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Uterine Artery Embolization for Iatrogenic Uterine Vascular Injuries

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Abstract

Purpose Uterine curettage or surgery can lead to uterine vascular injuries such as arteriovenous malformations (AVMs) or pseudoaneurysms (PsAs), and patients may present with life-threatening uterine bleeding. The purpose of our study is to evaluate the effectiveness of uterine artery embolization (UAE) in patients with abnormal uterine bleeding due to iatrogenic vascular injuries.

Methods This is a retrospective review of 22 patients who underwent UAE at our institution between January 2019 and January 2023. Sixteen patients had a history of iatrogenic procedures. Uterine curettage was done in 12 patients, manual vacuum aspiration in 1 patient, and cesarean surgery in 3 patients. The outcomes were assessed in the form of technical feasibility, cessation of bleeding, recurrence, and pregnancy on follow-up.

Results Eighteen (18/22) patients had vascular malformations and 4 (4/22) had PsA on computed tomography. Eight patients had typical AVM features with early draining vein and 10 patients had hypertrophied vessels with no early draining veins. A total of 35 uterine arteries were embolized in 22 patients. The most commonly used embolic material was polyvinyl alcohol particles (28/35 arteries). Postembolization, bleeding symptoms subsided in 19 patients (86.4%). Three patients had recurrence of bleeding symptoms for which they underwent repeat embolization. Six patients (27%) became pregnant during the follow-up period of 15 months.

Conclusion UAE is a safe and effective treatment for iatrogenic uterine vascular injuries. This procedure allows for the preservation of uterine function with the possibility of future pregnancy and should be considered as a primary treatment option.

Keywords
- uterine artery embolization
- uterine arteriovenous malformation
- uterine pseudoaneurysm
- uterine vascular pathologies
- iatrogenic
- uterine
- injuries

Introduction

Vascular injuries to the uterus are commonly encountered due to increasing iatrogenic procedures such as uterine curettage, manipulations during deliveries, pelvic surgeries, and cesarean surgeries. These vascular injuries can be in the form of arteriovenous malformations (AVMs), arteriovenous fistulas, pseudoaneurysms (PsAs), or direct rupture of vessels.[1] Affected patients usually present with menorrhagia or menometrorrhagia after spontaneous/induced abortion, uterine curettage,

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or pelvic/uterine surgeries. Life-threatening uterine bleeding can occur during curettage.[2] With advances in transabdominal and transvaginal ultrasound, majority of such cases can be easily diagnosed initially and can be confirmed with either computed tomography (CT) or magnetic resonance imaging (MRI).

Management of abnormal uterine bleeding depends on the diagnosis. Medical management in the form of progestins, gonadotropin-releasing hormone agonists, methotrexate, combined hormonal contraception, uterotonics, or danazol is started initially.[3] However, if the bleeding is from uterine AVMs/fistulas or PsA, patients are unlikely to respond the conservative treatment. Hysterectomy or ligation of bilateral uterine/internal iliac arteries was the only treatment option available prior to the advent of percutaneous transarterial embolization.[4–9] As most of these patients are of childbearing age, hysterectomy is a radical option. Transarterial uterine artery embolization (UAE) not only preserves the uterus and the menstrual pattern but also provides reasonable fertility and pregnancy outcomes postprocedure.

The purpose of our study is to evaluate the effectiveness of UAE in patients with abnormal uterine bleeding due to iatrogenic uterine vascular injuries and pathologies. The association of these pathologies with the iatrogenic procedures was analyzed. The treatment outcomes and pregnancy rates post-UAE were also assessed.

Materials and Methods

Patients

This was a retrospective study of patients who received UAE at our institution from January 2019 to January 2023. All procedures performed in the study involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards. This study was approved by our institutional ethics committee.

Twenty-two ($n = 22$) females who underwent uterine arterial embolization for abnormal uterine bleeding due to suspected vascular pathologies were included. The mean age of the patients was 28.6 ± 2.3 years (range: 20–46 years). Of these 22 patients, 16 patients had a history of iatrogenic procedures prior to the bleeding episodes. Uterine curettage was done in 12 patients, manual vacuum aspiration (MVA) in 1 patient, and cesarean surgery in 3 patients. The remaining six patients did not undergo any iatrogenic procedure but had a history of medical termination of pregnancy (four patients) and spontaneous abortion (two patients). All these patients underwent initial ultrasound to identify the cause of abnormal bleeding. AVMs/fistulas were suspected with abnormal vascular channels within uterine myometrium and dilated vessels in parametrium, and PsAs with an anechoic cyst-like lesion on B-mode, with aliasing on color Doppler. CT angiography or MRI was done to confirm the diagnosis and for preprocedural planning.

Technique

Written informed consent was obtained from the patients prior to the endovascular procedures. All the procedures were done in aseptic precautions under local anesthesia. Single vascular access was used in all the patients through the common femoral artery. Contralateral internal iliac artery was cannulated with diagnostic catheters (RDC/RC1 catheters, Cook Medical LLC, Bloomington, Indiana, United States) and ipsilateral internal iliac artery with reverse curve catheters (SIM1/2, RUC catheters, Cook Medical LLC). AVMs were diagnosed when there were dilated and tortuous arteries and early draining veins. PsAs were diagnosed when abnormal sac-like outpouching was noted from the arteries. Selective cannulation of the uterine artery, if needed, was performed with a microcatheter, and embolization was then performed. The choice of embolic material depended on the type of pathology and the vessel being embolized. Commonly used materials included polyvinyl alcohol (PVA) particles (300–500 and 500–700 µ), gel foam, coils, and n-butyl cyanoacrylate (►**Figs. 1**–**3**).

