Trans-Radial Embolization of Bleeding Renal Angiomyolipoma in Pregnant 30-Year-Old Female - A Case Report

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ABSTRACT

Trans-radial access offers several unique advantages and is being used more frequently for interventional radiology procedures. We report the use of trans-radial arterial access to embolize a large bleeding angiomyolipoma in a 30-year-old pregnant patient presenting in the first trimester. Trans-radial approach was chosen to minimize the effects of radiation on the fetus. Subsequent postprocedural pregnancy course was uneventful with stability of the angiomyolipoma and no further hemorrhage. This case highlights the benefits of trans-radial embolotherapy in gravid patients to reduce the risk of radiation exposure to the fetus.

CASE REPORT

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A 30-year-old female gravida 2, para 0 presented to the Emergency Department with acute onset, severe right upper quadrant pain and right flank pain at 6 weeks gestation. She also endorsed nausea but denied vomiting, diarrhea, hematuria, melena, or hematochezia. Aside from well-controlled asthma, she was otherwise in good health. Physical examination revealed right flank tenderness to palpation but negative costovertebral angle tenderness, rebound, or guarding.

Transabdominal grayscale and color Doppler ultrasound images revealed a 14 x 11 x 12 cm heterogeneous vascular mass in the right upper quadrant, unclear if arising from the kidney or adrenal gland (Figure 1 & Figure 2). After consideration of the risks and benefits of radiation exposure to the mother and fetus, a contrast enhanced computed tomography (CT) scan was performed to further delineate the mass. The pelvis was shielded, and a limited CT of the upper abdomen was obtained. It demonstrated a large vascular mass extending from the mid pole of the right kidney. The mass contained macroscopic fat with intralesional and perilesional high-density blood products consistent with an angiomyolipoma (Figure 3).

During the length of the admission, she was hemodynamically stable, not requiring transfusion or cardiovascular support. She was informed of the high risk for hemorrhage due to the tumor’s large size and the risks posed by a growing gravid uterus. This was weighed along with the potential risks to the fetus associated with radiation, and ultimately, she was advised to undergo a right renal AML embolization. It was recommended to perform trans-radial embolization after organogenesis and the completion of the neuronal cell proliferation phase in order to minimize the risk of radiation to the fetus. Therefore, the procedure was not performed immediately, as it was a priority to wait as long as possible into the second trimester before having the patient undergo the embolization procedure. The procedure was performed at 19 weeks gestation.

Moderate sedation was administered, and a lead apron was placed over the gravid uterus to further minimize radiation. A modified Allen's test was performed to ensure both the radial and ulnar arteries were patent in the left forearm. Under ultrasound guidance, the left radial artery was accessed using a micropuncture kit and then transitioned to a 5 French Low Profile vascular sheath (Terumo, Tokyo, Japan). Infusion of 2.5 mg verapamil, 2000 units heparin, and 200 mcg nitroglycerin was performed through the sheath to minimize arterial spasm and reduce the risk of arterial thrombosis.

A Bentson Wire and 5 French “Jacky” Optitorque catheter (Terumo, Tokyo, Japan) were advanced through the sheath and guided down the thoracic and upper abdominal aorta to select the right renal artery. To minimize radiation, the fluoroscopy rate was reduced to 3 pulse rates per second and limited digital subtraction angiography was performed. Fluoroscopic images demonstrated a patent right renal artery with perfusion to the right kidney and a prominent vessel feeding the large AML (Figure 4).

A 2.4 French Progreat microcatheter (Terumo, Tokyo, Japan) was advanced through the 5 French catheter and used to select the vessel feeding the AML. After confirming the feeding vessel, particle embolization was performed using a combination of 40-120 micrometer Embospheres followed with 100-300 micrometer Embospheres and was carried out to near stasis. Postembolization right renal artery angiographic images demonstrated significantly decreased flow to the tumor and no evidence of decreased perfusion to the kidney (Figure 5). All catheters were removed, and the radial artery sheath was flushed and removed. A TR band was placed for hemostasis. Thirteen minutes of fluoroscopy time was used during the procedure with a kerma-area product of 203.18 mGy · m2 and reference point air kerma of 28 mGy. Total contrast used amounted to 45 cc Visipaque 320.

Postembolization follow-up visits at approximately 2 weeks and 7 months confirmed that the patient was stable and symptom free. A postpartum CT scan obtained 13 months following embolization demonstrated stability of the lesion. There were no new intralesional or perilesional blood products and previously associated hemorrhage extending into the peritoneum was resolved (Figure 6).

DISCUSSION

Etiology & Demographics:

Renal angiomyolipoma is a benign tumor composed of blood vessels, fat, connective tissue, and smooth muscle that has an incidence of approximately 0.3-3%, making it the most common benign tumor of the kidney. Patient population analysis has shown a significantly higher prevalence of AML in females compared to males of 0.6% and 0.28% respectively [1]. Genetics, via mutation or inheritance, along with hormone imbalances are the major causes of renal angiomyolipomas, and there is a known correlation with tuberous sclerosis. The age predilection in the general population is 40 to 60 years old and 15 to 30 years of age in patients with tuberous sclerosis. The prognosis is generally favorable and worsens as the size of the tumor increases and if the patient presents with rupture/hemorrhage. The etiology and demographics are summarized in Table 1.

