Research paper

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Uterine vascular abnormalities linked to pregnancy complications: color and power Doppler-assisted transvaginal ultrasound evaluation

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Keywords
uterine artery pseudoaneurysm; uterine venous varix; uterine arteriovenous malformation; enhanced myometrium vascularity; hypervascular retained parts of conception

Abstract

Aim: Abnormal uterine vascular pattern can be observed during transvaginal ultrasound examination used for investigating post-abortion bleeding and secondary postpartum hemorrhage. The purpose of this series of cases was to evaluate almost all the rare causes of uterine vascular abnormalities linked to pregnancy complications, and determine how to arrive at the diagnosis to optimize patient management, which is crucial for preventing life-threatening massive vaginal bleeding. **Material and methods:** Retrospective observational case series study including 20 women with postpartum or post-abortion vaginal bleeding who were found to have an abnormal uterine vascular pattern during a transvaginal color duplex assessment. **Results:** The study yielded the following findings: 10 cases of enhanced myometrial vascularity, two cases of pseudoaneurysm in the uterine artery, one case of myometrial venous varix, one case of large uterine venous pseudoaneurysm, one case of uterine arteriovenous malformation, one case of retained placental polyp, one case of invasive vesicular mole, and three cases of subinvolution of the placental implantation site. **Conclusions:** Transvaginal color duplex ultrasound plays a crucial role in detecting uterine vascular abnormalities as a cause of post-abortion or secondary postpartum hemorrhage and can help differentiate the pathologies responsible for the abnormal vascular pattern, which is highly recommended to optimize patient management.

Introduction

Gray-scale transvaginal ultrasound is the primary imaging tool for investigating post-abortion bleeding and secondary postpartum hemorrhage. The main cause of post-abortion and postpartum bleeding is the presence of intrauterine retained parts[1].

Retained Part of Conception (RPOC) refers to the presence of parts of the fetus and/or placenta in the endometrial cavity after a miscarriage, delivery or pregnancy termination. RPOC may complicate 2.5% of all vaginal deliveries, 40% of pregnancies that end in the second trimester and 17% of pregnancies that end in the first trimester[1,2].

A total of four vascular patterns can be observed when diagnosing RPOC during transvaginal color Doppler sonography examination: pattern 0 – no color flow signal within the retained parts, pattern 1 – endometrial vascularity less than the myometrium vascularity, pattern 11 – endometrial vascularity equal to the myometrium vascularity, and pattern 111 – endometrial vascularity > the myometrium vascularity[3].

Hypervascularity of the retained parts can be explained by an excessive penetration of trophoblasts to the uterine myometrium with subsequent persistence of the physiological arteriovenous shunts at the implantation site, leading to prominent vessels[1].

Enhanced myometrium vascularity (EMV) is the presence of myometrial and endometrial hypervascularity that may demonstrate any of the aforementioned patterns apart from pattern 0; it occurs after RPOC or first/second trimester miscarriage[4,5].

Enhanced myometrial vascularity may be mistaken for acquired uterine arteriovenous malformation (AVM), and differentiation between the two entities may be difficult. However, each has its distinct outcomes and prognosis[6,7].

Uterine vascular abnormalities other than enhanced myometrial vascularity are usually iatrogenic, induced by dilation and curettage (D&C) or other instrumental uterine procedures; they may follow myomectomy or cesarean section.

