Role of the Multidetector CT Angiography in the Assessment of Renal Vascular Abnormalities

SHERIF F. ABD ELRAHMAN, M.D.* and REDA TABASHY, M.D.**
The Department of Radiology, Faculty of Medicine, Cairo University* and National Cancer Institute**

Abstract

Objective: To evaluate the role of the Multidetector Computed Tomographic (MDCT) angiography in the diagnosis and assessment of the common renal vascular abnormalities.

Patients and Methods: Between January 2012 and March 2013, 28 patients (19 males and 9 females) with clinical history and complains suggesting renovascular disease were examined by MDCT renal angiography. Resistant hypertension was the main complain in 13 patients. Hematuria was the main complain in 11 patients. Loin pain was present in 11 patients and varicocele in 4 patients.

Results: Eight patients had atherosclerotic renal artery stenosis (RAS). One patient had fibromuscular dysplasia (FMD). One patient had polyarteritis nodosa (PAN) with bilateral intrarenal micro-aneurysms and right renal infarcts. Three patients diagnosed to have renal artery arteritis with renal artery stenosis and renal infarcts. One patient had renal artery aneurysm. Three patients had renal arteriovenous fistula (AVF), two congenital and the other occurred post biopsy. Three cases diagnosed to have uretero-pelvic junction obstruction, due to crossing accessory vessels on each side. One patient had arterio-pelvic postoperative fistula. Five patients had nutcracker syndrome. One patient had renal vein pseudoaneurysm after stab injury and one patient had malignant renal vein thrombosis.

Conclusion: Multidetector Computed Tomographic (MDCT) angiography is an essential diagnostic tool in the diagnosis and assessment of the common renal vascular abnormalities.

Key Words: MDCT – Angiography – Renal artery stenosis – Renal artery angiography.

Introduction

RECENTLY, multidetector computed tomographic (MDCT) angiography has become a key imaging investigation for assessment of the renal vasculature and has challenged the role of conventional angiography [1]. MDCT systems offer shorter image acquisition time, narrower collimation, improved temporal and spatial resolutions, and near isotropic data acquisition which is advantageous for two-and three-dimensional imaging, compared with original single slice spiral CT [2].

The disadvantages of MDCT angiography include potential for reactions to iodinated contrast material, nephrotoxicity and exposure to ionizing radiation. Magnetic resonance angiography is an alternative non-invasive imaging technique, which avoids ionizing radiation. However, its spatial resolution is inferior to that of MDCT; it also has less common availability and higher cost. Furthermore there are some recent concerns about the safety of some gadolinium based contrast agents.

Main clinical indications for renal MDCT angiography include the imaging workup for ruling out renovascular hypertension, renal transplant recipient and donor evaluation, acute onset flank pain in patients with coagulative disorders, direct renal trauma, arteriovenous communications, renal artery aneurysm, renal parenchymal or vascular calcifications, renal manifestations of a systemic disease (e.g., vasculitis, thromboembolic disease).

The purpose of this study is to evaluate the role of the Multidetector Computed Tomography (MDCT) in the diagnosis and assessment of the common renal vascular abnormalities.

Patients and Methods

Between January 2012 and March 2013, 28 patients (19 males and 9 females, age ranges from 20 to 67 years, mean age is 43 years) presenting to the Outpatient Clinics of Kasr El-Aini Faculty of Medicine with clinical history and complains suggesting renovascular disease.
Protocol for MDCT angiography:

Diagnostic accuracy of renal multidetector CT (MDCT) angiography depends on the quality of initial raw data acquired during the study. Adequate patient preparation, positioning, as well as the proper contrast material injection, are of paramount importance. CT protocol for the evaluation of the renal vasculature consists of both unenhanced and enhanced CT scans. Unenhanced scans of the kidneys and adrenal glands with contiguous sections of 3-mm thickness are necessary for the evaluation of adrenal lesions, vascular calcifications, and renal calculi [5].

The optimal anatomic coverage for the arterial phase scan, that is the principal part of the renal MDCT angiography, should include the region between the celiac artery and terminal part of the common iliac arteries. However, in patients with ectopic or transplanted kidney, the coverage can be modified; for this purpose careful preprocedural evaluation of the patient should be done.

Renal MDCT angiography was performed by using a 16-row MDCT system (Lightspeed Ultra, GE Medical Systems, Milwaukee, Wis., USA). The following paragraphs summarize our recommended protocol for CT angiography of the renal vasculature:

1- A large-bore (18-gauge) intravenous line is placed in the antecubital fossa.