Clinical & Imaging findings:

On imaging, renal angiomyolipomas are well-defined masses containing macroscopic fat with variable contrast enhancement. They possess heterogeneity due to fat, muscle, and vessel components. Specifically, on angiography, there is nonspecific tumoral vascularity with sacculated pseudoaneurysms and lack of arteriovenous shunting.

The primary clinical concern relating to AML is life-threatening hemorrhage, which increases in incidence with masses greater than 4 cm in diameter [2]. Thus, it is critical to use imaging modalities to determine whether the mass meets size criteria to potentially cause life-threatening hemorrhage. The patient highlighted in this report had a mass measuring 12 cm, greatly increasing potential complications from hemorrhage. The risks of additional complications are also substantially higher during pregnancy due to the physiological changes of pregnancy (increase of the blood volume) and renal changes (increased glomerular filtration rate and creatinine clearance, increased renal blood flow, and dilatation of the renal calyces and ureters) [3,4]. There is also risk for compression on the tumor/kidney by the growing uterus [3,4,5]. For these reasons, consistent imaging is of critical importance when dealing with a pregnant patient and must be used to determine if embolization should be performed. Renal artery embolization treats and prevents hemorrhage using catheter-directed placement of particulate or liquid agents into a selected renal artery [6].

Previous literature notes the increased difficulty of managing pregnant patients. Pregnancy can limit optimal evaluation with CT or fluoroscopy and can delay treatment, which can then lead to disease progression. According to the National Council on Radiation Protection and Measurements, radiation doses to the fetus greater than 50 mGy pose significant risks for malformations and growth deformities. Standards state the maximum permitted dose for the fetus of a pregnant worker is 0.5 mSv/month and the total gestational dose equivalent is 5 mSv. Additionally, the risks for childhood cancer are dose dependent. Due to these risks, it is advised to delay interventions until the fetus is no longer undergoing organogenesis and the gestational period is complete. The trans-radial approach offers an advantage because the femoral approach can impart more radiation exposure to the fetus [3,7,8]. In this case, fetal exposure was minimized using the trans-radial approach. The radiation dose to the patient was 28 mGy and the fetal exposure is assumed to be lower. This is below the 50 mGy guidelines and lower than the average radiation dose imparted to the uterus during uterine artery embolization of about 80 mGy [9].

Treatment & Prognosis:

The treatment of AML involves observation, embolization, nephron sparing surgery, nephrectomy, or the use of mammalian target of rapamycin (mTOR) inhibitors. The decision for modality of treatment tends to favor the most conservative approach. Traditionally, if embolization is performed, it is done via the femoral artery to devascularize the lesion, causing it to decrease in size by approximately 20-70% of its original volume [10]. However, this approach may lead to an increased radiation exposure to the pelvis. Minimizing pelvic radiation exposure is crucial during pregnancy, as radiation exposure to the developing fetus has been shown to increase the fetus' risk of organ malfunction and death [3,7]. The trans-radial approach represents an effective alternative treatment method that can reduce fetal exposure to potentially damaging radiation as well as reduce radiation to the mother [8]. Moreover, concerns with femoral artery access in pregnant patients also arise in the later stages of pregnancy due to concerns on how to properly position the mother on the angiographic table while limiting compression of any major blood vessels [8,11]. The trans-radial approach allows the procedure to be performed with more flexibility in terms of patient positioning. Trans-radial access allows more flexibility in post-procedure recovery than femoral access since the patient can ambulate and does not have to lie supine for 2-4 hours with his or her lower extremity extended to achieve appropriate hemostasis [8,12,13]. Additionally, in contrast to the groin area, the arm and hand have a dual blood supply via the radial and ulnar arteries, thereby reducing the likelihood of issues related to ischemia [11]. Nerve damage is less likely with the trans-radial approach since the radial artery is easily compressible [12].

However, certain drawbacks of the trans-radial approach should be noted. The most common complication is radial artery spasm, which can make catheter manipulation difficult and lead to procedure failure or crossover to a different access technique. This can be prevented by selecting the appropriate sheath size compared to vessel diameter by evaluating the patient's body habitus/stature or using pre-procedure ultrasound to assess the size of the radial artery. The use of spasmolytic agents infused through the sheath during the duration of the procedure also significantly reduce the onset of spasm. Common agents include verapamil and nitroglycerin. Additional complications of radial access include radial artery occlusion and access site hematomas. Moreover, the small diameter of the vessel limits the size options for guide catheters, and the lack of familiarity and learning curve has limited the adoption of the trans-radial approach [11,12,14]. In abdominal and pelvic procedures, the increased distance between the puncture site and the target lesion has caused the trans-radial method to be somewhat overlooked [11,12].

