The subcapsular hematoma shown below occurred as a result of blunt abdominal trauma. In this image, the coagulated hematoma can be seen lying directly on top of the right kidney. There is no free fluid present in the Morison's pouch to suggest a retroperitoneal bleeding event.



Perirenal hematoma



Old hematoma

## Perirenal fluid

The presence of perirenal fluid can indicate a severe pathology, and its origin should always be explored.

It may be present after a renal pelvis rupture resulting from an obstructing kidney stone, after papillotomy and perforation, or due to pancreatitis.