2- The patient is given water orally. Water is used as a negative contrast agent because a positive orally administered contrast agent would interfere with the 3D rendering to follow.

3- The patient is instructed in breath-hold technique for 10-20 seconds for obtaining optimal images of the renal hilum.

4- The renal hilum is localized accurately by obtaining the non-enhanced images. The appropriate table position is calculated for evaluation of the renal hilum. The region of interest for scanning extends from the suprarenal abdominal aorta to the iliac artery bifurcation.

5- The main acquisition parameters for the non-enhanced scan are: Tube voltage of 120kV, tube current of 200-240mAs, gantry speed of 0.5s/rotation, the detector collimation of 16x1.5mm, slice thickness of 3mm, pitch of 1.25, and reconstruction interval of 3mm.

6- 100-140mL of non-ionic contrast material is injected at a flow rate of 4mL/sec by using a power injector. The estimated dose is determined on the basis of patient weight as follows: Weight of less than 45Kg, 100mL; 45-90Kg, 120mL; and greater than 90Kg, 140mL.

7- The start time of the arterial phase acquisition is determined using the automatic bolus tracking (Smart Prep, GE healthcare) 5 seconds after a threshold of 125 HU is reached in a region of interest within the abdominal aorta just cranial to the kidneys. This automatic bolus tracking means that the arterial phase acquisition begins 18-27 seconds after the start of injection.

8- The main acquisition parameters for the arterial phase are: Tube voltage of 140kV, tube current of 200-240mAs, gantry speed of 0.5s/rotation, the detector collimation of 16x0.75mm, slice thickness of 1mm, pitch of 1.5, and reconstruction interval of 1mm. The nephrographic images are then acquired 85s after the start of contrast medium injection with 2.5-mm collimation.

9- The venous phase images are acquired 60 s after the threshold of 125 HU is reached in the region of interest within the abdominal aorta. The main acquisition parameters for the venous phase are: Tube voltage of 120kV, tube current of 200-240mAs, gantry speed of 0.5s/rotation, the detector collimation of 16x1.5mm, slice thickness of 5mm, pitch of 1.25, and reconstruction interval of 3mm.

10- All images are reconstructed with a standard soft tissue algorithm and transferred to a separate workstation for postprocessing.

Postprocessing techniques:

For three-dimensional image reconstruction, the volumetric MDCT data sets were processed on a separate workstation (Advantage Windows, GE Medical Systems, Milwaukee, Wis., USA) with multiplanar reformatting (MPR), curved planar reformatting (CPR), maximum intensity projection (MIP) and volume rendering (VR). For three-dimensional MDCT angiography, volume rendering techniques were usually used, but multiplanar and maximum intensity projection images were also used, especially for evaluation of the venous system or small arteries.

In volume rendering, the entire CT data set is used to create the angiogram, and the contributions of each voxel are summed along a line from the viewer’s eye through the data set. For CT angiography, volume rendering is commonly performed with a window or level transfer function that results in high-density materials (e.g. enhanced vessels or vascular calcifications) appearing bright and opaque, whereas less-dense structures appear dim and translucent. Each voxel contributes a bright-
ness, color, and opacity that are used to form the final image. The result is an image that provides a single, comprehensive vascular map of the arteries and veins [6].

Volume rendering is an extremely user-friendly technique because it eliminates the need for preliminary editing; a cumbersome step that previously hampered the clinical utility of the other 3D reconstruction algorithms. By using volume rendering, one can perform all of the editing manipulations within seconds and view the resultant images in real time. The user actively interacts with the image, editing and modifying the position, orientation, opacity, and brightness of the structures. Overlying structures are easily removed with an interactive clip plane, and the vessels of interest are easily rotated into the best orientation for visualizing the region of interest. For examination of the renal hilum, axial, coronal, and sagittal views are often used in conjunction for optimal evaluation of the number, caliber, and course of the renal arteries and veins. Perspective volume rendering can provide an additional view, which allows the user to see the data set from “within” the vessel. With this technique, the user can produce an angioscopic view that can be helpful for identifying a vascular orifice and vascular stenosis [7].

MIP represents the other common reconstruction algorithm commonly employed in examinations of the renal vasculature. In the MIP technique, each voxel is evaluated from the viewer’s eye through the data set, but only the maximal voxel values are selected and displayed. The image produced lacks depth orientation, but a 3D effect can be produced with rotational viewing of multiple projections. In general, volume-rendered images are better than MIP images at displaying complex anatomy, especially when overlapping vessels are present. MIP images can still provide useful information about atherosclerotic burden, vascular stents, and vascular stenosis, and are therefore often reconstructed and interpreted in conjunction with volume-rendered images [5,8].

