

Color Doppler US in the Evaluation of Uterine Vascular Abnormalities¹

ONLINE-ONLY CME

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LEARNING OBJECTIVES

After reading this article and taking the test, the reader will be able to:

- Describe the relative prevalence and clinical manifestations of a variety of vascular abnormalities in the uterus.
- Identify the gray-scale and color Doppler US features of vascular abnormalities in the uterus.
- Discuss the role of arteriography in the diagnosis and treatment of vascular abnormalities in the uterus.

Pýnar Polat, MD • Selami Suma, MD • Mecit Kantarcý, MD • Fatih Alper, MD • Akýn Levent, MD

Uterine vascular lesions are rare but potentially life-threatening lesions that should be suspected in women of reproductive age with unexplained vaginal bleeding and in postmenopausal women in whom anechoic structures are detected at ultrasonography (US). This is especially true in patients with a history of infection, curettage, therapeutic abortion, pelvic surgery, endometrial carcinoma, or gestational trophoblastic disease. Color Doppler US is valuable in the detection and characterization of many uterine vascular lesions, including arteriovenous malformations (AVMs) (especially arteriovenous fistulas), true aneurysms, pseudoaneurysms, and chorioangioma of the placenta. Arteriovenous fistulas demonstrate a mosaic pattern representing turbulent flow. Spectral analysis of intralesional arterial flow demonstrates high-velocity flow with a low resistive index, and spectral analysis of intralesional venous flow shows high peak systolic velocities consistent with an arterial flow pattern. Spectral analysis of a true aneurysm demonstrates arterial signals, whereas a to-and-fro or swirling pattern of flow is seen at the neck of a pseudoaneurysm. Chorioangioma is a benign hypervascular lesion with arterial and venous flow that, like AVMs, contains numerous cystic spaces that produce color signals. Color Doppler US is useful in the early diagnosis and treatment of these potentially clinically significant disorders of the uterus and placenta. Response to treatment can also be assessed with this technique.

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Abbreviation: AVM = arteriovenous malformation

Index terms: Aneurysm, uterine, 854.73 • Arteriovenous malformations • Arteriovenous malformations, uterine • Fistula, arteriovenous, 854.1494 • Placenta, abnormalities, 857.824 • Placenta, chorioangioma, 857.318 • Placenta, US, 857.1298, 857.12983 • Uterus, US, 854.1298, 854.12983

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¹From the Department of Radiology, Faculty of Medicine, Atatürk University, Erzurum, Turkey. Received February 28, 2001; revision requested April 4 and final revision received July 7; accepted July 23. **Address correspondence to P.P.** (e-mail: drppolat@hotmail.com).

See also the article by Kwon and Kim (pp 35–46) in this issue.

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Introduction

A wide spectrum of vascular abnormalities can affect the uterine vasculature. These abnormalities may be categorized as those involving the uterus proper and those involving the placenta (eg, chorioangioma). Although rare, the most common vascular diseases affecting the uterine arteries are arteriovenous malformations (AVM) (especially arteriovenous fistulas), true aneurysms, and pseudoaneurysms (1–10). Clinically significant vascular malformations of the uterus are rare: Most previous reports in the literature consist of single case histories (ie, experience with this entity at individual institutions is limited).

The most common entity affecting the placenta is chorioangioma, a tumor of hamartomatous origin.

Recurrent vaginal bleeding (menometrorrhagia), which is resistant to treatment, is the most important clinical manifestation of these vascular disorders of the uterus and placenta. These lesions cause habitual or spontaneous abortion in pregnant women and may even be life-threatening. Chorioangiomas of the placenta that reach a diameter of 5 cm or are multiple may cause both fetal and maternal complications. Early diagnosis and treatment of these lesions is crucial because of potentially fatal outcomes.

Color Doppler ultrasonography (US) plays a significant role in demonstrating the vascular nature of these anechoic uterine lesions. In this article, we discuss and illustrate the features of these lesions at gray-scale and, in particular, color Doppler US.