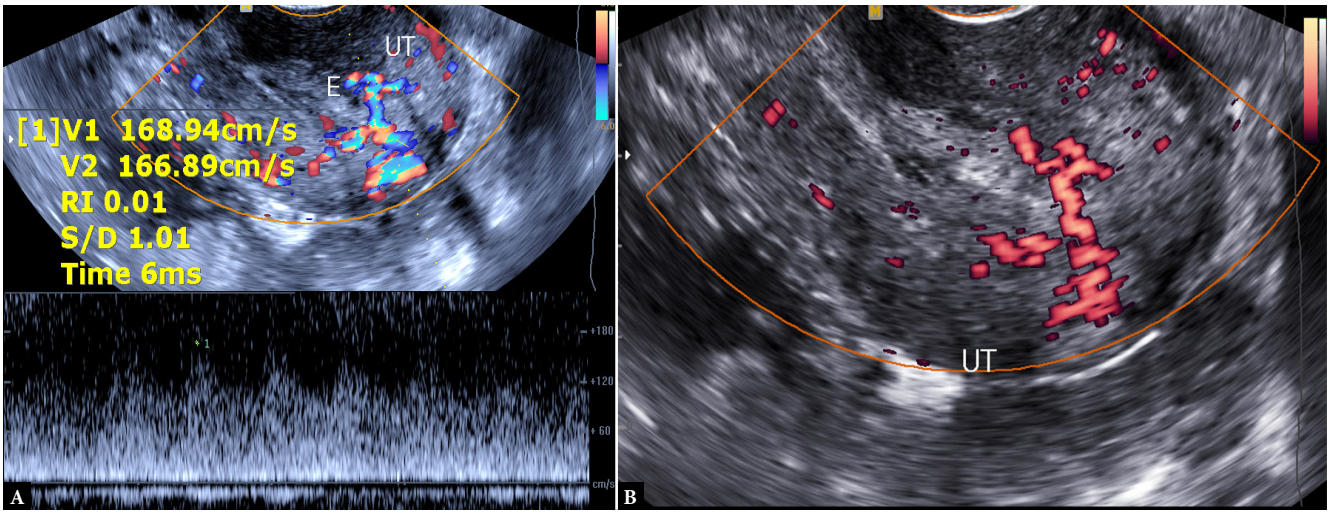

Fig. 1. *Transvaginal color duplex (CD) sonography examination showing enhanced myometrial vascularity, pattern type 11 with hypervascularity of the retained parts equal to that of the myometrium hypervascularity and low resistant arterial flow pattern*

Secondary postpartum hemorrhage occurs 24 hours to six weeks after delivery; it can be caused by endometritis cesarean section scar dehiscence, RPOC, and rarely subinvolution of the placental implantation site, uterine artery pseudoaneurysm or acquired arteriovenous malformation[8].

The purpose of this series of cases was to evaluate almost all the rare causes of uterine vascular abnormalities linked to pregnancy complications, and determine how to arrive at the diagnosis to optimize patient management, which is crucial to prevent life-threatening massive vaginal bleeding.

Methodology

The retrospective observational case series study was conducted between May 2018 and March 2021, including 20 women with postpartum or post-abortion vaginal bleeding who were found to have an abnormal uterine vascular pattern during a transvaginal color duplex assessment. The age of the study participants ranged from 18 to 35 years, and averaged 26 years.

All the participants attended a private ultrasound clinic specialized in gynecology and obstetrics ultrasound. Among them, 14 women presented with post-abortion bleeding and six with secondary postpartum hemorrhage.

All patients with postpartum or post-abortion abnormal vaginal bleeding without an abnormal uterine vascular pattern were excluded from the study. All cases were subjected to a transvaginal ultrasound examination using multifrequency transvaginal probe (5–9 Mhz), assisted with color and power Doppler capabilities, Sonoace x8 ultrasound machine, (Medison, Korea).

The patients evacuated their bladder prior to the examination, were examined in the lithotomy position, and the uterus was assessed for the presence of retained intrauterine parts, hypervascularity of the endometrium or the myometrium. The pattern of blood flow was evaluated using pulsed Doppler ultrasound.

All cases were followed up for the outcome of conservative treatment, vascular intervention or surgical management.

Results

A total of 20 females presenting with secondary postpartum hemorrhage or post-abortion/ post-D&C bleeding showed an abnormal uterine vascular pattern during transvaginal color duplex assessment, with 10 cases of enhanced myometrial vascularity, two cases of pseudoaneurysm in the uterine artery, one case of myometrial venous varix, one case of large uterine venous pseudoaneurysm, one case of uterine arteriovenous malformation, one case of retained placental polyp, three cases of subinvolution of the placental implantation site, and one case of invasive vesicular mole.

Enhanced myometrial vascularity (10 cases) (Fig. 1)

Four cases were detected post-medical abortion and six cases were detected post-surgical abortion (D&C).

All cases were subjected to transvaginal color duplex exam which revealed the presence of intrauterine retained parts showing inhomogeneous or heterogeneous endometrial cavity contents of thickness >10 mm.

Among them, there were two cases with type 1 pattern of enhanced myometrial vascularity showing vascularity within the retained parts continuous with and less than that of myometrial hypervascularity, five type 11 pattern cases showing hypervascularity of the retained parts equal to the hypervascularity of the myometrium, and three cases of pattern type 111 having hypervascularity of the retained parts exceeding myometrial hypervascularity.

Two cases with type 1 pattern were subjected to manual suction and evacuation, whereas the other eight cases with type 11 and type 111 patterns of enhanced myometrial vascularity were subjected to conservative management including expectant management and utero-

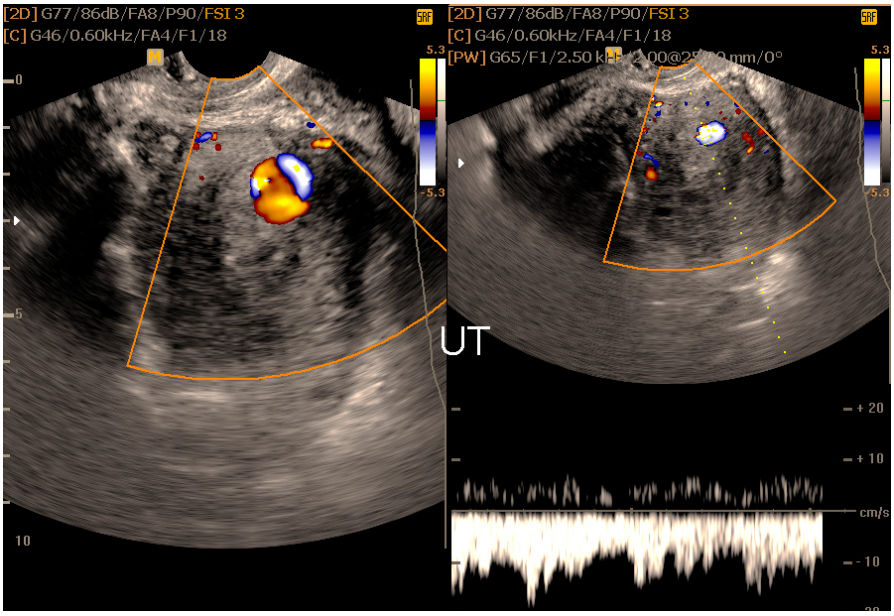

Fig. 2. *Transvaginal color duplex image showing well-defined anterior myometrial cyst with bidirectional arterial flow pattern inside suggesting intrauterine arterial pseudoaneurysm*