The patient highlighted in this case presented with a 12 cm right renal angiomyolipoma, which posed a significant risk of hemorrhage. The potential risk to the patient and fetus from tumoral hemorrhage was determined to outweigh the potential risk from embolization and radiation. Therefore, embolization of the right renal AML was recommended. Embolization was not performed until 19 weeks of pregnancy in order to minimize the harmful effects of radiation exposure that can occur early in the pregnancy. The embolization was performed using the trans-radial approach to reduce radiation to the mother's pelvic area and to the fetus. Additionally, use of the trans-radial approach removed any concerns regarding positioning of the patient [8].

Differential Diagnosis:

The differential diagnosis for a fat containing renal mass includes but is not limited to an angiomyolipoma, renal cell carcinoma, perirenal liposarcoma, and renal oncocytoma.

An angiomyolipoma on ultrasound appears as a well-defined hyperechoic mass with acoustic shadowing. It shows intratumoral vascularity on color doppler. On a CT scan, an angiomyolipoma contains macroscopic fat (measuring less than -20 HU). Fat deficient AMLs mimic renal cell carcinomas. On CT, there is variable contrast enhancement due to tumor composition and hemorrhage within and surrounding the AML. There may be prolonged enhancement. MRI demonstrates heterogeneous signal with high signal intensity on T1 and T2 and decreased signal on fat suppression. There is variable enhancement. Angiography shows a mass with increased vascular components and disorganized tortuous vessels with possible pseudoaneurysms.

Renal cell carcinomas (RCC) are heterogeneous solid masses that can occasionally contain cystic components. They rarely contain fat. Intratumoral fat may be related to engulfment and invasion of the perirenal fat/renal sinus fat, lipid producing necrosis, or bony metaplasia. Fat-containing RCCs are difficult to differentiate from AMLs. RCCs demonstrate aggressive behavior and have the propensity to encase surrounding venous structures, like the renal vein and inferior vena cava. On ultrasound, a hypoechoic rim, intratumoral cysts, or a lack of acoustic shadowing can be seen. On CT, calcifications/ossifications, necrosis, metastasis, and/or invasions of veins and adjacent muscles can be exhibited. They exhibit heterogeneous CT enhancement depending on the subtype. T1-weighted scans are hypointense/isointense, and T2-weighted scans show clear cell-high signal intensity. Papillary RCC has a low signal intensity. RCCs enhance less than normal renal parenchyma on MRI. On angiography, neovascularity with abnormal vessels and puddling of contrast is observed.

Liposarcomas are typically large, bulky masses that originate in the perirenal retroperitoneal space and displace and smoothly compress the kidney with no associated defect in the adjacent renal parenchyma. Primary renal liposarcomas are very rare and originate between the renal capsule and the kidney. Liposarcomas are heterogeneous fat and soft tissue masses that are hypovascular with few or no visible vessels. Large exophytic AMLs can mimic liposarcomas. On ultrasound, they appear as well-defined echogenic masses. On CT imaging, they appear as heterogeneous masses with predominate fat attenuation with or without fibrous septa. On contrast-enhanced CT, they can appear as either homogeneous or heterogeneous and show no prominent vessels. On MRI, there is variable signal intensity depending on components of fat and soft tissue. With angiography, they are seen as a hypovascular tumor with displacement of large vessels.

Oncocytomas are the second most common benign renal tumor. They are well-defined solid renal masses that can have a stellate central area of fibrosis or hyalinized connective tissue with compressed blood vessels. They can be bilateral or multicentric. They demonstrate homogeneous hypervascular enhancement. Half of oncocytomas demonstrate a hypointense pseudocapsule, and based on imaging features, differentiation from RCC is not possible. Specifically, on ultrasound imaging, they appear to be well-defined homogeneous isoechoic masses and show a central scar and intratumoral vascularity. On CT examination, they appear to be solid homogeneous cortical renal masses with a stellate hypodense central scar and no aggressive features. They rarely contain fat, and with contrast-enhanced CT, they appear hypodense relative to renal parenchyma. On MRI, relative to renal parenchyma, they are T1 hypointense and T2 hyperintense with late gadolinium enhancement of central scar. With angiography, they show no bizarre neoplastic vessels and sharp demarcation from the kidney.

TEACHING POINT

This case demonstrates the successful use of the trans-radial approach in treating renal tumors in pregnant patients. The trans-radial approach reduces direct radiation to the fetus, which is critical in reducing the risk of birth malformations and childhood cancer, while also allowing greater flexibility in patient positioning, making it the ideal approach for treating angiomyolipomas throughout pregnancy.