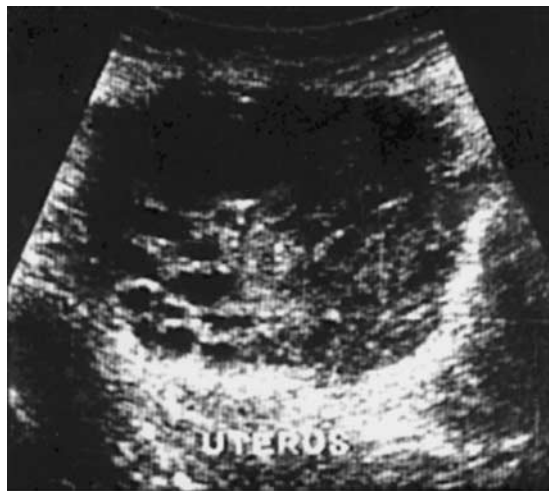
Arteriovenous Malformations

Uterine AVMs are rare in nonpregnant women and were first described by Dubreil and Loubat in 1926 (1). Since then, several terms have been

used to refer to these lesions, including cavernous hemangioma, cirroid aneurysm, racemose aneurysm, arteriovenous aneurysm, pulsatile angioma, and arteriovenous fistula (1–5).

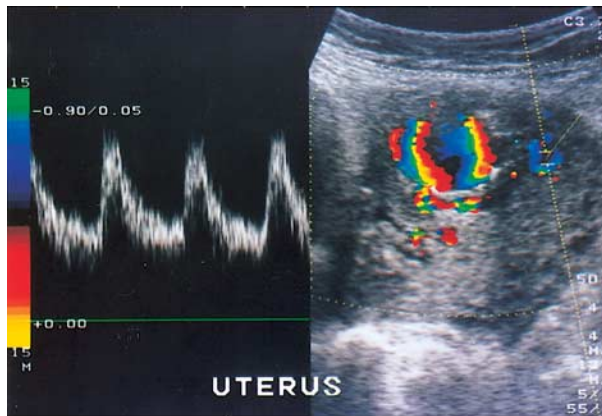
As a normal blood vessel courses toward the region of the tissue it supplies, it divides into smaller and smaller branches. By the time it reaches its destination, it has branched into many thin capillaries. Because there are normally so many capillaries, blood flow within them is slow and under low pressure. An AVM consists of a proliferation of vascular channels with fistula formation and an admixture of small, capillary-like channels. The size of these vessels varies considerably, which probably accounts for the variety of descriptive terms found in the literature. Uterine AVMs are generally congenital (4). Congenital AVMs have multiple vascular connections and tend to invade the surrounding structures (eg, muscle, skin, viscera). They are believed to result from arrested vascular embryologic development. In contrast, arteriovenous fistulas are usually acquired and typically represent a single artery joining a single vein. They have been reported as a consequence of previous uterine trauma (eg, prior pelvic surgery, curettage), use of intrauterine contraceptive devices, pathologic pregnancy-related events, and previous treatment for gestational trophoblastic disease.

Bleeding is the major presenting symptom in AVMs. Because these malformations are less common after menopause, postmenopausal bleeding is rarely seen. Congestive heart failure secondary to a vascular steal syndrome is a less common clinical manifestation. Clinical examination may be unremarkable. At vaginal examination, audible bruits and a pulsatile mass may be detected. In patients with a history of unexplained vaginal bleeding, the possibility of a uterine AVM must be considered. In uterine AVMs, gray-scale US shows a normal-appearing endometrium, whereas the myometrium contains multiple hypo-

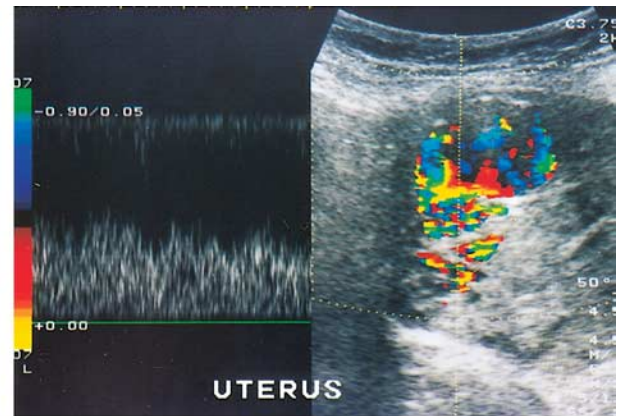


a.