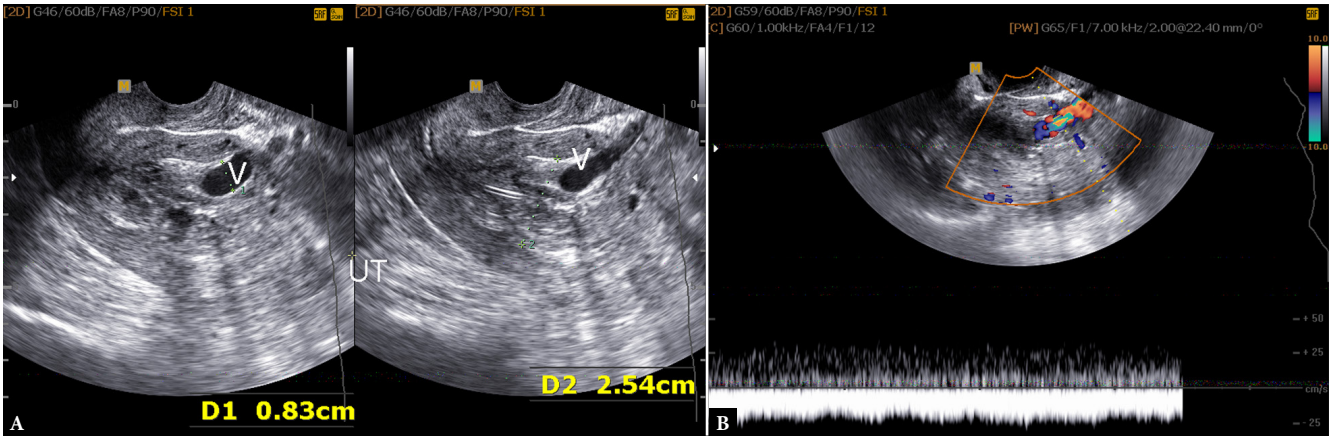

Fig. 3. *Transvaginal CD sonography showing intrauterine venous varix (V) with normal venous wall and phasic venous flow inside*

tonic drugs in four cases, with the remaining four cases subjected to hysteroscopic resection of the retained parts with an excellent outcome in all cases.

Uterine artery pseudoaneurysm (two cases) (Fig. 2)

One case presented with a heavy vaginal bleeding, for two months, after delivery by cesarean section.

The patient was referred for an examination by transvaginal color duplex ultrasound that revealed a small cyst close to the site of uterine CS scar showing bidirectional arterial flow pattern inside the cyst with mild dilation of the surrounding myometrial vessels, suggesting uterine artery branch pseudoaneurysm. Two days after the examination, the patient was admitted to hospital after a severe attack of vaginal bleeding. She received a blood transfusion and was advised to repeat the ultrasound after the cessation of bleeding, which revealed spontaneous thrombotic occlusion of the pseudoaneurysm. The patient was discharged from the hospital with an excellent outcome.

In the second case, the woman complained of significant vaginal bleeding 10 days after she suffered a miscarriage followed by D&C.

Transvaginal color duplex examination revealed a large cyst measuring >2 cm at the fundal anterior aspect of myometrium, showing bidirectional low resistant arterial flow pattern, suggesting intrauterine arterial pseudoaneurysm.

The patients underwent hysterectomy following repeated episodes of heavy vaginal bleeding.

Myometrial venous varix (one case) (Fig. 3)

The patient was complaining of secondary postpartum hemorrhage after delivery by cesarean section. She presented for transvaginal