**Results**

Our study included 28 patients (19 males and 9 females, age ranges from 20 to 67 years) with clinical history and complains suggesting renovascular disease.

They were examined by MDCT renal angiography. Resistant hypertension was the main complaint in 13 patients. Hematuria was the main complaint in 11 patients. Loin pain was present in 11 patients and varicocele in 4 patients (Table 1).

<table>
<thead>
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<th>Character</th>
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<td>Age:</td>
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<td>Main complain:</td>
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<td>Resistant hypertension</td>
<td>13</td>
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<td>Hematuria</td>
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They were examined by MDCT renal angiography. Resistant hypertension was the main complaint in 13 patients. Hematuria was the main complaint in 11 patients. Loin pain was present in 11 patients and varicocele in 4 patients (Table 2).

<table>
<thead>
<tr>
<th>MDCT angiography</th>
<th>Number of patients</th>
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<tr>
<td>Atherosclerotic renal artery stenosis</td>
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<tr>
<td>Fibromuscular dysplasia</td>
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<td>Polyarteritis nodosa with renal parenchymal aneurysms</td>
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<tr>
<td>Arteritis with renal artery stenosis</td>
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<tr>
<td>Renal artery aneurysm</td>
<td>1</td>
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<tr>
<td>Arteriovenous fistula</td>
<td>3</td>
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<tr>
<td>Uretero-pelvic junction vascular obstruction</td>
<td>3</td>
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<tr>
<td>Arterio-pelvic fistula</td>
<td>1</td>
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<tr>
<td>Nutcracker syndrome</td>
<td>1</td>
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<tr>
<td>Renal vein thrombosis</td>
<td>5</td>
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<td>Renal vein aneurysm</td>
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Eight hypertensive patients not responding to the antihypertensive drugs were diagnosed to have atherosclerotic renal artery stenosis (RAS). One patient had fibromuscular dysplasia (FMD) and renal artery narrowing. One patient was known to have polyarteritis nodosa (PAN) with hypertension and infrequent hematuria. MDCT angiography revealed only multiple renal infarcts but bilateral intrarenal micro-aneurysms were detected by conventional angiography. Three patients were complaining of resistant hypertension and infrequent hematuria. They were diagnosed by the MDCT angiography to have renal artery arteritis with renal artery stenosis and renal infarcts. One 21 years old female presented by infrequent hematuria, the MDCT angiography revealed left renal artery aneurysm and confirmed by digital subtraction angiography.
Three patients presented by frequent hematuria and MDCT angiography revealed renal arteriovenous fistula (AVF), two congenital and the other occurred post biopsy. Three patients were complaining of loin pain and there was hydronephrosis without evident cause by conventional imaging. MDCT angiography revealed uretero-pelvic junction obstruction due to crossing accessory vessels on each side.

One patient had arterio-pelvic postoperative fistula after endoscopic removal of renal pelvic stone and presented by gross hematuria. Five patients had nutcracker syndrome presented by loin pain and varicocele. One patient had left renal vein pseudoaneurysm after stab injury and one patient had malignant renal vein thrombosis during staging of renal cell carcinoma.

Fig. (1): 53-year-old female patient presented by abdominal pain, hematuria, and recent resistant hypertension. Coronal MIP (A&B) and VR (C) images show dysmorphic left kidney with areas of cortical thinning out, and left renal artery stenosis. Sagittal and coronal oblique MIP (D&E) images show celiac and superior mesenteric arteries occlusion with collateral flow through the artery or Riolan (arrow).

Fig. (2): Fibromuscular dysplasia in 20-year-old female patient presented by resistant hypertension. Maximum intensity projection image shows beaded stenosis of the right renal artery just after its origin and smaller right kidney.
Fig. (3): 22-year-old male with frequent loin pain and hematuria. Axial (A), MIP (B), and VR (C) Images show bilateral renal infarcts. Nephrogenic (D) and Excretory (E) Phases show the cortical defects and secondary calyceal dilatations. Digital angiography (F) Shows parenchymal microaneurysms (arrows). The laboratory tests confirmed polyarteritis nodosa.

