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Renal Adenoma

- A renal adenoma is a benign renal neoplasm. It is traditionally classified into three distinct types (renal papillary adenoma, renal tubular adenoma, and alveolar renal adenoma). The papillary type is the commonest variant with an estimated prevalence of 40 % in patients older than 70 years of age.
- Such lesions are histologically indistinguishable from larger carcinomas more commonly encountered in the kidneys, and they often have histologic grades indicating a definite potential for malignant behavior. Accordingly, most investigators believe that these lesions should be regarded as carcinomas in an early stage of evolution and should not be classified as adenomas.
- On CT, these small renal tumors are usually well defined and homogeneous in appearance. Less commonly, they show marginal irregularity, heterogeneity, or central calcification, findings that may suggest pathologically high-grade tumors. These lesions are best managed with partial nephrectomy, provided that the other kidney is normal.

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Renal Angiomyolipoma

- Renal angiomyolipoma (AML) is a type of benign mesenchymal neoplasm composed of adipose tissue, thick-walled vessels and smooth muscle elements in varying proportions. 80 % of angiomyolipomas are sporadic and have a female predilection (F:M of 4:1). 20 % can be seen in association with phakomatoses, e.g., tuberous sclerosis, and in these cases they present earlier, are larger and far more numerous.
- When they are symptomatic, they present with spontaneous retroperitoneal hemorrhage. The bleeding risk is proportional to the size of the lesion, being greater if it measures more than 4 cm. Other common signs and symptoms are palpable mass, flank pain, urinary tract infections, hematuria, renal failure, and hypertension.
- When the triad of adipose tissue, thick-walled vessels, and smooth muscle elements is present, the radiologic diagnosis is uncomplicated. However, "monophasic" variants exist, i.e., consisting of only one of these three components, such as the form composed exclusively of spindle-shaped smooth muscle cells, or the epithelioid variant, which is particularly problematic because it can be interpreted as a carcinoma.
- On CT, most lesions involve the cortex and demonstrate macroscopic fat (<20 HU). Sometimes, especially in the context of a syndrome, they can be fat-poor.
- MRI is a valuable tool at evaluating fat-containing lesions, and two main set of sequences are employed, that is fat saturated techniques (which demonstrate high signal on nonfat saturated sequences, and loss of signal following fat saturation) and in and out of phase imaging which generates India ink artifact at the interface between fat and nonfat components. It is important to remember that rarely renal cell carcinomas may have macroscopic fat components; therefore, the presence of fat is suggestive of an angiomyolipoma, but it is not pathognomonic.

Renal Bacterial Infection (Acute Pyelonephritis)

- Pyelonephritis is an infectious process affecting the kidney, which is caused mainly by Gram-negative bacteria (*E. coli*, *Proteus*, *Pseudomonas*, *Klebsiella*, and *Enterococcus* species), whereas less than 20 % of cases are caused by Gram-positive bacteria. Ascending infections caused by bacteria of the fecal flora are the most common, especially in patients with concomitant urinary tract diseases such as lithiasis or vesicoureteric.
- Acute pyelonephritis can be defined as a clinical syndrome characterized by lumbar pain and hyperpyrexia, associated with laboratory findings of renal bacterial infection including leukocytosis, pyuria, bacteriuria, and positive urine culture. In anatomopathologic terms, pyelonephritis is a bacterial infection of the kidney, with consequent acute inflammation often involving the pelvis and renal parenchyma of both kidneys. This causes suppurative interstitial inflammation with tubular necrosis.
- Imaging is needed to determine if there are complications requiring prolonged antibiotic therapy or surgical intervention (e.g., renal and perinephric abscess or pyonephrosis). Imaging is also useful for excluding abnormalities that predispose to refractory infections such as nephrolithiasis or ureteral obstruction.
- In patients with acute bacterial renal infection, CT scans are acquired with contrast enhancement during the corticomedullary phase (30 s after initiation of injection) and during either the nephrographic phase (70–90 s after injection) or the excretory phase (5 min after injection). A nephrogram on contrast-enhanced CT that consists of discrete rays of alternating attenuation extending to the cortex is characteristic of pyelonephritis and is better demonstrated on CT than on excretory urography. Striations result from stasis of contrast material within edematous tubules that demonstrates

increasing attenuation over time. Severe tubulointerstitial inflammation may progress to form a hypodense mass or masses with rounded or irregular contours and bulging of the renal surface. If treated too late or inadequately, such lesions may develop single or multiple small areas of liquefaction (i.e., small abscesses). These areas are often irregular and of near water attenuation (20–30 HU); they do not enhance after intravenous administration of contrast medium.

