

Opinion

Enhanced myometrial vascularity secondary to retained pregnancy tissue: time to stop misusing the term arteriovenous malformation

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Introduction

Historically, the term 'arteriovenous malformation' (AVM) has been used to describe striking myometrial vascularity identified on Doppler after a recent intrauterine pregnancy. In 2004, Van Schoubroeck *et al.* introduced the term 'enhanced myometrial vascularity' (EMV) to describe this sonographic finding when it is associated with retained pregnancy tissue¹. The terms AVM and EMV continue to be used interchangeably^{2–5} leading to confusion as to the pathophysiology of these two different entities and, more importantly, their management⁵.

Arteriovenous malformation

Congenital AVMs are rare lesions resulting from embryological maldevelopment, and are not related to the placenta. These aberrant connections between arteries and veins may occur anywhere in the body, including the brain, and do not disappear spontaneously. Treatment involves surgery or interventional radiology with selective embolization⁶. On the other hand, EMV represents a natural manifestation of the pathophysiology of retained pregnancy tissue. The term EMV should only be used in the first weeks postnatally or following a non-viable normally sited intrauterine pregnancy. Using AVM as a

synonymous term for EMV should be avoided, as the former is a persistent congenital vascular malformation whereas the latter is a pregnancy-related physiological condition^{1,7,8}. This is more than a semantic discussion^{5,9}. While selective embolization and/or vascular surgery are key to the management of AVMs⁶, embolization is rarely indicated in pregnancy-related EMV. Serious complications reported after selective uterine artery embolization include thromboembolic events, vesicovaginal and uteroenteric fistulae, buttock and labial necrosis, and septic shock. Obstetric- and fertility-related consequences include delayed subsequent pregnancy, abnormal placentation and subfertility due to intrauterine synechiae or decreased ovarian reserve^{10–13}. Although these complications may be uncommon, embolization should only be considered in life-threatening indications.

Enhanced myometrial vascularity

The reported prevalence of EMV ranges between 1.5% and 6.3%^{7,14}. Progressive upstream remodeling of the spiral and radial arteries starts in the early first trimester¹⁵. At the end of the first trimester, the dilated radial and adapted spiral arteries within the myometrium allow for an adequate perfusion of the intervillous spaces in the maternal part of the placenta. In early pregnancy failure, an increased flow in the intervillous space has been reported¹⁶. Towards the end of the pregnancy, about 700 mL of maternal blood flows to the placenta each minute. Immediately after delivery of the placenta, myoepithelial and myometrial contractions constrict the myometrial vessels, preventing excessive maternal blood loss. These vessels are seen on grayscale ultrasonography as anechoic, irregular, tubular structures in the myometrium. Doppler imaging may show unusually high flow velocities, while the flow in the radial and spiral vessels remote from the implantation site is not enhanced (Figure 1).

According to the laws of hemodynamics, high-velocity circulation within the myometrium is possible only in the presence of a direct connection between the high-pressure arterial system and the low-pressure venous system, as seen in the placental bed (Figure 2). Once the retained pregnancy tissue is expelled completely (either spontaneously or by surgical intervention), the high-velocity vessels disappear as in the normal third stage of labor^{1,17}. EMV beneath retained pregnancy tissue is therefore part of a normal physiological process, and so is its disappearance once the retained tissue has been removed or has passed^{1,7,17}.

In cases of EMV, retained trophoblastic tissue is the most likely explanation of the high-velocity flow, but the

amount of residual tissue may sometimes be limited. A focal yellowish flat area undetectable on ultrasonography may be seen during hysteroscopy.

Management of enhanced myometrial vascularity

The management outlined here is not applicable to increased myometrial vascularity seen in gestational trophoblastic disease, Cesarean scar pregnancy or placenta accreta spectrum, or in non-pregnancy-related conditions associated with uterine hypervascularity, such as uterine malignancy, post-traumatic arteriovenous shunt following intrauterine surgery or the rare case of congenital AVM¹⁸. A post-traumatic arteriovenous shunt is a direct shunt between an artery and a vein

which occurs secondary to trauma (Figure 3). It has been described after hysteroscopic surgery, accidental uterine wall perforation or Cesarean section at the uterine incision site. In post-traumatic arteriovenous shunt the placental bed is not involved, and this entity should be distinguished from pregnancy-related EMV.