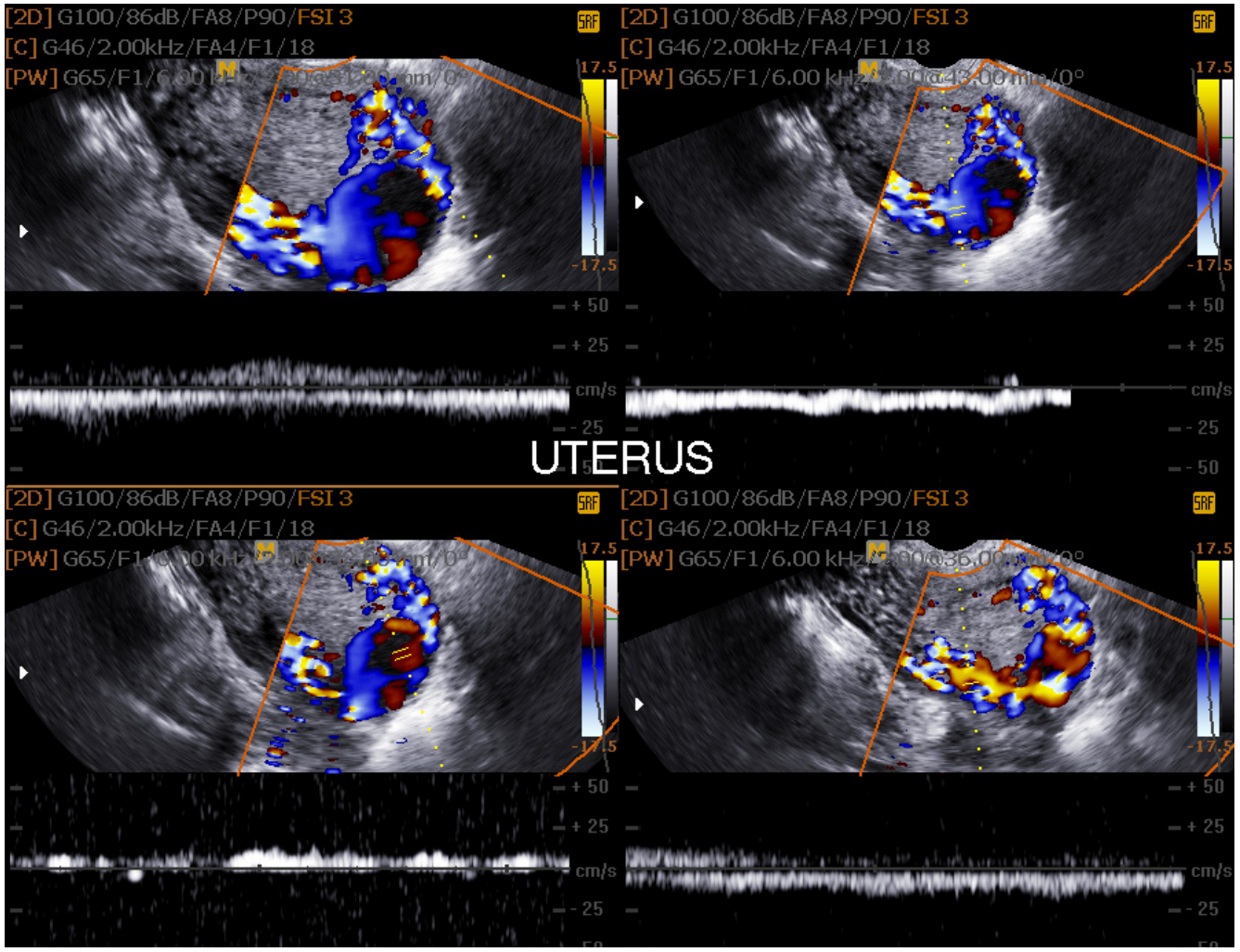

Fig. 4. *Transvaginal CD sonography showing large fundus myometrium cyst with bidirectional venous flow inside revealed by pulsed Doppler and color Doppler study suggesting large venous pseudoaneurysm*

color duplex examination, which revealed retained intrauterine parts, with the thickness of endometrial cavity contents measuring 26 mm, intrauterine loop, and the presence of anterior myometrial wall tubular-like lesion extending to the endometrial cavity, inseparable from the retained parts, measuring 25 × 8 mm and showing unidirectional phasic venous flow pattern. The wall of the tubular lesion being similar to the normal vein wall, the features suggested intrauterine venous varix.

The patient had a history of severe pelvic congestion syndrome, and transvaginal ultrasound revealed markedly dilated refluxing pelvic venous plexus, with refluxing right and left ovarian veins. The patient was subjected to conservative expectant management and uterotonic drugs, and was referred for further vascular intervention by embolization of the ovarian veins.

Uterine large venous pseudoaneurysm (one case) (Fig. 4)

The patient complained of heavy vaginal bleeding 40 days after post-abortion dilation and curettage. Transvaginal color duplex examination showed large fundus cyst with abnormal wall thickness, showing bidirectional venous flow inside, consistent with uterine vein pseudoaneurysm, distinguished from uterine venous varix by the presence of an abnormal wall that did not simulate the venous wall and bi-directional swirling venous flow inside.

The patient underwent hysterectomy following repeated profuse vaginal bleeding.

Uterine arteriovenous malformation (one case) (Fig. 5)

The patient was 18 years old and had been married for five months. Two months after getting married she suffered her first miscarriage and was subjected to D&C.