Renal Cell Carcinoma

- The most common renal cancer is the carcinoma (renal cell carcinoma, RCC), which accounts for 3 % of all adult cancers and 80–85 % of malignant renal tumors.
- Patients with RCC can present with a range of symptoms; unfortunately, many patients are asymptomatic until the disease is advanced. At presentation, approximately 25 % of individuals either have distant metastases or advanced locoregional disease. The classic triad of RCC (flank pain, hematuria, and a palpable abdominal renal mass) occurs in most 9 % of patients. Many patients with RCC present with or subsequently develop systemic symptoms or paraneoplastic syndromes.
- Of all the available prognostic factors, tumor extension at diagnosis is the most important element for predicting disease progression; as a result, CT plays a key role and still today can be considered the best imaging modality for staging RCC.
- CT is currently recognized as the best imaging technique for *identifying* renal parenchymal neoplasms. CT can identify more and smaller lesions than US, although it is unable to improve on their characterization; Fig. 8. There are two fundamental aims to the *characterization* of solid renal lesions to distinguish a renal tumor from normal anatomic variants or

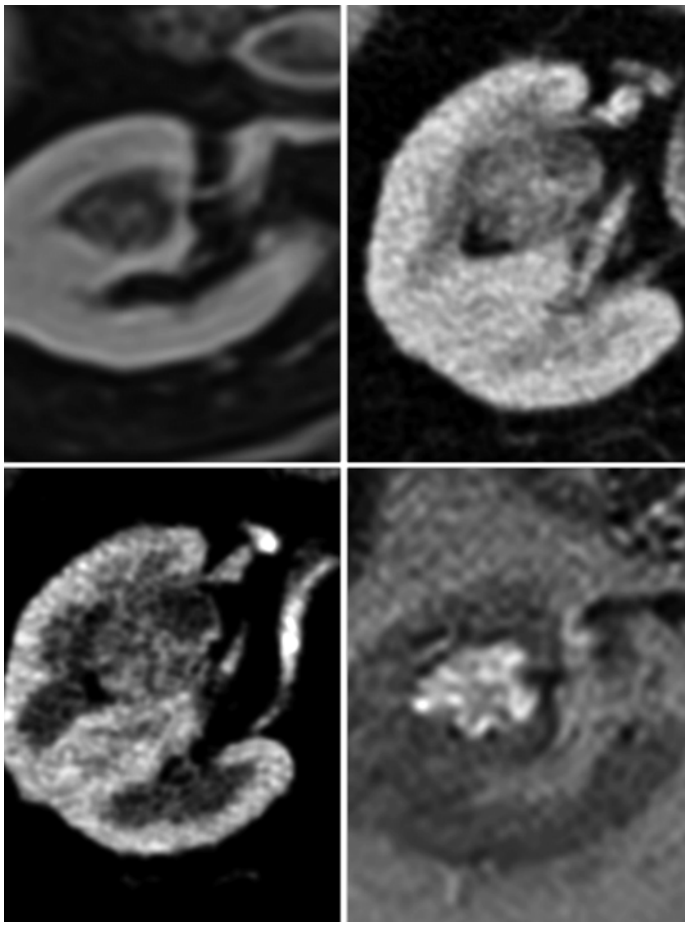

Fig. 8 CT images showing a capsulated renal mass with inhomogeneous contrast enhancement on arterial and venous phase which was found to be a Renal Cell Carcinoma. MR images depicting a round-shaped, well-capsulated renal mass with inhomogeneous high signal intensity on T2-weighted images and contrast enhancement, without any signs of infiltration of renal vein. After surgery this mass was found to be a Renal Cell Carcinoma

thrombus into the vena cava itself, where it becomes evident as an intraluminal defect. CT remains the most immediately used imaging modality for the evaluation of distant metastases (lungs, liver, and skeletal system). The most specific CT parameter for classifying a solid mass as T3a is provided by the identification of a solid enhancing nodule in the perirenal fat, which possibly behaves in a similar manner to the primary lesion. Stranding and increased thickness of perirenal fat are not necessarily signs of tumor spread, since they are identifiable in 50 % of patients with lesions confined to the capsule.