In the absence of heavy bleeding, EMV may be managed expectantly. The EMV should disappear as the retained pregnancy tissue is expelled or resorbed. Although prompt EMV disappearance within minutes after the surgical removal of retained pregnancy tissue has been described by Van den Bosch *et al.*¹⁷, surgical management should be considered only in the case of heavy or persistent bleeding, or if wish to conceive is deemed hindered by persistent retained tissue¹⁴. In the case of extensive

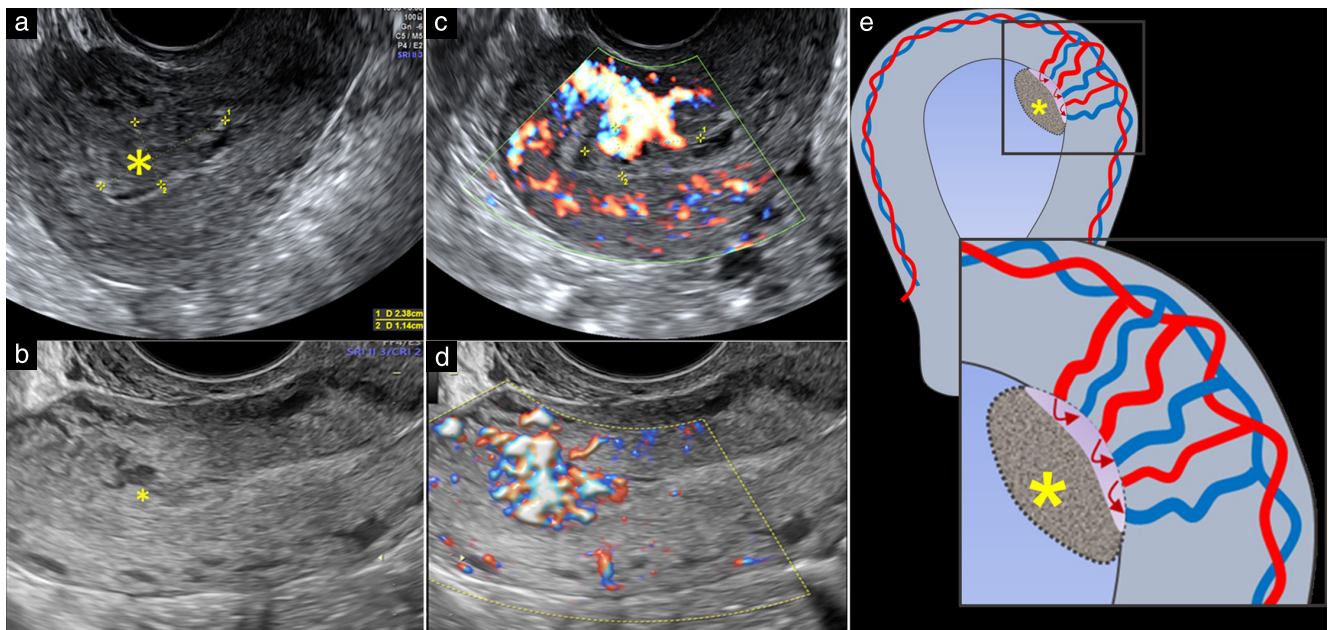


Figure 1 Grayscale (a,b) and power Doppler (c,d) ultrasound images of retained pregnancy tissue (*) after early miscarriage with underlying enhanced myometrial vascularity (EMV) in two different patients. Note the tortuous dilated hypoechoic vessels on grayscale ultrasound, which correspond to the dilated high-velocity myometrial vessels visible on power Doppler. (e) Schematic diagram showing EMV underlying retained pregnancy tissue (*).