Three months later she was referred to the ultrasound clinic. Her pregnancy test was positive, and the serum beta-hCG level was 1,500 mIU/mL two days prior to the ultrasound exam and 2,000 mIU/mL on the day of the examination. There was no history of vaginal bleeding after the patient had the D&C procedure. Transvaginal ultrasound revealed multiple dilated anterior myometrium

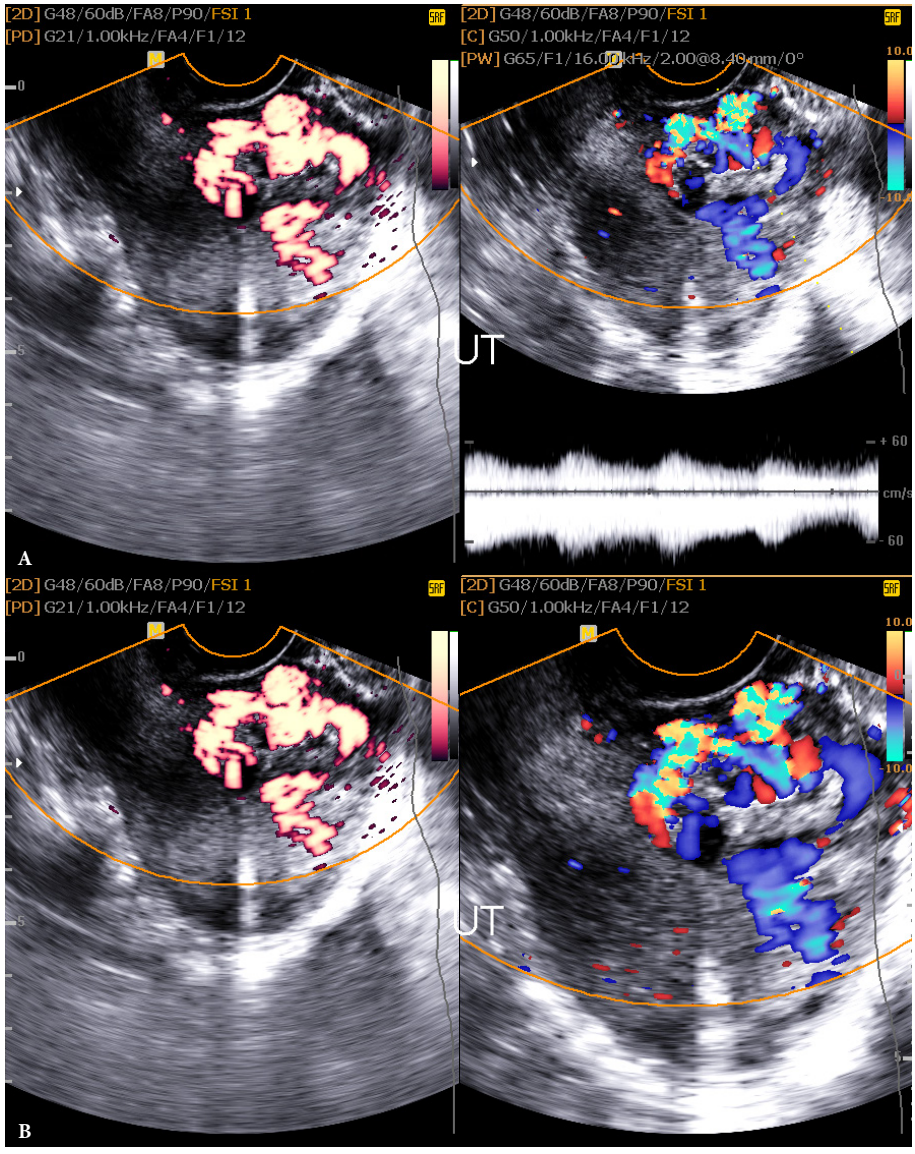

Fig. 5. *Transvaginal CD sonography examination showing multiple large anterior myometrial dilated, tortuous vessels with high velocity turbulent arterial flow and ectatic veins showing venous flow inside associated with normal endometrium suggesting arteriovenous malformation*

arterial and venous channels, with few uterine venous varices. The flow had a low-resistance arterial turbulent pattern with markedly elevated peak velocity. The venous flow within the varices had a pulsatile venous flow pattern, the endometrium was thin (5.5 mm), and the dilated vessels were seen reaching the outer surface of the endometrium.

The patient was referred for vascular intervention and underwent uterine artery embolization, followed by full recovery in the follow-up exam two months later.

Retained placental polyp (one case) (Fig. 6)

The patient was 33 years old and her pregnancy was delivered by cesarean section. She suffered a secondary postpartum hemorrhage and was subjected to D&C without improvement.

Transvaginal color duplex examination revealed a large echogenic soft tissue swelling seen attached to the inner endometrial surface with sluggish vascularity inside and prominent myometrial hypervascularity. The features suggested a retained placental polyp, and the patient was referred for hysteroscopic resection of the retained placental polyp. Histopathology revealed intrauterine retained parts.