- MRI has an important role to play in the characterization of renal lesions. Thanks to the efficacy of the dynamic study, the increase in signal intensity can be measured over time and the vasculature of small lesions can be evaluated. In T1-weighted images medium to large lesions can appear hypo-isointense or even weakly (but never clearly) hyperintense. In T2-weighted sequences, the appearance is hypo- and hyperintense. MR is able to resolve the problems CT has with complex cysts, i.e., small lesions with calcified walls, in which the absence of enhancement can help make the diagnosis of benign lesions.

Renal Cysts (Simple Renal Cyst)

- The most common causes of radiologically evident renal cysts in adults are simple renal cysts, which will be discussed here, autosomal dominant polycystic kidney disease, and, acquired cystic disease in patients with end-stage renal disease after several years of dialysis, particularly hemodialysis. Unusual causes of renal cysts in adults are Von Hippel–Lindau disease, tuberous sclerosis complex, and nephronophthisis. Postmortem studies have shown that more than 50 % of people under the age of 50 have one or more cysts.

- To help diagnose and manage these lesions, the Bosniak renal cyst classification system was created. Based upon morphologic and enhancement characteristics with CT scanning, cystic renal masses are placed into one of five different categories. The presence of true contrast enhancement of the lesion (a minimum increased attenuation of 10–15 Hounsfield units) is the most important characteristic separating categories III and IV, which are associated with malignancy in 40–90 %, from the categories I, II, and IIF, which are typically benign processes.
- MRI is typically used to evaluate patients with indeterminate lesions. In addition to signal characteristics, MRI evaluates the same morphologic findings as described above for CT scanning: wall thickening, nodularity, septa, and enhancement. One difference is that MRI does not detect calcification. MRI is especially useful for characterizing internal contents of cysts, such as hemorrhage or mucin, and is more sensitive than both ultrasonography and CT in showing enhancement of internal septations. The combination of mural irregularity and intense mural enhancement had the highest correlation with malignancy.

  Serial MRI examinations at 3, 6, and 12 months are warranted in patients with indeterminate lesions on gadolinium-enhanced MRI.

Renal Lipomatosis

- Renal sinus lipomatosis refers to a condition where there is excessive renal sinus fat replacement, which can be due to inflammation, renal parenchymal atrophy, renal stones, ageing or steroids.
- There is a variant, called “replacement lipomatosis of the kidney” in which infection, renal calculi, and long-standing hydronephrosis are accompanied by severe renal parenchymal damage.

- Minor anatomic variants like this one are commonly encountered and are usually evaluated using excretory urography. However, CT is sometimes necessary for further evaluation when urographic findings are confusing. Renal sinus lipomatosis may masquerade as mass lesion in the renal sinus, but CT reveals the benign nature of the process by showing that the renal sinus is occupied by tissue with a fat-attenuation value.

Renal Medullary Carcinoma

- Renal medullary carcinoma is a rare tumor of the kidney. This tumor occurs exclusively in young black patients with sickle cell trait (HbSA and HbSC) but not sickle cell anemia. Affected patients range from 11 to 39 years in age.
- Flank pain and hematuria are the most common presenting symptoms. Metastatic involvement of regional lymph nodes, liver, and lungs at presentation is common.
- The radiologic appearance of renal medullary carcinoma is that of a prototypical infiltrative lesion. An ill-defined mass centered in the renal medulla with extension into the renal sinus and cortex is characteristic; caliectasis may be seen, and the reniform contour of the kidney is maintained. The tumors are heterogeneous on ultrasonography and contrast-enhanced CT, reflecting the characteristic tumor necrosis. The prognosis is extremely poor. The constellation of renal medullary mass, black race, sickle cell trait, and hemoglobin SC disease suggests the diagnosis.