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FIGURES

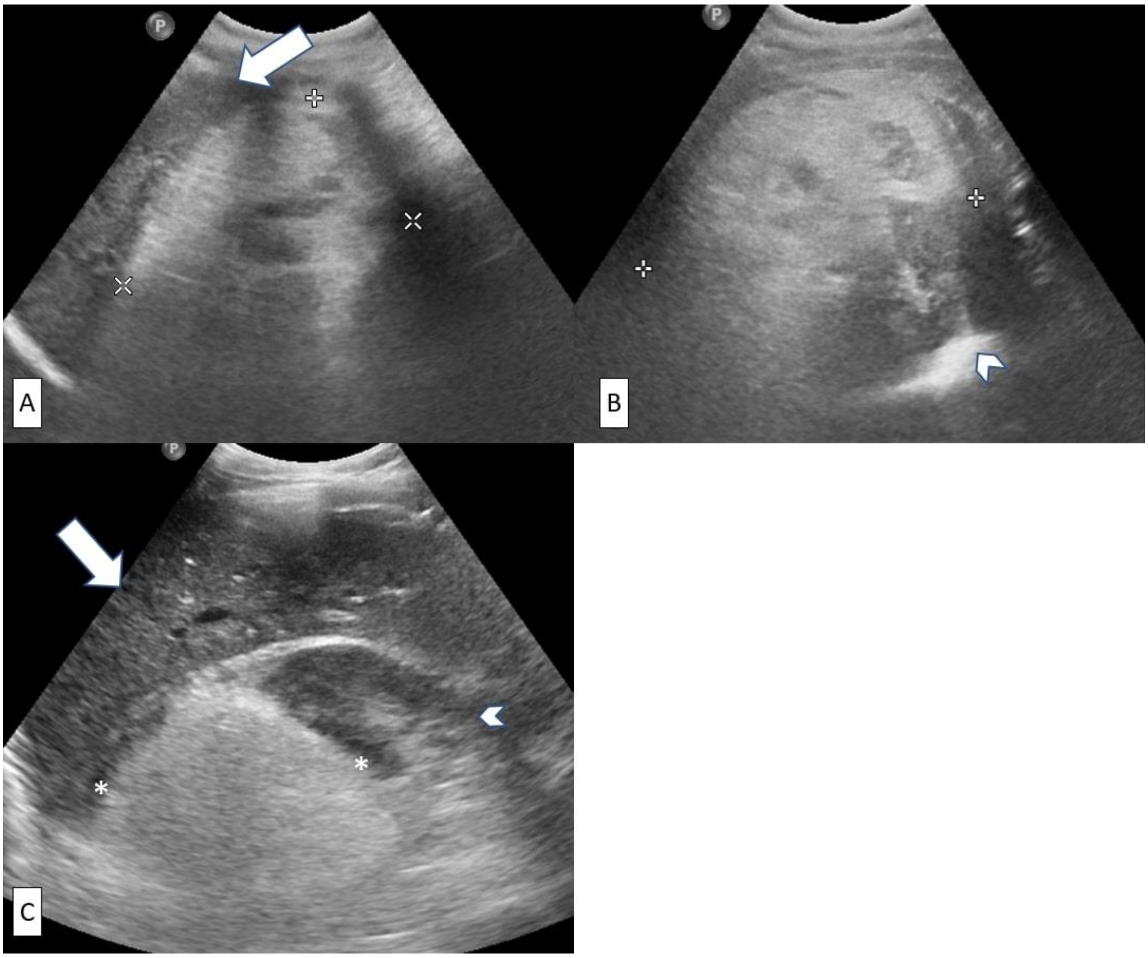

Figure 1: A 30-year-old pregnant female with a right renal angiomyolipoma.
FINDINGS: Sagittal greyscale (A), Transverse greyscale (B), and Transverse greyscale (C) ultrasound images of the right upper quadrant demonstrates a predominantly hyperechoic heterogeneous circumscribed mass measuring 14.2 x 10.5 x 12.4 cm (asterix) abutting the inferior margin of the liver (arrow) and posterior aspect of the right kidney (arrowhead). No evidence of hydronephrosis.
TECHNIQUE: GE LOGIQ E9 C5-1 Broadband curved array transducer 6 MHz

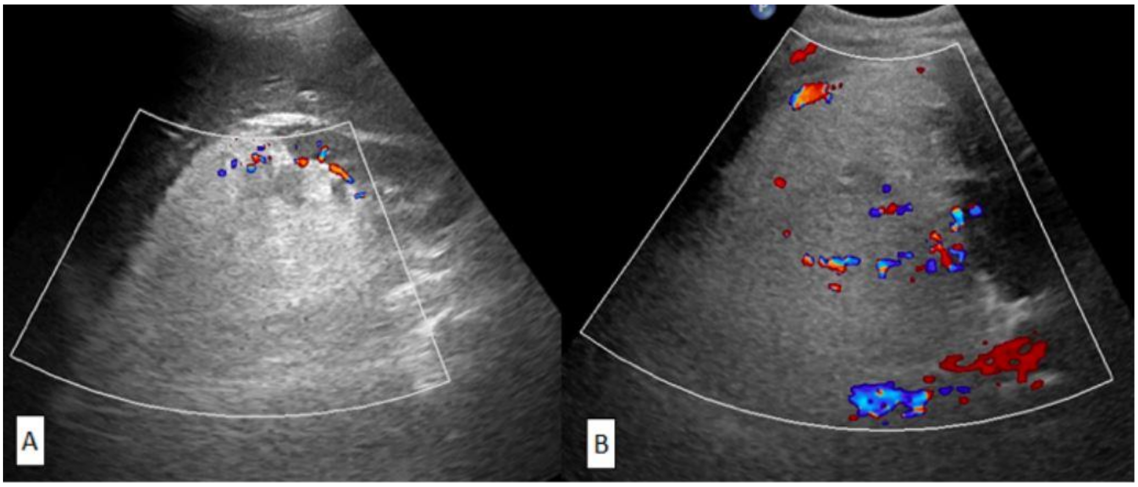

Figure 2: A 30-year-old pregnant female with a right renal angiomyolipoma.
FINDINGS: Transverse color Doppler (A) and Sagittal color Doppler (B) ultrasound images of the right upper quadrant demonstrate a predominantly hyperechoic mass measuring 14.2 x 10.5 x 12.4 cm with color flow identified around the periphery.
TECHNIQUE: GE LOGIQ E9 C5-1 Broadband curved array transducer 6 MHz