Subinvolution of placental implantation site (three cases) (Fig. 7)

All three cases suffered recurrent secondary postpartum hemorrhage after the pregnancies were delivered by cesarean section. In two cases, bleeding commenced one month and five weeks, respectively, after cesarean section and in the third case bleeding occurred five months after cesarean section. Transvaginal color duplex sonography revealed multiple dilated serpentine vessels

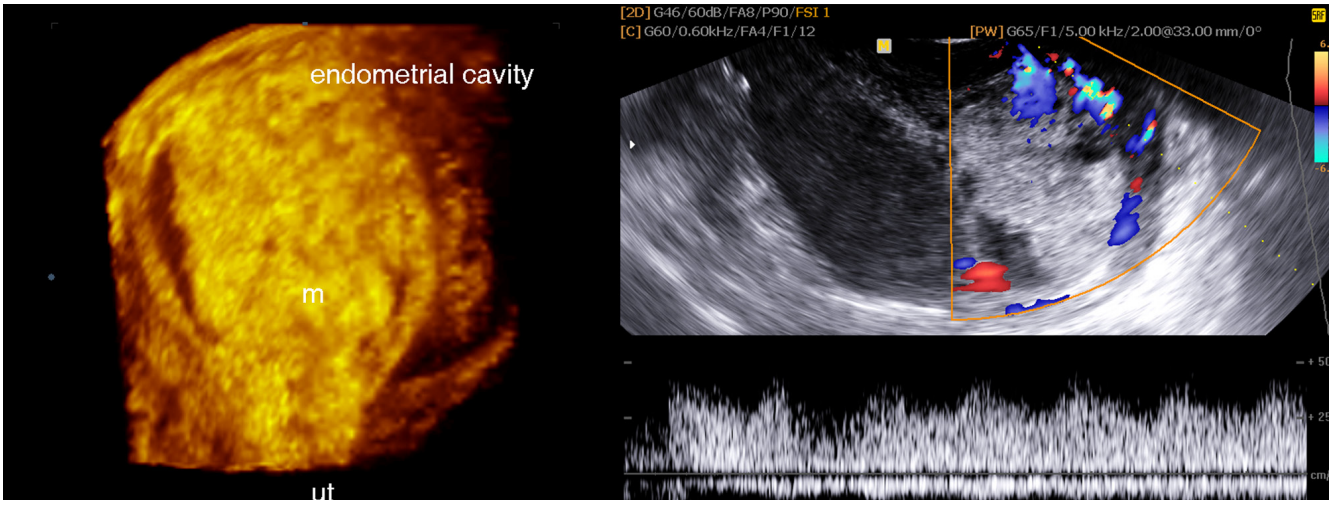

Fig. 6. *Transvaginal 3D and CD sonography examination showing large hypovascular echogenic mass located inside the endometrium cavity with associated myometrial hypervascularity suggesting retained placental polyp*

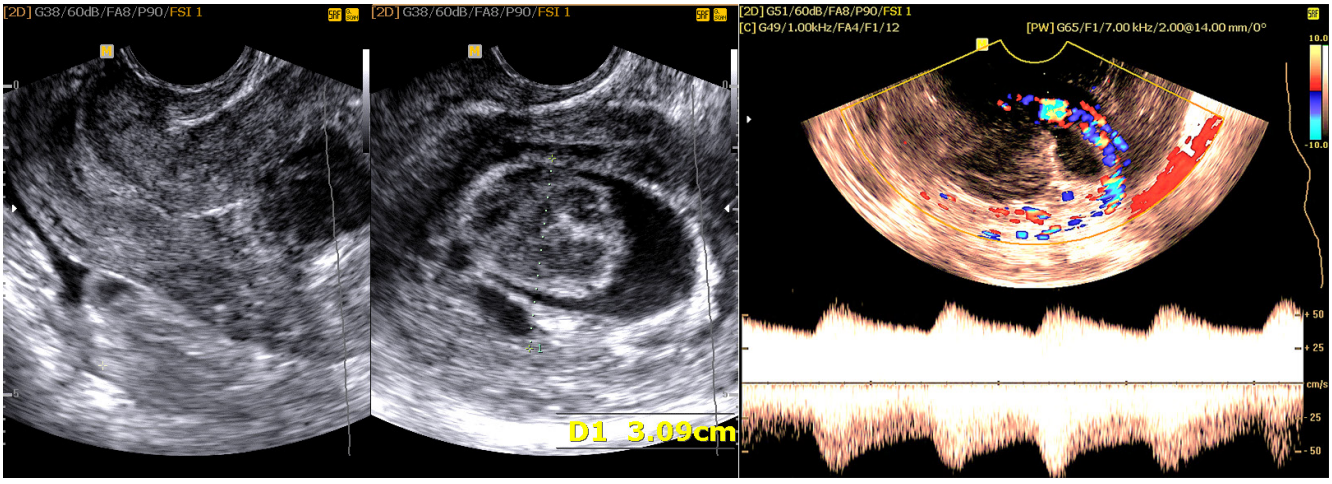

Fig. 7. *Transvaginal CD sonography examination of a case with postpartum hemorrhage showing large mobile and compressible blood clot of heterogeneous texture within the endometrial cavity associated with hypervascularity of the inner myometrium at the implantation site suggesting subinvolution of placental implantation site*

mainly involving the inner myometrium and the joining portion of the endometrium at the implantation site. The implantation site was recognized by revising previous ultrasound examination reports performed during pregnancy follow-up. The vessels showed low resistant arterial flow pattern of elevated peak velocity and phasic flow of the ectatic veins. The features were consistent with subinvolution of the placental implantation site. The patients were managed by uterotonic drugs and expectant management. In one patient, treatment was unsuccessful and she had repeated episodes of profuse vaginal bleeding and underwent hysterectomy.