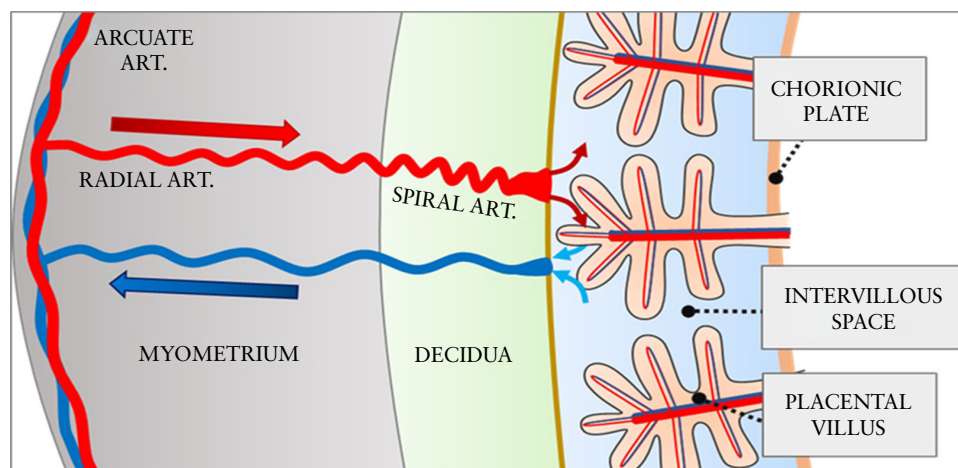


Figure 2 Schematic diagram showing normal vascularization of placental bed. ART, artery.

EMV, the patient should be informed that heavy bleeding may occur, necessitating emergency admission. Should this occur, surgical removal of the retained tissue is indicated (Figure 4). The earlier theory that high peak systolic flow correlates with the risk of heavy blood loss is not supported by the literature and should not be used to guide management^{7,17,19}.

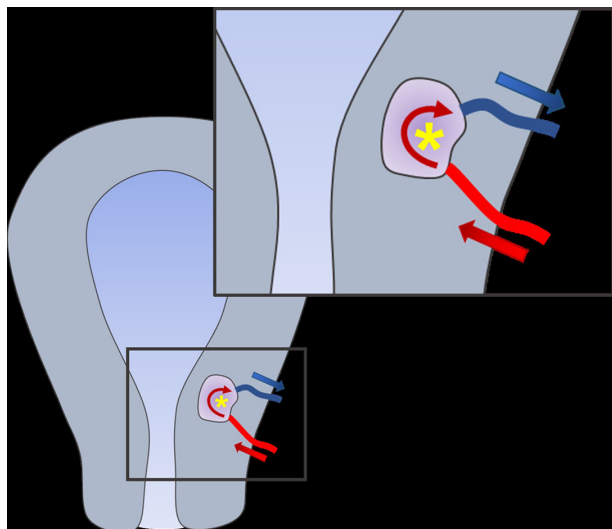


Figure 3 Schematic diagram showing post-traumatic arteriovenous shunt (unrelated to pregnancy), characterized by an iatrogenic cavity within the myometrium (*) into which an artery flows and from which a vein arises.

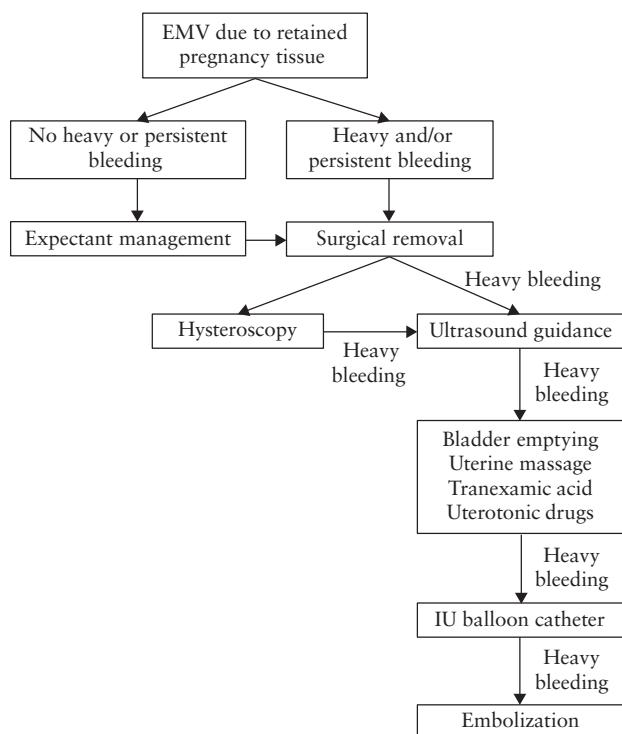


Figure 4 Management of enhanced myometrial vascularity (EMV) associated with retained pregnancy tissue. Hysteroscopic management is considered in case of persistent bothersome light bleeding or if wish to conceive is deemed hindered by persistent retained tissue. IU, intrauterine.