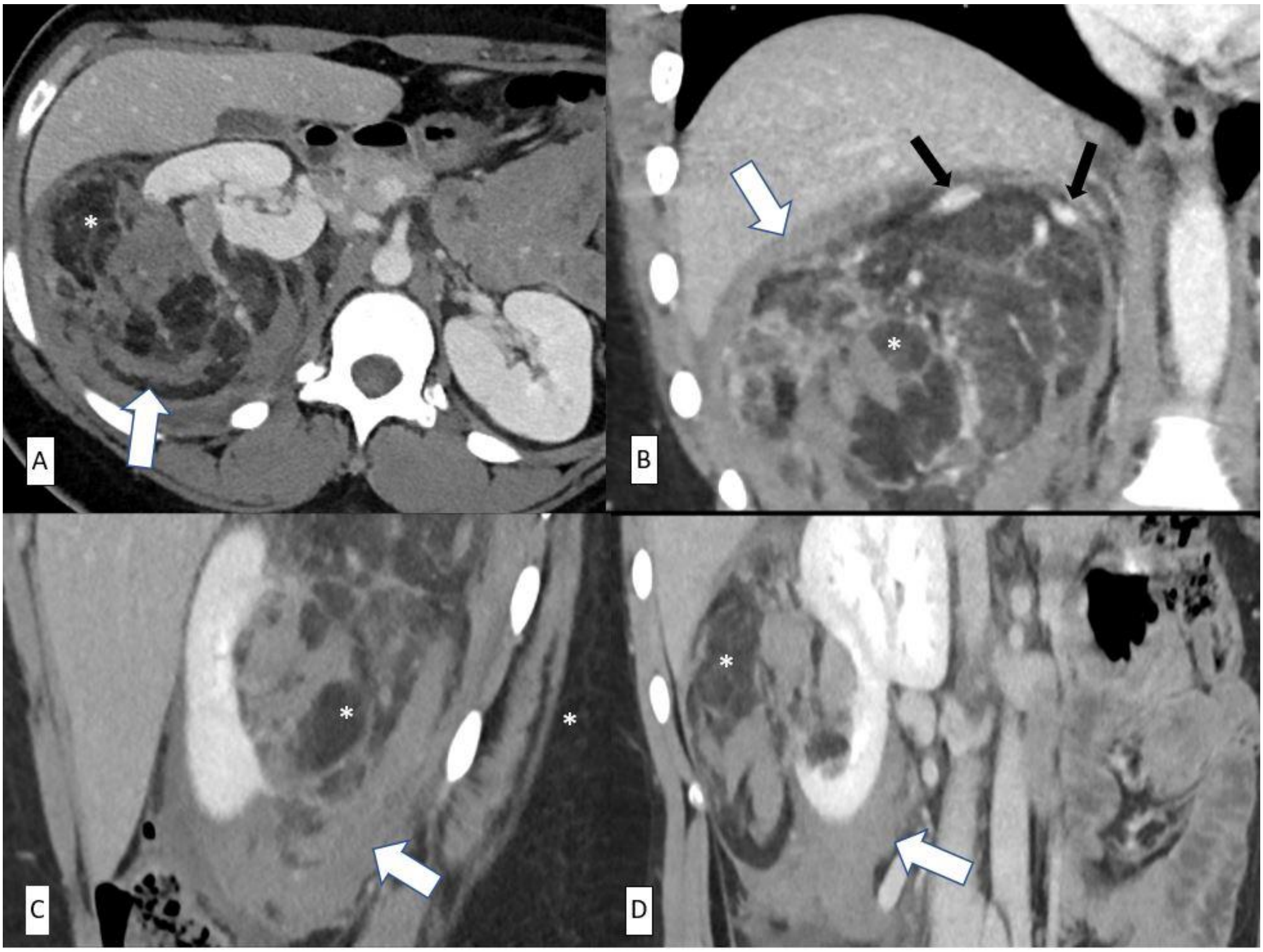

Figure 3: A 30-year-old pregnant female with a right renal angiomyolipoma.
FINDINGS: Axial (A), Coronal (B), Sagittal (C), and Coronal (D) CT images at the level of the kidney. Large, heterogeneous, right mid pole renal mass measuring 11.5 x 7.3 cm in the greatest axial dimension with large areas of macroscopic fat (asterix), large internal vessels (black arrows), and internal/surrounding regions of high density reflecting blood products (white arrow). The mass extends into the right renal hilus without involvement of the renal artery or vein and causes anterior displacement of the right kidney. No abdominal lymphadenopathy.
TECHNIQUE: Siemens Healthineers Global - SOMATOM Definition AS (Total mAs 3185, kVP 120, 3.0 mm slice thickness, 120 mL Omnipaque 350 IV contrast, portal venous phase)