Figure 1. Uterine AVM in a 22-year-old woman who had undergone curettage on several occasions for spontaneous abortion. Evaluation of hysterectomy material had confirmed the presence of a malformation. **(a)** Transabdominal gray-scale US image shows multiple anechoic spaces. **(b, c)** Color Doppler US images show a mosaic pattern of color signals within the cystic spaces. **(b)** Spectral analysis of the arterial vessels within the lesion shows high blood flow velocity with a low resistive index. **(c)** Spectral analysis of venous flow shows high blood flow velocities and peak systolic velocities, findings similar to those seen in **b**.



b.



c.

echoic or anechoic spaces (Fig 1a). At color Doppler US, these cystic spaces generate color signals in a mosaic pattern representing turbulent flow (Fig 1b, 1c) (5). Spectral analysis of the arterial vessels within the lesion shows high-velocity flow with a low resistive index (approximately 0.51–0.65) (Fig 1b). Spectral analysis of venous flow demonstrates a similar pattern (Fig 1c).

Many imaging methods have been used to diagnose pelvic AVMs. Contrast material-enhanced computed tomography, US, angiography, and, more recently, magnetic resonance imaging have proved useful in this setting. Anechoic serpentine structures containing color signal is a reliable finding in AVMs. Spectral analysis of these structures provides additional diagnostic clues. The definitive diagnosis has traditionally been

made with angiography. Today, angiography is the preferred method in patients who may potentially undergo embolization. Color Doppler US is the modality of choice in diagnosing uterine AVMs. Some uterine AVMs are asymptomatic and are seen incidentally at hysterectomy.

Acute treatment consists of hemodynamic stabilization and management of active bleeding. Occlusion with a Foley catheter bulb may be effective. Ultimate treatment depends on the patient's reproductive desires. If fertility is not an issue, hysterectomy is the treatment of choice. More recently, uterine AVMs have been treated successfully with intra-arterial embolization (8,10). Sometimes, massive uterine hemorrhage necessitates hysterectomy.