Fig. (4): 23-year-old patient presented with hematuria after renal biopsy. An axial maximum intensity projection image shows early filling of the renal vein during the arterial phase with an intra-parenchymal nidus connecting the renal artery to the vein.
Fig. (5): 37-year-old patient presented by bilateral loin pain. Sagittal oblique (A&B) and Coronal (C) MIP images show right mild hydronephrosis due to crossing renal artery and the origin of the aberrant right renal artery (arrow) from the aorta. Sagittal oblique (D&F) and Coronal (F) MIP image show left mild hydronephrosis due to crossing accessory renal artery and the origin of the accessory left renal artery from the IMA.

Fig. (6): Post-surgical arterio-pelvic communication, patient with hematuria following right nephrolithotomy. Axial (A&B) images show the extravasation of the blood in the calyces and the percutaneous entry of the nephrolithotomy (arrow in A). Coronal reconstruction (C&D) images show pelvic and ureteric linear filling defect blood.
Fig. (7): 29-year-old female patient presented by hematuria after a stab to her left loin. Coronal reformatted (A) image during the acute stage shows left renal lacerations. Follow-up axial CT (B,C,D) images show gradual filling of the left renal pseudo aneurysm (arrows). Sagittal oblique reformatted (E,F,G), oblique MIP (G) and VR (H) images show the origin of the aneurysm from the left renal vein (arrows). VR (I&J) images in the chronic stage show the narrow-necked left renal vein aneurysm (arrows).

**Discussion**

Multidetector computed tomographic (MDCT) angiography represents an increasingly important clinical tool that, in many institutions, is replacing conventional angiography in the depiction of normal vascular anatomy and the diagnosis of vascular disorders. Evaluation of conditions affecting the renal vasculature constitutes a major focus of MDCT angiography, which has documented utility for demonstrating both arterial and venous disease [1].

Arterial disorders include renal artery stenosis, renal artery aneurysms, and dissection. Venous disorders include splenorenal shunts, thrombosis, and intravascular tumor extension. In addition, MDCT angiography accurately displays the normal and variant renal vascular anatomy, which is crucial to detect before surgery, especially partial nephrectomy and laparoscopic nephrectomy. CT angiography is also useful in the evaluation of the renal vasculature following renal transplantation. Familiarity with proper CT protocols and data acquisition techniques is crucial for accurate diagnosis [2].

CT angiography is commonly used to evaluate the abdominal aorta and diseases that involve the renal arteries. These disorders include renal artery stenosis, renal artery aneurysms, arteriovenous malformations, dissection, thrombosis, and fibromuscular dysplasia. CT angiography is also valuable in assessing abdominal aortic aneurysms and is very helpful for preoperative evaluation. It can accurately depict the extent and location of the aortic abnormality as it relates to the renal arteries. CT angiography demonstrates not only the renal vascular anatomy but also the secondary parenchymal changes, including infarcts and atrophy [9].

A diagnosis of renal artery stenosis is important, since the condition represents a potentially reversible cause of hypertension. It occurs in fewer than 5% of adult patients with hypertension [10].

Atherosclerotic disease is the most common cause of renal artery stenosis, with the majority of
affected individuals being men over 50 years of age. The stenosis typically results from atherosclerotic plaque and calcification located at the proximal renal artery near the orifice. The disease is bilateral in approximately 30% of patients [11].

Fibromuscular dysplasia is the second most common cause of renal artery stenosis and accounts for a significant number of patients with renovascular hypertension. The majority of these patients are young or middle-aged women. Lesions typically develop in the mid or distal main renal artery, as opposed to the more proximal stenosis seen with atherosclerotic disease. The disease is bilateral in two-thirds of the patients. Fibromuscular dysplasia is classified according to the location of involvement within the vessel wall. Medial fibroplasia constitutes the most common type and often demonstrates multiple ridges, which appear as alternating areas of narrowing and dilatation that are often referred to as a “string of beads” [11].

In a study of 21 patients, Sabharwal et al., [12] found CT angiography to be 100% sensitive in the diagnosis of fibromuscular dysplasia. He concluded that CTA is non-invasive, reliable and accurate method for the diagnosis of renal artery fibromuscular dysplasia. In our study, there are 9 patients presented by resistant hypertension, all were diagnosed by the MDCT angiography. Eight patients diagnosed to have atherosclerotic renal artery stenosis (Fig. 1) with typical proximal renal artery affection. One case was fibromuscular dysplasia with typical features of beaded renal artery stenosis affecting its middle portion (Fig. 2).