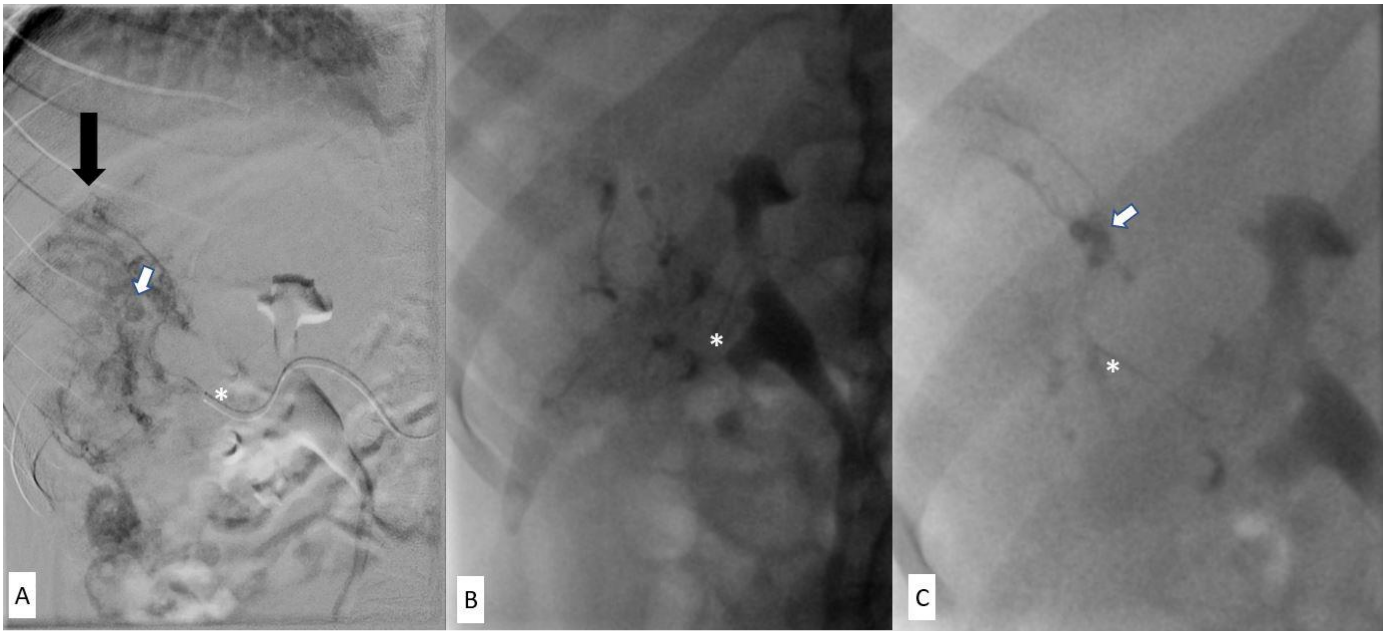

Figure 4: A 30-year-old pregnant female with a right renal angiomyolipoma.
FINDINGS: A) Digital subtraction angiogram B) Fluoroscopic image C) Fluoroscopic image of selective right renal angiogram with a Progreat microcatheter (asterix) in the distal right renal artery demonstrates a highly vascular mass consistent with AML (black arrow) with sacculated pseudoaneurysms (white arrow). No substantial shunting visualized.
TECHNIQUE: Siemens Axiom-Artis. Kerma-Area Product 203.18 microGy m(sq), Reference Point Air Kerma 28 mGy, 25 mL Visipaque 320 IV contrast