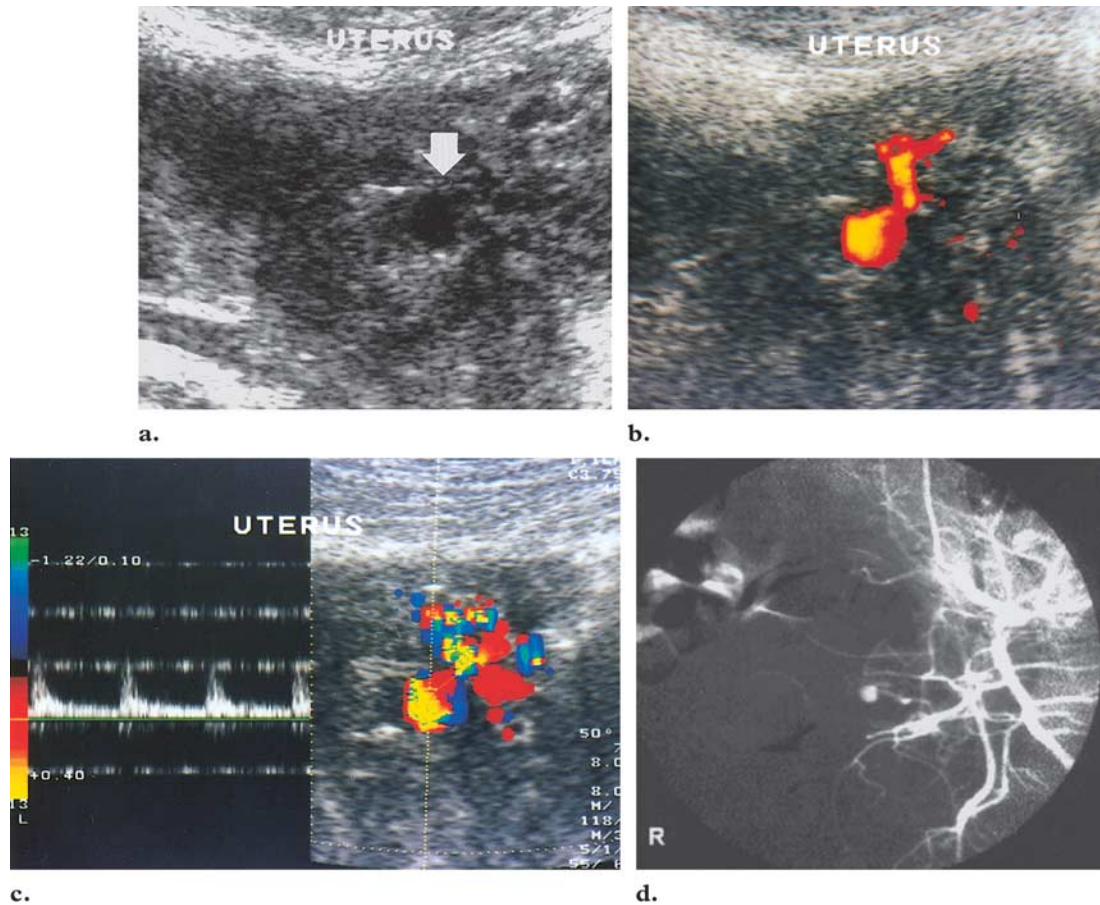


Figure 2. Left uterine artery aneurysm in an 18-year-old woman with habitual abortion. **(a)** Real-time gray-scale US image shows an anechoic lesion in the myometrium (arrow). **(b)** Power Doppler US image shows color signal within the lesion. **(c)** Color Doppler US image with spectral analysis demonstrates the lesion with a typical arterial flow pattern. **(d)** Arteriogram of the left common iliac artery shows a saccular aneurysm that protrudes from the left uterine artery.

Uterine Artery Aneurysms

Although true aneurysms are common at other sites in the body, they are rare in the uterine arteries (6). Nevertheless, they are recognized causes of uterine hemorrhage. Uterine artery aneurysms can be categorized as either fusiform or saccular. Fusiform aneurysms are characterized by localized dilatation of the vessel lumen to approximately twice the size of the proximal and distal portions. Saccular aneurysms are localized extrusions from the vessel that contain all three layers

of the vessel wall; however, only one case was reported in the English language medical literature between 1980 and 2000 (6). A true uterine artery aneurysm is usually congenital, whereas aneurysms in other parts of the body are generally atherosclerotic or traumatic in origin. Systemic disorders that cause vasculitis may affect all of the arteries in the body and give rise to the formation of aneurysms. Aneurysmal rupture is associated with significant morbidity and mortality, especially during pregnancy and puerperium.

A true aneurysm manifests at gray-scale US as a pulsating anechoic structure in the myometrium

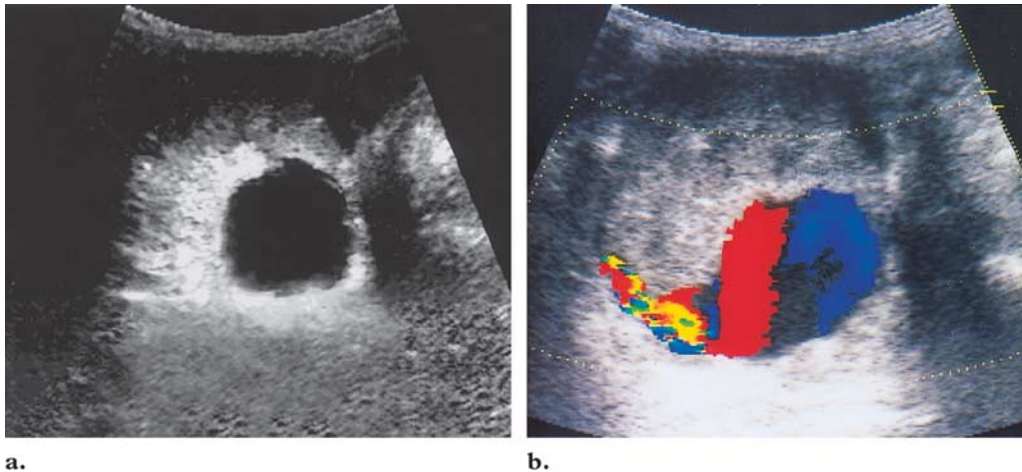


Figure 3. Right uterine artery pseudoaneurysm in a 20-year-old woman with infection that was proved at hysterectomy. The patient had undergone curettage on several occasions. **(a)** Transabdominal gray-scale US image shows an anechoic lesion in the uterus. **(b)** Transverse color Doppler US image shows a pseudoaneurysm that originates from the right uterine artery. Color signals within the arterial lumen represent turbulent flow.