CT angiography represents a reliable, non-invasive screening examination for the detection of renal artery stenosis, with reported accuracies in the mid 90th percentile [13]. The examination has nearly 100% specificity in the diagnosis of severe (>50%) stenosis of the renal artery [13,9]. Normal results from CT angiography virtually rule out renal artery stenosis [13]. CT angiography is also very sensitive and specific in the demonstration of renal artery occlusion.

Both MIP and volume rendering techniques are useful and complementary in the CT angiographic evaluation of renal artery stenosis. Axial images alone are not sufficient because the renal arteries often have a tortuous, variable course. The additional views provided by CT angiography allow for display of the renal arteries in multiple planes and projections, which is often necessary for depiction of stenosis. In cases with extensive calcification, stenosis can be obscured by MIP rendering techniques, and careful evaluation with volume-rendered images is needed [10,13]. Angioscopic views often provide the best analysis.

CT angiography can also depict secondary signs of renal artery stenosis, including post-stenotic dilatation and renal parenchymal changes of atrophy and decreased cortical enhancement. CT angiography is also helpful in the evaluation of renal stent grafts, and the highly attenuating graft material and the intraluminal contrast material can usually be distinguished [8].

Polyarteritis nodosa frequently occurs in the renal artery, with aneurysms reported in up to 85% of patients. Patients with polyarteritis nodosa often present with hematuria as these inflammatory aneurysms do not calcify and are more prone to rupture [10]. Renal ischemia occurs as a result of involvement of medium-sized vessels, and renin-mediated hypertension is common [14].

We described one case of polyarteritis nodosa with typical CT and angiographic findings, which were described in four cases examined by Ozaki et al., [15].

Because they are often quite small and peripheral in the distal branches or the interlobar arteries and beyond, these aneurysms may not always be detectable with CT angiography [14]. Selective angiography typically shows small aneurysms at the bifurcation of the interlobar or arcuate arteries. Contrast-enhanced CT can demonstrate areas of infarction of different ages. The kidneys may appear lobulated with irregular thinning of the parenchyma due to prior cortical infarcts. The collecting system is usually preserved. Multiple linear bands of low attenuation may be present in the kidneys and are attributed to occlusion of intrarenal arteries (Fig. 3). The small aneurysms in polyarteritis nodosa occasionally rupture and produce intrarenal, subcapsular, or perinephric hematoma [15].

Arteriovenous communications can be congenital or acquired. They are direct communications from an artery to a vein without an intervening capillary bed. Arteriovenous malformations (AVMs) are usually asymptomatic and are found more often in women than in men. Cirrhotic AVMs consist of multiple small arteriovenous communications that are supplied by multiple segmental or interlobar arterial branches of normal caliber and tend to be located adjacent to the collecting system. Patients with AVMs often present with gross hematuria. An AVM is a rare cause of subcapsular or perinephric hematoma [16].
Arteriovenous fistulas comprise 70%-80% of arteriovenous communications in the kidney. Arteriovenous fistulas can result from trauma, surgery, tumors, inflammation, or erosion of an aneurysm directly into a vein (idiopathic arteriovenous fistula). Arteriovenous fistulas typically have a single feeding artery and a single draining vein, both of which are markedly enlarged. Arteriovenous fistulas are seen more often in men than in women because penetrating trauma is the most common cause. Although the prevalence of arteriovenous fistulas after trauma (e.g. stab wound, percutaneous needle biopsy, percutaneous nephrostomy, nephrolithotomy) is unknown, most are asymptomatic and close spontaneously within a few months. The most common clinical manifestation of a renal arteriovenous fistula is an abnormal bruit. Cardiomegaly or congestive heart failure occurs in one-half of symptomatic patients. Persistent or delayed hematomas are also common. Ischemia in the renal parenchyma distal to the arteriovenous fistula may induce renin-mediated hypertension and impaired renal function [17].

Dönmez et al., [17] presented one case of idiopathic renal arteriovenous aneurysm diagnosed by color Doppler and MDCT angiography. We have three cases, two are congenital and the third one developed after renal biopsy.

The CT appearance of arteriovenous communications depends on the timing of image acquisition relative to intravenous contrast material administration, the amount of contrast material, and the injection rate. Contrast-enhanced helical CT performed during the vascular and early cortical nephrographic phases is valuable in detection of an intrarenal vascular mass with feeding and draining vessels, which are usually engorged. There is prompt filling of the draining veins as well as the renal vein and IVC immediately after enhancement of the arteries (Fig. 4). A diminished nephrogram with or without cortical atrophy distal to an arteriovenous fistula may be seen at helical CT; this appearance is most likely due to the decreased flow to the renal segment because of the shunt. When an AVM bleeds, an intrarenal hematomatoma is present. A subcapsular or perinephric hematoma may be present as a result of bleeding from an AVM [17].