Invasive vesicular mole (one case) (Fig. 8)

A 33-year-old patient with a history of molar pregnancy was managed by suction and evacuation.

The patient complained of repeated vaginal bleeding. Her serum beta- hCG was markedly elevated and plateau, with transvaginal color duplex examination revealing a large ill-defined anterior myometrial echogenic mass with multiple small cystic spaces inside. Color duplex revealed high vascularity of the mass of mixed low resistant high velocity arterial flow pattern and a venous flow pattern suggesting an invasive mole. The patient's chest X-ray was normal. She was managed with chemotherapy (methotrexate) and complete resolution was achieved on follow-up, as proved by three normal weekly and consecutive serum beta-hCG level and normal transvaginal ultrasound findings.

The patient was followed monthly for a year, with no abnormalities found.

Discussion

Abnormal uterine vascular pattern revealed by transvaginal color duplex sonography as a cause of per vaginal bleeding may be caused by different pathologies, but differentiation between them is critical, as each will be managed differently[6].

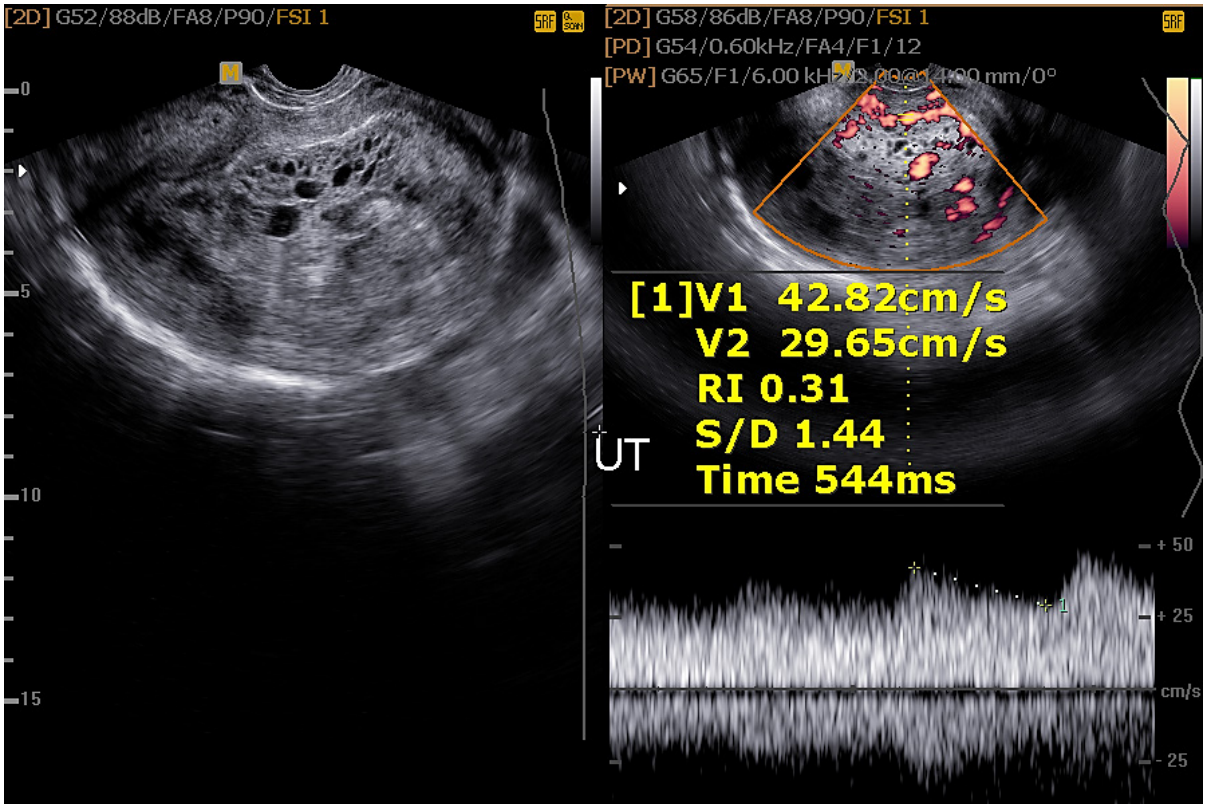

Fig. 8. *Transvaginal CD sonography examination showing large ill-defined echogenic myometrium mass with cystic changes inside and hypervascularity in a patient presenting with recurrent vaginal bleeding following a suction and evacuation of molar pregnancy, suggesting invasive mole*

Enhanced myometrial vascularity may be caused by abnormal adherence of retained placental tissue to the underlying myometrium suggesting an accreta as a possible etiology or increased peritrophoblastic flow with subsequent enhanced vascularity. It can be treated conservatively with expectant management and uterotonic drugs or through hysteroscopic resection of the retained parts of conception[9]. With other causes of abnormal uterine vascular pattern, such as arteriovenous malformation, uterine artery pseudoaneurysm, venous pseudoaneurysm or uterine venous varix, the risk of life-threatening vaginal bleeding is high, so they are better managed through vascular intervention to preserve the fertility or hysterectomy[8,10].