(Fig 2a). Power Doppler US (Fig 2b) and color Doppler US (Fig 2c) can help detect a true aneurysm with high sensitivity and specificity. At color Doppler US, a true aneurysm manifests as color-coded fusiform dilatation or excessive color filling of the parent artery. Spectral analysis demonstrates a typical arterial flow pattern (Fig 2c). Arteriography can be used to confirm the diagnosis but is not essential. At arteriography, excessive contrast material filling representing a saccular aneurysm is seen protruding from the wall of the uterine artery (Fig 2d).

In the past, most uterine artery aneurysms were treated with hysterectomy with or without hypogastric artery ligation. In recent years, uterine artery embolization has become an accepted treatment method (8,10).

Uterine Artery Pseudoaneurysms

Like a uterine artery aneurysm, a uterine artery pseudoaneurysm is rare, although it is more common than a true aneurysm and is usually due to interventional procedures, surgery, curettage, or infection (7–10).

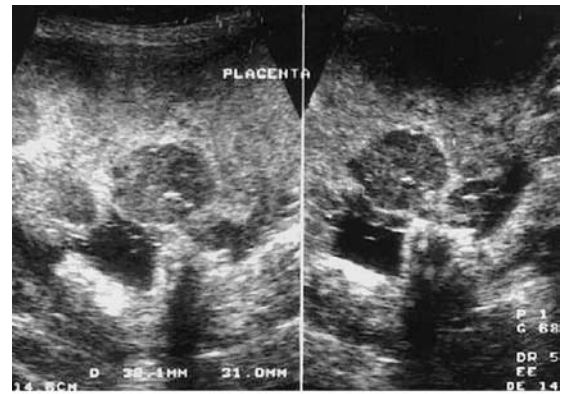
Myometrial infectious processes may lead to degeneration and occlusion of the vasa vasorum with resultant vasculitis and, possibly, transmural

necrosis of the arteries. Ultimately, perforation of the vessel wall can occur, and pseudoaneurysm formation follows. The other cause of uterine pseudoaneurysm is vascular injury, which in the uterus is due to abortion, repeated curettage, or pelvic surgery. Traumatic injury to the vessel wall causes wall incompetence and hemorrhage. The wall of a pseudoaneurysm is formed by a peripheral thrombus, not by all three layers of the vessel wall as in true aneurysms.

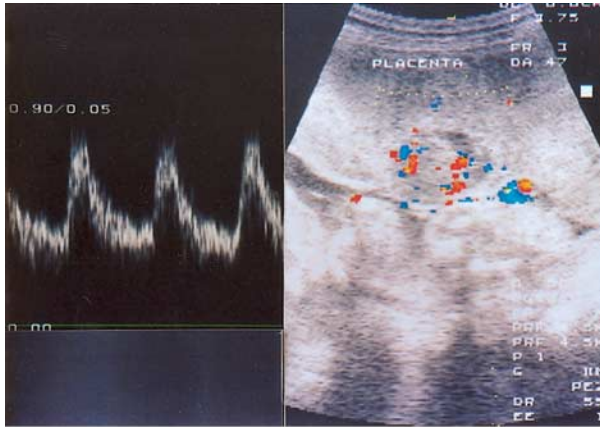
At gray-scale US, a pseudoaneurysm manifests as a pulsating hypoechoic mass connected to a parent artery by a narrow neck (Fig 3a) and is thereby easily differentiated from a hematoma or true aneurysm. Color Doppler US demonstrates turbulent arterial flow with a to-and-fro pattern (Fig 3b). Blood flowing into the collection during systole and away from the collection during diastole is explained by the pressure gradient between a distended high-pressure pseudoaneurysm and the low-pressure artery during diastole.

