A 47-year-old woman presented to our hospital with chief complaints of hematuria and left flank pain. The patient denied any recent history of trauma, renal surgery or urinary tract disease. Arterial-phase CT and three-dimensional CT angiography were performed by 64-row multiple detector computed tomography (64-MDCT) and manufacturer-provided workstation. Tortuous fistulas close to the collecting system between the branches of left renal artery and vein were found on arterial phase 64-MDCT and CT angiography. The diagnosis of cirrroid renal arteriovenous malformation (AVM) was made according to CT imaging findings. The patient underwent conventional angiography and transcatheter arterial embolization for renal AVM. She remained symptom free at three-month clinical follow-up.

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The initial IVU showed relative delay function of the left kidney and a suspicious filling defect in the left pelvocalyceal system. Cystoscopy identified a large amount of blood clot lodged in the urinary bladder and left ureteral orifice. Non-enhanced CT (NECT) and dual-phase contrast-enhanced CT (CECT) was performed using the 64-MDCT (Somatom Sensation 64, Siemens AG, Forchheim, Germany). The transverse thin sections were analyzed on a workstation (Syngo, Siemens) with manufacturer-provided software that allows generation of two-dimension and three-dimension volume-rendered images. The NECT demonstrated left side hydronephrosis with high-density blood clots in the left renal pelvis. The arterial-phase CECT images (Fig. 1a-b) and three-dimensional reformatted CTA (Fig. 1c) identified tortuous fistulas close to the collecting system between the branches of left renal artery and vein, and the diagnosis of cirsooid renal AVM was suggested.

The patient underwent conventional renal angiography for further interventional therapy. Digital subtraction angiography images revealed multiple small tortuous fistulas between segmental renal arteries and veins (Fig. 2a). Transcatheter arterial embolization of the renal AVM was performed with coils and the follow-up angiography confirmed successful embolization (Fig. 2b). The patient

Figure 1. a-c: Imaging of renal AVM using 64-MDCT. a-b. Axial view and reformatted sagittal images of the arterial-phase CT reveals abnormal enhancing vascular lesions (arrow) close to left renal pelvocalyceal system. c. The renal CTA with volume-rendered technique demonstrates multiple renal vascular fistulas, the renal AVM nidus (arrows) and early enhancing left renal vein (arrowhead).
remained symptom free at three-month clinical follow-up.

**DISCUSSION**

Abnormal renal vascular communications between the intrarenal arterial and venous systems may be described as renal arteriovenous fistula or renal AVM [3, 4]. Renal AVM is rare and accounts for less than one-quarter of all renal vascular abnormalities, with an incidence of less than 0.04% [5]. Renal AVM is either congenital or acquired (often by iatrogenic procedures). The clinical symptoms include hematuria, systolic hypertension, and flank pain. Hematuria is the most common initial clinical symptom of renal AVM [6]. Renal AVM can also cause increased systemic venous return, which results in high-output heart failure [7].

Congenital renal AVM can be classified as cirrroid, angiomatous or aneurysmal type [8]. The diagnosis of cirrroid renal AVM should fulfill certain criteria, including no history of renal injury or disease, typical angiographic findings, and tortuous vascular channels between segmental or interlobar renal arteries and veins [7]. The tortuous and hypertensive vessels, the so-called nidus, are located immediately beneath the urothelium and often cause clinical symptoms of flank pain or hematuria. It is believed that aneurysmal renal AVM arises from a congenital renal arterial aneurysm, which expands and eventually erodes into adjacent renal vein. Sometimes, intraluminal thrombus could be found within dilated vessels. Most acquired renal AVMs are small, asymptomatic, and close spontaneously. Therapeutic intervention is indicated when persistent hematuria or rupture of the renal AVM occurs.