Subinvolution of the placental implantation site can be managed with uterotonic drugs, but more aggressive intervention by percutaneous embolization or hysterectomy may not be avoided[11,12].

Retained placental polyps can be managed successfully with hysteroscopic resection[13].

Color Doppler-assisted transvaginal ultrasound combined with the patient's clinical data and laboratory test results may help distinguish these pathologies[6–8,10].

Enhanced myometrium vascularity was difficult to differentiate from acquired uterine AVM in some situations. Grewal *at al.* and Groszmann *et al.* observed that the presence of inhomogeneous hypervascular retained parts within the endometrial cavity with an extension of the vascularity to the myometrium, pointed towards enhanced myometrial vascularity[4,5]. Timmerman *et al.* reported that AVM was a predominantly myometrium vascular abnormality; being widespread and more aggressive in its vascular pattern than EMV, the arteries are more dilated and the veins may show variceal dilations due secondary venous hypertension[7]. Arterial flow is of markedly high velocity and turbulent, with a high diastolic flow component, compared to that observed in EMV. Uterine AVM is considered as high-flow vascular abnormality, while EMV is regarded as a low-flow vascular abnormality. The absence of uterine instrumentation history is highly suggestive of EMV. However, the main differentiating factor between them will be through digital subtraction angiography, which will demonstrate early venous filling in cases of AVM[6,10].

Youssef *et al.* found that the presence of traumatic history of the endometrium with an intrauterine bloody cyst that demonstrates bidirectional venous flow in cases with venous pseudoaneurysm or bidirectional arterial flow in cases of intrauterine arterial pseudoaneurysm, in conjunction with abnormal cyst wall not compatible with the multilayered venous or arterial wall (intima, media and adventitia), will be diagnosed as uterine arterial or venous pseudoaneurysm[8]. Such cases necessitate further vascular or surgical (hysterectomy) interventions. D&C or any uterine sharp instrumentation should be avoided[8,10].

Tanaka *et al.* and Nakaya *et al.* observed that the presence of dilated vein or veins with normal venous wall and unidirectional phasic flow were diagnostic of uterine venous varix[14,15]. The cases reported in the literature were either cervical venous varices associated with the placenta previa, which exhibited severe vaginal bleeding following a ruptured venous varix[14], or ruptured venous varix

on the surface of the uterus during pregnancy, was presented by severe intraperitoneal hemorrhage[15]. The current study showed that myometrial venous varix could be associated with uterine AVM following venous hypertension or caused by severe pelvic congestion syndrome or associated to a lesser degree with subinvolution of the placental implantation site. Rupture venous varix may lead to severe per vaginal bleeding.

Alhaussami *et al*. reported that retained placental polyp presented during transvaginal ultrasound with an echogenic hypovascular mass located within the endometrial cavity, with an associated myometrial hypervascularity and occasionally observed feeding vessel[13]. However, as found in the current study, this should be differentiated from retained large blood clot/thrombus within the endometrial cavity in cases presenting with postpartum hemorrhage, as each of them will be echogenic, of sluggish or no vascularity and located within the endometrial cavity. During the follow-up, the clot will change its echo characteristics and will be compressed with the application of compression of the transvaginal ultrasound probe.

Subinvolution of the placental implantation site is a rare cause of secondary postpartum hemorrhage It is caused by the inability of the uteroplacental vessels to be obliterated by fibrosis and thrombosis during the postpartum period, with subsequent dilation of the uteroplacental vessels at the implantation site[11]. Histopathology of the hysterectomy specimen revealed dilated superficial myometrial vessels with thickened walls at the implantation site[11,12]. Triantafyllidou *et al*. found that it could be observed during the TV ultrasound, presenting as multiple dilated arteries and veins showing low resistant arterial flow of elevated peak velocity mixed with a phasic venous flow pattern, mainly observed at the inner myometrial layer at the implantation site. The presence of normal endometrium helps with differentiating placental implantation site subinvolution from the EMV associated with retained intrauterine parts[12].

Levine *et al*. reported that invasive mole could be diagnosed based on the patient's history of a previous molar pregnancy and significantly higher serum beta-hCG showing a plateau during serial follow-up, combined with the presence of myometrial echogenic ill-defined mass showing cystic spaces inside and marked hypervascularity during transvaginal ultrasound evaluation[16].

Conclusion

Transvaginal color duplex ultrasound can be useful in detecting uterine vascular abnormalities as a cause of post-abortion or secondary postpartum hemorrhage, and can help differentiate the pathologies responsible for abnormal vascular patterns, which in turn can contribute to optimized patient management.

Conflict of interest

The author does not report any financial or personal connections with other persons or organizations which might negatively affect the contents of this publication and/or claim authorship rights to this publication.

Ethical approval

All procedures were performed in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975 (revised version of 2000)[5].

Informed consent

All patients provided their written informed consent to the enrollment in the study and to the publication of information that could potentially lead to their identification.

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