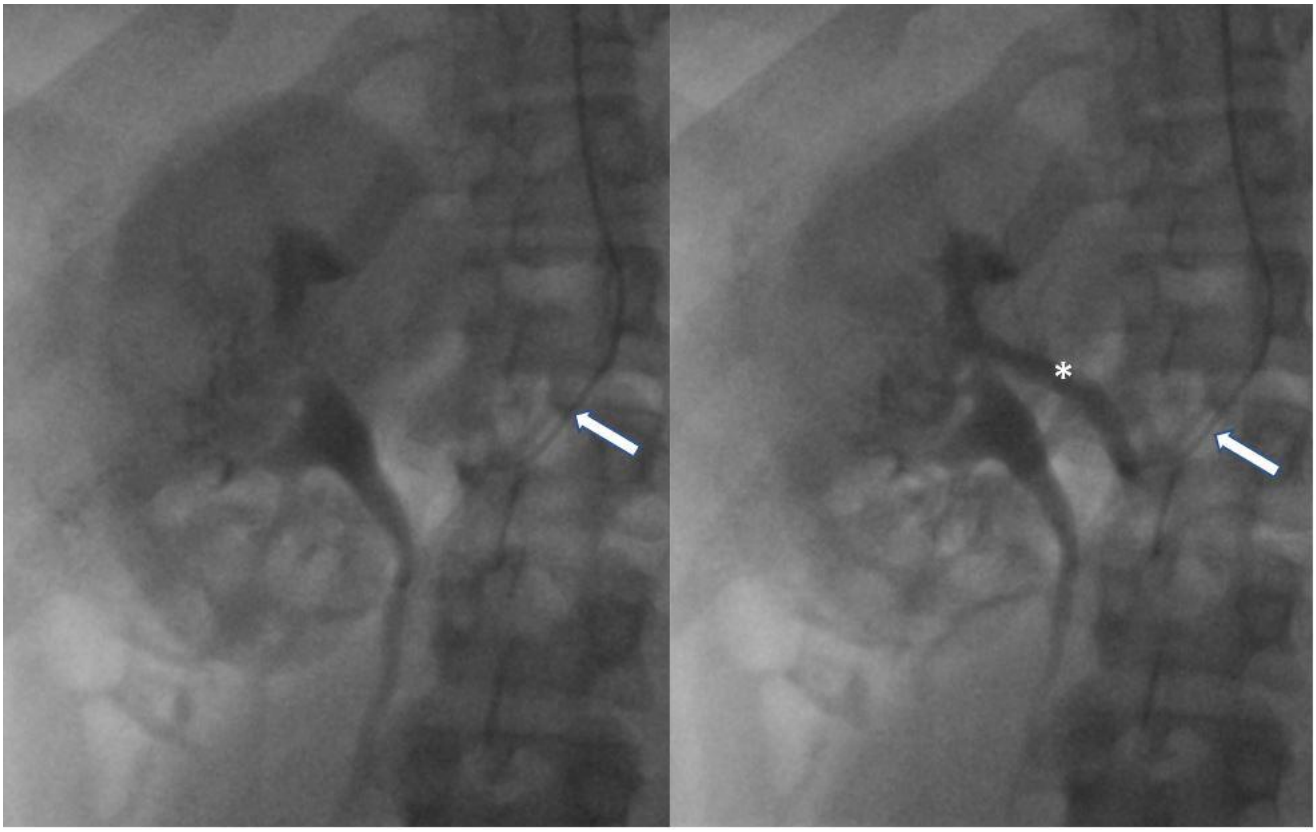

Figure 5: A 30-year-old pregnant female with a right renal angiomyolipoma.
FINDINGS: A) Fluoroscopic image B) Fluoroscopic image of right renal artery angiogram status post-embolization with 40-120 and 100-300 µm Embospheres demonstrates parenchymal enhancement of the right kidney. No evidence of any substantial decrease in perfusion to the right kidney with significantly decreased flow to the AML. 5 French "Jacky" Optitorque catheter (arrow) in the proximal renal artery (asterix).
TECHNIQUE: Siemens Axiom-Artis. Kerma-Area Product 203.18 µGy, Reference Point Air Kerma 28 mGy, 25 mL Visipaque 320 IV contrast