Renal Pelvis, Transitional Cell Carcinoma of

- Transitional cell carcinoma (TCC) of the renal pelvis is an uncommon cancer, and it can be challenging to identify on

routine imaging. Renal pelvis tumors are more common in males, and are typically diagnosed during the sixth decade.

- Microscopic or macroscopic hematuria is the typical presenting symptom. Depending on the location, symptomatic hydronephrosis may be the presenting symptom (flank pain) and a renal colic due to a clot may mimic an impacted calculus. Patients may also present once metastatic disease becomes symptomatic.
- CT urographic study is performed in two or more dynamic phases. An initial baseline examination to rule out stone formations is followed by a delayed arterial or early corticomedullary phase acquired 15–25 s after the injection of contrast medium, which is especially useful in identifying vascular anomalies. The nephrographic phase used for the study of the renal parenchyma begins at 80–140 s after the injection of contrast medium. The final excretory phase is acquired at 4–8 min and enables study of the collecting system and the bladder. TCCs $\geq$1 cm can be visualized in the baseline examination as solid or cystic-like lesions with attenuation values between 8 and 40 HU, location in the renal pelvis or a calyx, and a round, plaque-like or arborescent appearance. In the arterial and venous phases of the dynamic study, there is a moderate but significant increase in the attenuation values of the lesion. TCC is identified in the excretory phase as a sessile, nodular filling defect with lobulated margins. Occasionally dilatation of a calyx, hydronephrosis, and/or delayed enhancement of the collecting system may be the only signs of the presence of a lesion. When the tumor is invasive, its extraluminal growth can be identified with invasion of the perirenal pelvic fat and/or psoas muscle. In addition, multidetector-row CT is able to study its precise anatomy and relations with the arterial and venous vessels. The differential diagnosis should include pelvicalyceal inflammatory processes, which can produce wall thickening and heterogeneity of the surrounding adipose tissue.

- MR urography is especially indicated in children, pregnancy, and patients with known allergies to iodinated contrast medium. The study can be either static or dynamic. Static examination is done with heavily T2-weighted images to exploit the hyperintense signal of the static or semistationary fluids such as urine in the event of stenosis of the collecting system. Dynamic study can be done with or without an associated diuretic agent and is performed after the injection of gadolinium, which is concentrated in the collecting system during the delayed phase. Like on CT images, tumors of the pelvicaliceal cavities appear on MR urography as filling defects with a vegetative polypoid appearance and irregular or stippled margins. Their attachment, which is readily identifiable at the level of the pelvis, is more challenging in lesions arising from the calices or collecting ducts due to the limited size of their lumina. TCC appears isointense to renal parenchyma in T1- and T2-weighted images, and hypointense to urine in T2-weighted images, making its identification simple in the event of dilatation of the pelvicalyceal cavity. Despite being hypovascular, the lesion may appear moderately enhancing after contrast medium administration.

Renal Sinus Cyst

- Renal sinus cysts (parapelvic) are benign extraparenchymal cysts located in the renal sinus. They are not true renal cysts but are probably lymphatic in origin. They may be unilocular or multilocular and are often bilateral. They do not communicate with the renal collecting system.
- Most renal sinus cysts are asymptomatic and are discovered incidentally on imaging studies. They may in rare cases cause hypertension, hematuria, and hydronephrosis, or may become secondarily infected.

- Renal sinus cysts display the same CT features as simple renal parenchymal cysts. They have attenuation values in the water range and are difficult to distinguish from dilated or extrarenal renal pelvis on unenhanced CT scans. The characteristic feature of a sinus renal cyst is a surrounding halo of renal sinus fat, indicating its extrarenal origin. After intravenous administration of contrast medium, the cysts remain of water density and cause displacement of the renal pelvis and calyces. Differentiation from hydronephrosis is thus readily made on contrast-enhanced CT. CT easily distinguishes between renal sinus cyst and renal sinus lipomatosis, which causes a similar deformity of the collecting system on excretory urography. In renal sinus lipomatosis, the attenuation value of the tissue is in the fat range. Solid masses in the renal sinus, such as lymphoma and invasive transitional cell carcinoma, are readily differentiated from renal sinus cyst because of their soft tissue attenuation values.