Treatment is the same as for AVMs and true aneurysms, depending on the patient's reproductive desires.

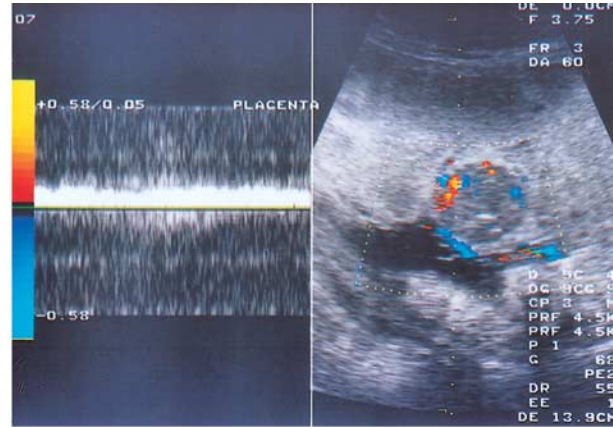
Figure 4. Placental chorioangioma in a 35-year-old pregnant woman in the 24th week of gestation. **(a)** Transabdominal gray-scale US images show a well-defined hypoechoic mass containing multiple cystic spaces that protrudes from the fetal surface of the anterior placenta. **(b)** Color Doppler US image shows color signals in the cystic spaces. Spectral analysis shows arterial flow within the lesion. **(c)** Color Doppler US image of a different vessel with spectral analysis reveals venous flow within the lesion.



a.



b.



c.

Chorioangioma of the Placenta

Chorioangioma is the most common benign tumor of the placenta. It is a well-circumscribed intraplacental mass with increased vascularity that arises from the chorionic tissue and, like AVMs, contains numerous cystic spaces that produce signal at color Doppler US (11,12).

Chorioangioma of the placenta typically ranges from 1 to 5 cm in size and is found in approximately 1% of placentas (13,14). Large, clinically significant chorioangiomas occur much less fre-

quently, with a reported prevalence ranging from 1 in 3,500 to 1 in 9,000 births (13,14). Chorioangioma results from deficient formation of the chorion. Excess capillarization with complete absence of villous differentiation gives rise to formation of the chorioangioma. Chorioangiomas may be either single or multiple, and the majority are asymptomatic. Chorioangiomas larger than 4–5 cm in size may be associated with maternal and fetal complications (13) including polyhydramnios, preeclampsia, acute antepartum hemorrhage, preterm delivery, congenital malformation, hepatomegaly, congestive cardiac failure, mi-

croangiopathic hemolytic anemia, and low birth weight. Abruptio placentae can be seen during the course of the pregnancy.

At gray-scale US, chorioangioma manifests as a hypoechoic intraplacental mass containing anechoic cystic spaces and protruding from the placental surface (Fig 4a). As mentioned earlier, these anechoic spaces produce signal at color Doppler US. Spectral analysis of these color-coded areas reveals pulsatile flow consistent with arterial and venous structures (Fig 4b, 4c).

When a chorioangioma is demonstrated in the placenta, the fetus should be carefully evaluated for possible related complications. Color Doppler US is also useful in the evaluation of intrauterine growth retardation, which can be associated with this lesion. Such evaluation is performed with spectral analysis of uterine and fetal arteries (umbilical artery, fetal aorta, middle cerebral artery).

Most chorioangiomas are small and can be diagnosed after delivery with careful sectioning of the placenta. Three histologic patterns of chorioangioma have been described: angiomatous (capillary), cellular, and degenerative. The most common of these patterns is angiomatous (11,13).

Conclusions

Gynecologic vascular abnormalities are uncommon causes of uterine bleeding. However, they should be considered in women of reproductive age with unexplained vaginal bleeding and in postmenopausal women in whom anechoic structures are detected at US. This is especially true in patients with a history of infection, curettage, therapeutic abortion, pelvic surgery, endometrial carcinoma, or gestational trophoblastic disease. In pregnant women with polyhydramnios or intrauterine growth retardation, the placenta must be carefully evaluated for the presence of a chorioangioma. Color Doppler US is useful in the early diagnosis of these uterine vascular abnormalities and placental lesions, which are potentially life-threatening to the mother or fetus.

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