Ultrasonography is essential for preoperative mapping and guidance during surgical management of retained pregnancy tissue²⁰. Blind tissue removal may lead to an incomplete and lengthy procedure, prolonged heavy bleeding and unnecessary scarring of the endometrial–myometrial junction associated with Asherman syndrome or perforation²¹. The exact position of the retained tissue within the uterine cavity can be deduced from the position of the EMV which underlies the retained tissue. In the absence of heavy bleeding, operative hysteroscopy with cold loop resection or selective morcellation is often successful. If brisk bleeding obscures the hysteroscopic image, swift switchover to ultrasound-guided tissue removal is required, either by suction aspiration, ovoid swab forceps removal or with a blunt curette. Both transabdominal and transrectal ultrasound guidance may be used, depending on the patient.

As soon as the retained pregnancy tissue is removed completely, the EMV disappears and the bleeding usually stops¹⁷. If bleeding persists, incomplete removal of the retained tissue should be suspected. The spontaneous filling of the cavity with fresh blood, which is a negative contrast agent, optimizes the detection of residual tissue by ultrasound. Thus, aspiration should be stopped temporarily whilst the tissue is located.

Persistent bleeding in the absence of visible retained pregnancy tissue requires standard measures to optimize uterine contraction and hemostasis, including emptying the bladder, bimanual uterine massage, and administration of uterotonic drugs and tranexamic acid. If bleeding remains problematic, the next step is use of an intrauterine balloon catheter. The balloon should be inserted under ultrasound guidance up to the level of the active bleeding site and then inflated. The balloon catheter should be left *in situ* for 2–24 h, depending on the clinical situation.

If life-threatening bleeding persists despite the above-mentioned management, selective embolization should be considered, to avoid lifesaving hysterectomy. In our experience, this is a rare occurrence.

Conclusions

The presence of focally enhanced high-velocity/low-resistance vessels in the myometrium following miscarriage or delivery should be termed ‘enhanced myometrial vascularity (EMV)’. EMV is a reliable sign of the presence of retained pregnancy tissue and can be managed expectantly. Complete resorption, expulsion or surgical removal of the retained tissue leads to rapid resolution of the EMV, irrespective of the initial peak systolic velocity. If treatment is indicated, the retained tissue should be removed. The cornerstone of safe surgical removal of the retained tissue is accurate preoperative mapping of the EMV and a procedure performed under hysteroscopic or ultrasound guidance in a center that is experienced in managing bleeding complications on the rare occasions when they arise.