Renal Transplantation

- Renal transplantation makes the recipients susceptible to a number of complications. These can be broadly categorized as perirenal, renal parenchymal (acute and chronic rejection), renal collecting system (urinoma), and renal vascular complication (renal artery stenosis and renal vein thrombosis). Complications not confined to the kidney are avascular necrosis, amyloidosis, metastatic joint calcification, and increased incidence of malignancy (especially hematologic malignancy).
- Radiologic evaluation for suspected surgical complications and of kidney dysfunction in patients with renal transplants is best achieved by renal scintigraphy and ultrasonography. Peritransplant fluid collections, including hematomas,

lymphoceles, abscesses, and urinomas, are readily assessed on ultrasonography. Unenhanced CT and MRI are reserved for cases in which ultrasonography fails either because of lack of access due to a recent surgical incision or because the transplant area is obscured by intestinal gas. Contrast-enhanced CT should be avoided because of the potential for nephrotoxicity. MRI is a suitable alternative in the evaluation of the transplanted kidney and peritransplant region; however, sonography and sonographic-guided biopsy remain the primary imaging and interventional modalities.

Renal Vein, Diseases of

- Renal vein occlusions may be categorized into five groups: (1) extrinsic occlusion of the renal vein by an adjacent neoplasm; (2) direct renal vein extension of RCC or adrenal neoplasms; (3) renal vein thrombosis associated with primary renal disease (e.g., about 20 % of patients with the nephrotic syndrome); (4) secondary renal vein occlusion or thrombosis may occur when the inferior vena cava is thrombosed after caval extension of thrombus from pelvic or leg veins; and (5) renal vein thrombosis, which may occur as a primary phenomenon.
- A classic acute presentation consists of flank pain, hematuria, and loss of renal function. Patients with chronic renal vein occlusion are usually asymptomatic.
- Contrast-enhanced CT is an excellent method for the noninvasive diagnosis of renal vein thrombosis, provided that renal function is normal. CT permits differentiation between acute renal vein thrombosis and conditions that have similar clinical presentations, such as acute pyelonephritis, acute renal infarction, and acute renal obstruction. Renal vein thrombosis

is generally unilateral. In acute and subacute cases, an enlarged, swollen kidney is seen on CT. The nephrogram in the affected kidney is initially diminished because of impaired renal perfusion; however, once the nephrogram develops, it persists for a prolonged period and there is often prolonged enhancement of the renal cortex relative to the renal medulla. Calyceal opacification is often delayed, diminished, or absent in the affected kidney. Stranding of the perinephric fat due to edema and thickening of the renal fascia may occur. Enlarged perirenal collateral veins are often noted. Perinephric hemorrhage may occur. On CT, the renal vein is commonly enlarged and may show a filling defect because of thrombus. Thrombosis of the inferior vena cava at *or* near the renal vein orifices occurs in about 40–50 % of patients with renal vein thrombosis. Demonstration of venous thrombus is facilitated by scanning during the peak phase of vascular opacification after bolus injection of contrast medium and by obtaining 5-mm-thick sections.

- MRI is widely used for detecting renal vein extension of RCC; it can also be used in the evaluation of nonneoplastic renal vein thrombosis. MRI is most useful for evaluating patients with significant renal functional impairment and symptoms suggesting renal vein thrombosis. Renal vein thrombus may be shown on T1-weighted spin-echo pulse sequences when the signal void of flowing blood in the renal vein is replaced by high signal because of thrombus. Gradient-echo technique shows thrombus as a filling defect of medium signal intensity that replaces the high signal of flowing blood. Coronal MRI helps determine the extent of involvement in the vena cava. MRI in patients with acute renal vein thrombosis may also show loss of corticomedullary differentiation on T1-weighted spin-echo images, increased signal in the affected kidney on T2-weighted images, renal fascial thickening, and renal enlargement.