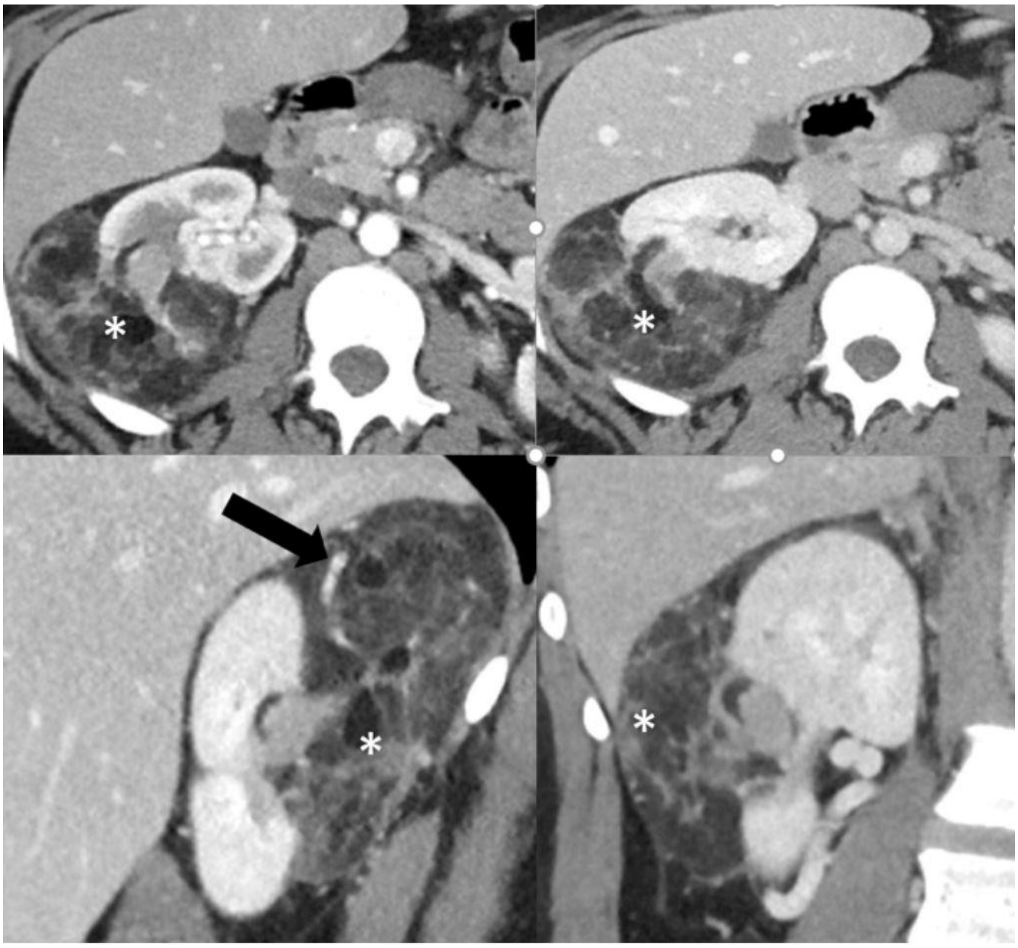

Figure 6: A 32-year-old female with a right renal angiomyolipoma.
FINDINGS: Axial arterial phase (A), Axial portal venous phase (B), Sagittal portal venous phase (C), and Coronal portal venous phase (D) CT images at the level of the right kidney. Remonstrated large, heterogeneous renal angiomyolipoma measuring 8.8 x 5.9 cm extending into the hilum with large areas of macroscopic fat (asterix) and large internal vessels (black arrows). Internal regions of high-density, reflecting blood products have resolved. Patient is asymptomatic. Compared to prior CT, AML is significantly decreased in size and perilesional hemorrhage is no longer visualized.
TECHNIQUE: Siemens Healthineers Global - SOMATOM Definition AS (Total mAs 5518, kVP 120, 3.0 mm slice thickness, 100 mL Omnipaque 350 IV contrast)

Etiology	• Sporadic • Tuberous sclerosis complex associated
Incidence	0.3:100 – 3:100
Gender Ratio	F:M = 2:1
Age Predilection	• 40-60 years • 15-30 years in patients with tuberous sclerosis
Risk Factors	• Tuberous Sclerosis • Family History/Genetics • Hormone Imbalances
Treatment	• Observation • Embolization • Nephron sparing surgery • Nephrectomy • mTOR inhibitors
Prognosis	• Favorable • Prognosis decreases as the size of the tumor increases and if presenting with rupture/hemorrhage
Findings on Imaging	Well-defined mass containing macroscopic fat with variable contrast enhancement. Heterogeneity due to fat, muscle, and vessel components. On angiography, nonspecific tumoral vascularity with sacculated pseudoaneurysms and lack of arteriovenous shunting.

Table 1: Summary table of renal angiomyolipoma.

	US	CT	MRI	Angiography
Angiomyolipoma	• Well-defined hyperechoic mass with acoustic shadowing • Color doppler: intratumoral vascularity	• Macroscopic fat (less than -20 HU); • Fat deficient AMLs mimic RCC • Variable contrast enhancement due to tumor composition • Hemorrhage within and surrounding AML • CECT: Prolonged enhancement	• Heterogenous signal • T1: High signal intensity with decreased signal on fat suppression • T2: High signal intensity • Variable enhancement	• Mass with increased vascular components • Disorganized tortuous vessels • Pseudoaneurysms
Renal Cell Carcinoma	• Hypoechoic rim • Intratumoral cysts • Lack of acoustic shadowing	• Heterogeneous solid mass +/- cystic components • Rarely contains fat • Calcifications or ossifications • Necrosis • Invasion of renal vein or IVC • Metastasis and invasion of adjacent muscles • CECT: Heterogeneous enhancement depending on subtype	• T1: Hypointense/ isointense • T2: Clear cell- high signal intensity. Papillary- low signal intensity • Enhances less than normal renal parenchyma	• Neovascularity with abnormal vessels and puddling of contrast
Perirenal Retroperitoneal Liposarcoma	• Well-defined echogenic mass	• Heterogeneous mass with predominate fat attenuation +/- fibrous septa • Displaces and compresses the kidney • Rarely originates in subcapsular kidney • CECT: Homo-/Heterogeneous. No prominent vessels	• Variable signal intensity depending on components of fat and soft tissue	• Hypovascular tumor with displacement of large vessels
Renal Oncocytoma	• Well-defined homogeneous isoechoic mass • Central scar • Intratumoral vascularity	• Solid homogeneous cortical renal mass • Stellate hypodense central scar • Rarely contains fat • No aggressive features • CECT: hypodense relative to renal parenchyma	• T1: Low signal intensity • T2: High signal intensity • Central scar late gadolinium enhancement • Some have a hypointense pseudocapsule • Heterogeneous enhancement	• No bizarre neoplastic vessels • Sharp demarcation from kidney

Table 2: Differential diagnoses table for renal angiomyolipoma.

ABBREVIATIONS

AML = Angiomyolipoma
CT = Computed Tomography
HU = Hounsfield units
IVC = Inferior vena cava
MRI = Magnetic Resonance Imaging
mTOR = Mammalian target of rapamycin
RCC = Renal cell carcinoma

KEYWORDS

Renal Angiomyolipoma; Pregnancy; Kidney Tumor; Radial Artery; Embolization; Hemorrhage

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