REFERENCES

- van Schoubroeck D, Van den Bosch T, Scharpe K, Lu C, van Huffel S, Timmerman D. Prospective evaluation of blood flow in the myometrium and uterine arteries in the puerperium. *Ultrasound Obstet Gynecol* 2004; **23**: 378–381.
- Timor-Tritsch IE, Haynes MC, Monteagudo A, Khatib N, Kovács S. Ultrasound diagnosis and management of acquired uterine enhanced myometrial vascularity/arteriovenous malformations. *Am J Obstet Gynecol* 2016; **214**: 731.e1–10.
- Timmerman D, Wauters J, van Calenbergh S, van Schoubroeck D, Maleux G, Van den Bosch T, Spitz B. Color Doppler imaging is a valuable tool for the diagnosis and management of uterine vascular malformations. *Ultrasound Obstet Gynecol* 2003; **21**: 570–577.
- Agarwal N, Chopra S, Aggarwal N, Gorski U. Congenital Uterine Arteriovenous Malformation Presenting as Postcoital bleeding: A Rare Presentation of a Rare Clinical Condition. *J Clin Imaging Sci* 2017; **7**: 1–4.
- O'Rourke-Suchoff D, Benitez S, Higgins MCCS, Stier EA. Diagnosis and treatment of women with radiologic findings suspicious for uterine arteriovenous malformations. *J Obstet Gynaecol* 2021; **41**: 769–773.
- Greene AK, Orbach DB. Management of arteriovenous malformations. *Clin Plast Surg* 2011; **38**: 95–106.
- Grewal K, Al-Memar M, Fourie H, Stalder C, Timmerman D, Bourne T. Natural history of pregnancy-related enhanced myometrial vascularity following miscarriage. *Ultrasound Obstet Gynecol* 2020; **55**: 676–682.
- Van den Bosch T, van Schoubroeck D, Lu C, de Brabanter J, van Huffel S, Timmerman D. Color Doppler and gray-scale ultrasound evaluation of the postpartum uterus. *Ultrasound Obstet Gynecol* 2002; **20**: 586–591.
- Bazeries P, Paisant-Thouveny F, Yahya S, Bouvier A, Nedelcu C, Boussion F, Sentilhes L, Willoteaux S, Aubé C. Uterine Artery Embolization for Retained Products of Conception with Marked Vascularity: A Safe and Efficient First-Line Treatment. *Cardiovasc Intervent Radiol* 2017; **40**: 520–529.
- Tropeano G, di Stasi C, Amoroso S, Gualano MR, Bonomo L, Scambia G. Long-term effects of uterine fibroid embolization on ovarian reserve: a prospective cohort study. *Fertil Steril* 2010; **94**: 2296–2300.
- Berkane N, Moutafoff-Borie C. Impact of previous uterine artery embolization on fertility. *Curr Opin Obstet Gynecol* 2010; **22**: 242–247.
- Homer H, Saridogan E. Uterine artery embolization for fibroids is associated with an increased risk of miscarriage. *Fertil Steril* 2010; **94**: 324–330.
- Serres-Cousine O, Kuijper FM, Curis E, Atashroo D. Clinical investigation of fertility after uterine artery embolization. *Am J Obstet Gynecol* 2021; **225**: 403.e1–22.
- Van den Bosch T, Daemen A, Van Schoubroeck D, Pochet N, De Moor B, Timmerman D. Occurrence and outcome of residual trophoblastic tissue: A prospective study. *J Ultrasound Med* 2008; **27**: 357–361.
- Roberts VHJ, Morgan TK, Bednarek P, Morita M, Burton GJ, Lo JO, Frias AE. Early first trimester uteroplacental flow and the progressive disintegration of spiral artery plugs: new insights from contrast-enhanced ultrasound and tissue histopathology. *Hum Reprod* 2017; **32**: 2382–2393.
- Jauniaux E, Greenwold N, Hempstock J, Burton GJ. Comparison of ultrasonographic and Doppler mapping of the intervillous circulation in normal and abnormal early pregnancies. *Fertil Steril* 2003; **79**: 100–106.
- Van den Bosch T, van Schoubroeck D, Timmerman D. Maximum Peak Systolic Velocity and Management of Highly Vascularized Retained Products of Conception. *J Ultrasound Med* 2015; **34**: 1577–1582.
- Memtsa M, Jamil A, Sebire N, Jauniaux E, Jurkovic D. Diagnosis and management of intramural ectopic pregnancy. *Ultrasound Obstet Gynecol* 2013; **42**: 359–362.
- Groszmann YS, Healy Murphy AL, Benacerraf BR. Diagnosis and management of patients with enhanced myometrial vascularity associated with retained products of conception. *Ultrasound Obstet Gynecol* 2018; **52**: 396–399.
- Grewal K, Jones B, L'Heveder A, Jindal S, Galazis N, Saso S, Yazbek J. The use of intra-operative ultrasound in gynecological surgery: a review. *Future Sci OA* 2021; **7**: FSO678.
- Hooker AB, de Leeuw RA, Emanuel MH, Mijatovic V, Brolmann HAM, Huirne JAF. The link between intrauterine adhesions and impaired reproductive performance: a systematic review of the literature. *BMC Pregnancy Childbirth* 2022; **22**: 837.