Imaging tools can detect most of renal parenchymal or urinary tract diseases causing hematuria. Traditionally, IVU and retrograde pyelography are used as first line methods to evaluate urinary mucosa lesions or urolithiasis. US is a convenient tool for detect renal parenchyma malignancy or obstructive uropathy. Color Doppler US has been shown to be more effective for patients with renal vascular diseases [9]. Color Doppler US has advantage of low cost, non-invasive nature, and wide availability. However, the commonly encountered problems with Color Doppler US are operator dependence, limited usage for patients with fat figure, and sometime equivocal diagnosis.

![Figure 2](image_url)

**Figure 2.** a-b: Conventional angiography and transcatheater arterial embolization of renal AVM. a. Conventional arteriography of the left renal artery demonstrate two nidus (arrows), which are composed of multiple small vascular fistulous connections between segmental or interlobar renal arteries and veins. b. Transcatheater arterial embolization of the left renal AVM with two metallic coils (arrows) was done smoothly. The follow-up angiography shows disappearance of renal AVM.
NECT can detect blood clots in collecting system, renal parenchyma or vascular wall calcifications, and urolithiasis. CECT can identify renal parenchyma abnormalities and uroepithelial lesions that cause hematuria. Arterial-phase CT images of renal AVM show typical early enhancement of vascular abnormalities and are different from common renal malignancies [10]. The arterial-phase CECT is valuable in differential diagnosis between renal malignancy and vascular lesion. An arterial-phase CECT depends on the optimized arterial-phase scanning timing, volume and injection rate of contrast agent [11, 12]. A diminished focal renal enhancement or cortical atrophy distal to the renal AVM may be due to vascular shunting [10]. Early visualization of the ipsilateral renal vein and inferior vena cava are valuable signs of AVM [7]. CECT has disadvantages of iodinated contrast agent allergy and relative higher radiation dose due to multiple-phase scanning [12]. Vascular lesions of kidney can be overlooked due to thick-sliced images or inappropriate scanning time.

A flow void in renal MRI will raise the suspicion of a renal vascular lesion [6]. MR angiography of renal AVM may identify tangles of engorged vascular structures, fistulas, and early enhancement of the ipsilateral renal vein as well as suprarenal inferior vena cava [13]. Conventional angiography has been a standard procedure for determining the precise location, extent of lesion, feeding and draining vessels of renal AVM [7]. Conventional angiography has disadvantages of being invasive, causing suffering from procedures, and less renal parenchyma information compared with CT or MRI.

In the past, partial or total nephrectomy combined with arterial reconstructive procedures was the most common procedure of renal AVM. Surgery for renal AVM required extensive dissection of renal arterial branches with high-risk of renal parenchymal damage or even radical nephrectomy [14]. Currently, transcatheter arterial embolization is the treatment of choice for symptomatic renal AVM. Transcatheter arterial embolization can preserve a maximum amount of normal renal parenchyma while eliminating the abnormal renal vascular structures [15].

Recent advances of 64-MDCT technology have great advantage of thin slice images for isotropic image, less scanning time, and covering entire urinary tract from kidney to urinary bladder. In this case, the thin-sliced MDCT images and CTA can well demonstrate the features of a renal AVM, including multiple renal vascular fistulas (nidus) located immediately beneath the urothelium and early enhancing ipsilateral renal vein. With optimized contrast agent injection technique, CTA could generate screening reformatted CTA images like conventional angiography.

REFERENCES
利用 64 排多切面電腦斷層及電腦斷層血管影像診斷腎動靜脈畸形

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一名 47 歲的婦女主訴血尿和左側背痛至醫院求診。患者否認有最近的創傷、腎臟手術或者尿道疾病的病史。在 64 排多切面電腦斷層執行動脈相電腦斷層並使用製造商提供的工作站做出三維電腦斷層血管影像。在動脈相 64 排多切面電腦斷層與重組的電腦斷層血管影像發現左腎緊鄰著泌尿收集系統，在動脈分支與靜脈之間有彎曲的血管。依據電腦斷層影像的結果而做出曲張性腎臟動靜脈畸形的診斷。這名患者接受了傳統血管攝影檢查及經導管動脈栓塞治療腎動靜脈畸形。她在後續 3 個月的臨床追蹤中，依然沒有症狀。