A vessel crossing the ureteropelvic junction (UPJ) in association with hydrenephrosis is present in 25%-39% of adult patients with UPJ obstruction. The presence of vessels crossing the UPJ is of concern because the success rate of endopyelotomy in such cases is only 42% as opposed to 86% in patients without crossing vessels. Vascular injury during endoscopic treatment has been reported in up to 10% of cases. CT angiography has been shown to be useful for identifying crossing vessels in evaluation of patients who previously underwent endopyelotomy for true UPJ obstruction and in preoperative assessment [18].

The crossing vessel is usually located anterior to the UPJ, with posterolateral vessels present in only 5%-10% of patients. In a study by Rouviere et al., 1999 in which digital subtraction angiography was used as the standard of reference, CT angiography had a sensitivity of 100% and specificity of 96.6% for detection of arteries crossing the UPJ. Pelvecaliectasis is present. The ureter distal to the UPJ where the crossing vessels are present is not dilated. Nephrographic progression may be delayed, although it is usually normal (Fig. 5) [19].

Braun et al., studied 27 patients, 12 patients (44%) were found to have 16 crossing vessels. Endopyelotomy was contraindicated in these 12 patients due to the presence of crossing vessels. Eleven out of the 12 patients underwent a pyeloplasty by open surgery or laparoscopy, where the presence of crossing vessels was confirmed. One of the 12 patients did not undergo surgery [20]. In our three cases, there are bilateral accessory crossing renal vessels with significant obstruction, all patients underwent pyeloplasty to relieve the obstruction.

Communication between the collecting system and an artery or vein most often occurs from iatrogenic trauma associated with percutaneous nephrostomy and nephrolithotomy procedures (Fig. 6). Vessels may be inadvertently punctured during needle insertion or the catheter may erode into adjacent vascular structures, leading to fistula formation. Arteriocaliceal fistula in a transplant kidney following biopsy has been described. The presentation may vary from severe hemorrhage to intermittent hematuria. Angiography can be both diagnostic and therapeutic (selective transcatheter embolization). In some cases, partial nephrectomy may be necessary [21]. To our knowledge, all cases described before are case report, as we have only one case after right nephrolithotomy with postoperative frank hematuria. This case was treated by urgent embolization.

Suspicion of renal vein thrombosis is an indication for CT angiographic evaluation of the renal pedicle. In children, dehydration and sepsis are
common underlying factors for renal vein thrombosis. In adults, renal vein thrombosis can result from a variety of disorders, including glomerulonephritis, collagen vascular disease, and diabetes. Trauma is another potential cause of renal vein thrombosis [22].

Arguably, the most important cause of renal vein thrombosis is tumor thrombus from renal cell carcinoma. Determining the extent and location of renal vein involvement by tumor is crucial in planning the surgical approach for removing a renal tumor [23]. The renal veins are well depicted on the CT angiogram during the early corticomedullary phase of enhancement; thus, this phase is recommended for renal vein evaluation at CT angiography. In the acute state, renal vein thrombosis is seen as a hypoattenuating filling defect within an enlarged renal vein. Over time, thrombus may contract and extensive collateral vessels may develop. CT angiography can also directly demonstrate secondary signs of renal vein thrombosis, including delay in the renal cortical nephrogram and global renal enlargement. Thrombus from tumor extension can extend into the inferior vena cava and grow toward the right side of the heart. Complete opacification of the inferior vena cava usually occurs 90-120 seconds after injection of contrast material, and this additional acquisition is recommended in patients with known tumors [24].

Nutcracker syndrome refers to the compression of the left renal vein between the aorta and the superior mesenteric artery, which results in elevated left renal vein pressure and possible collateral vein development. Clinically, Nutcracker syndrome is characterized by intermittent hematuria with or without left flank or abdominal pain. The syndrome occurs in relatively thin patients and adolescents who often have an otherwise healthy medical history [25,26].

Renal vein aneurysms are extremely rare. They are usually congenital, asymptomatic, and found incidentally [27,28]. To our knowledge, few cases have been described in the literature and all are congenital but no traumatic cases reported as our case (Fig. 7).

Conclusion:

Multidetector computed tomographic (MDCT) renal artery angiography represents an excellent noninvasive imaging technique that depicts the normal renal vascular anatomy and accurately diagnoses the various renal vascular disorders.

References