Renal Oncocytoma

- Renal oncocytoma is a rare benign renal tumor, but it is clinically important since distinguishing it preoperatively from renal cell carcinoma (which has similar epidemiology, presentation, imaging, and even histology) may be particularly challenging. Renal oncocytomas account for only 5 % of resected primary adult epithelial renal neoplasms. They typically present during the 6th or 7th decade, similar to renal cell carcinoma.
- On CT, oncocytomas typically are well-defined masses with smooth, rounded margins. Tumor calcification occurs rarely, and oncocytomas are sometimes multiple and bilateral. Small oncocytomas are usually homogeneous in appearance on contrast-enhanced CT scans, although they are occasionally heterogeneous because of the presence of central scars. On CT, small oncocytomas are usually indistinguishable from slowly growing small RCCs that lack hemorrhage or necrosis. A central, sharply defined stellate scar is present in up to one-third of large oncocytomas and strongly suggests the diagnosis. However, CT criteria are usually poor discriminants for distinguishing between oncocytoma and RCC, regardless of tumor size.
- On MRI, oncocytoma is generally isointense to hypointense to normal parenchyma on T1-weighted images and has a variable appearance on T2-weighted images (it may be hyperintense compared to renal cortex and may demonstrate hypointense central renal scar, which suggests the diagnosis). Oncocytomas do enhance in a homogeneous fashion with gadolinium administration, but less than renal parenchyma.

Renal Trauma

- Renal trauma may be caused by both blunt and penetrating abdominal injuries. Blunt trauma is responsible for most

renal injuries. Such injuries are usually mild and heal without specific therapy. Serious renal injury is often associated with damage to other structures.

- Renal injuries are classified into four categories on the basis of imaging findings. Category I lesions (75–85 % of cases) are clinically insignificant; they consist of contusions and small corticomedullary lacerations that do not communicate with the collecting system. Category II lesions (10 % of cases) are more serious and comprise major lacerations through the renal cortex extending to the medulla or collecting systems with or without urinary extravasation. Category III lesions (5 % of cases), which are catastrophic, consist of shattered kidney (multiple deep lacerations) and injury to the renal pedicle. The rare entities of ureteropelvic junction avulsion and laceration of the renal pelvis are designated as category IV lesions.
- Gross hematuria is the most reliable indication of potentially serious renal damage. However, the absence of hematuria does not preclude significant renal injury.
- Contrast-enhanced CT is the preferred modality for evaluation of patients with blunt or penetrating abdominal trauma with scans obtained at 70 s and 3 min after the start of injection of contrast material. The three basic types of renal injury demonstrable by CT are contusions, lacerations, and infarcts, any of which may be further complicated by intrarenal or extrarenal hematomas or by urinary extravasation. The mildest form of renal injury is the contusion, characterized by an amorphous, interstitial extravasation of blood and edema. On unenhanced CT scans, the affected kidney zones may show focal swelling and irregular infiltrates of high-density fresh blood. On contrast-enhanced CT, renal contusions appear as ill-defined, round or ovoid areas of hypoattenuation. Superficial lacerations are limited to the renal cortex; deep lacerations extend into the medulla, where they may enter the collecting system or transect the kidney. Contrast extravasation

is often seen in the perinephric space. In patients with multiple lacerations (shattered kidney), the fragments are separated and surrounded by blood clot. Thrombosis or laceration of a segmental branch of the renal artery produces a focal area of renal infarction. Infarcts typically appear as peripherally based, wedge-shaped areas of parenchyma that fail to enhance during both the corticomedullary and pyelographic phases of CT. Posttraumatic bleeding is commonly associated with all injuries to the kidney. Hematomas may be intrarenal or subcapsular or may involve the perinephric or pararenal spaces. The most significant vascular injury after blunt trauma is thrombosis of the main renal artery; the diagnosis of pedicle injury can be suggested by a hematoma surrounding the renal hilus and abrupt cutoff of the contrast-filled renal artery. Acute renal vein occlusion may be suspected if the kidney is enlarged and shows thrombus in the renal vein. Ureteropelvic junction injuries are rare. In these patients, CT typically demonstrates excellent excretion of contrast material with an intact intrarenal collecting system, but with medial perinephric urinary extravasation rather than lateral urinary extravasation in category II injuries with involvement of the collecting system. A circumrenal urinoma may be seen around the affected kidney, but typically, there is no perinephric hematoma.

- Gadolinium-enhanced MRI may be used to assess suspected renal injury when the use of iodinated contrast material is contraindicated.

Reninoma

- Renin-producing tumors (juxtaglomerular neoplasm or reninomas) are a rare, but curable, cause of hypertension. Two-thirds of juxtaglomerular cell tumors of the kidney occur in

young women of child-bearing age. None of the reported neoplasms has been invasive or has metastasized.

- Reninomas are usually well shown on contrast-enhanced CT scans on which they show a smooth outline and sharp margination. Small foci of hemorrhage may cause a heterogeneous tumor appearance. Because of their benign nature, reninomas may be managed by partial nephrectomy.
- On MRI, reninomas are isointense to hypointense to normal cortex on TI-weighted images and hypointense to normal cortex on T2-weighted images. These tumors tend to enhance less than normal cortex on MRI because of their relative hypovascular architecture.

Retroperitoneal Fibrosis

- Retroperitoneal fibrosis is a proliferation of fibrous and/or chronic inflammatory tissue in the retroperitoneum. Its incidence is 1:200000, it is three times more common in men, and the peak incidence is in the 6th decade. It can be primary or secondary.
- Symptoms are nonspecific: diffuse, dull back pain; weight loss, leg lymphedema.
- The modality of choice to investigate this condition is MRI, and US can then be used for follow-up. Pathognomonic findings are proliferation of fibrous tissue in the retroperitoneal space, fibrotic process surrounding the aorta and ureters, medial deviation of the mid-ureters, and concentric ureteral narrowing.
- On MRI, there is retroperitoneal proliferation of fibrous tissue that may extend from the pelvic wall to the renal hilum. The tissue has low signal intensity on T1-weighted images and moderately low signal intensity on T2-weighted images. Encasement of the aorta and ureters is often evident. If there

is an acute inflammatory process, this will be indicated by increased signal intensity on T2-weighted images and more marked enhancement. Medial deviation of the ureters is sometimes observed and there is possible urinary obstruction. Thickening and irregularity of the aortic wall is often associated with idiopathic retroperitoneal fibrosis. A highly inhomogeneous appearance on T2-weighted images suggests the malignant form of retroperitoneal fibrosis.

- On CT, there is low-attenuating fibrous tissue in the retroperitoneum. The other findings are similar to those on MRI. Differential diagnosis should include urothelial carcinoma of the ureter and retroperitoneal lymphadenopathy.

Retroperitoneum in Renal Cell Carcinoma, Bladder Cancer, and Other Pelvic Neoplasms

- Retroperitoneal lymph node enlargement can be encountered in patients with renal cell carcinoma (RCC). Both CT and MRI appear equally effective in detecting retroperitoneal lymph node metastases, but these techniques are usually helpful only when bulky metastatic disease is present. Unfortunately, RCC and other pelvic malignancies frequently metastasize to normal sized or only slightly enlarged nodes, so that identification of tumor spread to pelvic and retroperitoneal nodes by CT and MRI is often impossible. Reported sensitivities for detecting abdominal and pelvic lymph node involvement vary widely, and specificities have also been less than optimal. Some work has demonstrated that MRI lymph node enhancement with gadolinium-based contrast material is more rapid when metastases from bladder cancer are present. This difference in enhancement rate between normal and abnormal lymph nodes has resulted in MRI detection of metastatic disease even in normal-sized lymph nodes. On CT

scan, however, lymph nodes invaded with metastatic tumor occasionally enhance with contrast material to the same extent as adjacent vessels. Such enhancement, which has been observed in some patients with bladder cancer and some other nonpelvic primary neoplasms (e.g., thyroid and RCC), may lead to the erroneous impression that lymph nodes actually represent abnormal dilated vessels.

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