The outcomes were assessed in the form of technical feasibility of embolization, cessation of symptomatic bleeding, recurrence of symptoms, and pregnancy on follow-up.

Results

Of the 22 patients, 18 patients were suspected of having uterine vascular malformations based on ultrasound and CT/MRI, and 4 patients had PsAs. Among 18 patients with vascular malformations, 8 patients had typical AVM features with early draining veins on angiography. Remaining 10 patients had tortuous and hypertrophied vessels with no early draining vein. The mean duration between the uterine procedure and onset of symptoms was 21.3 days (range: 3–60 days). All AVMs were seen after curettage procedures, hypertrophied vessels were seen after both curettage and MVA, and PsAs were seen mainly postcesarean surgeries (►**Table 1**).

A total of 35 uterine arteries were embolized in these 22 patients. Bilateral UAE was performed in 13 patients for either AVMs or hypertrophied vessels. The most commonly used embolic material was either PVA alone (66%) or with Gelfoam (14%). In three cases of AVMs (8%), where there were grossly dilated vessels with rapid flow and large dilated veins, pushable coils followed by Gelfoam were utilized. All the PsAs in our study were embolized with 25 to 33% glue. The technical feasibility of performing UAE was 100%. All the patients underwent successful embolization.

Postembolization, bleeding symptoms subsided in 19 patients (86.4%) within 1 to 3 days without any further treatment. In three patients, additional medical management was required for 6 to 10 days to control the bleeding. No major complications were seen in any of the patients. Minor complications were seen in six patients, which included puncture site hematoma in two patients and postprocedural mild abdominal pain in four patients, which was managed conservatively.

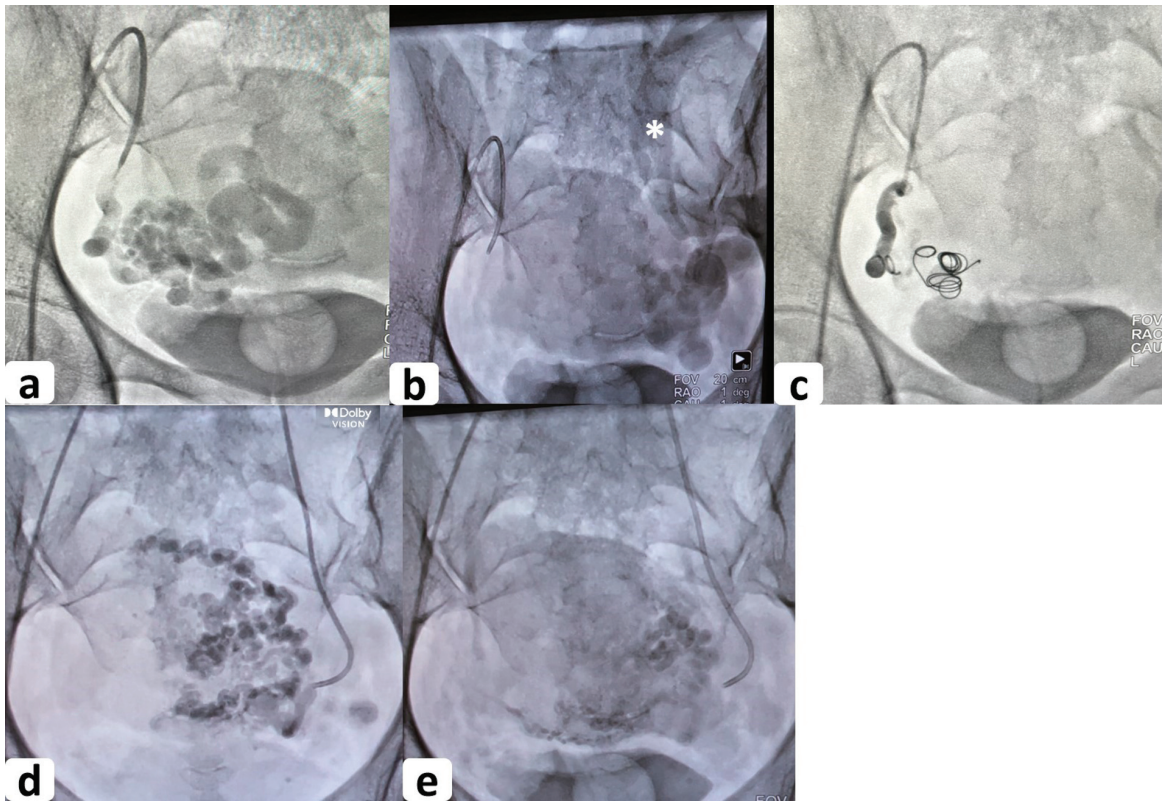

Fig. 1 Angiographic images of bilateral uterine artery embolization performed for uterine arteriovenous malformation (AVM) in 30-year-female patient. (a) Ipsilateral uterine angiogram showing large dilated and tortuous arteries s/o AVM; (b) dilated early draining vein can be seen (*); (c) uterine artery embolized initially with two pushable coils followed by Gelfoam slurry. No filling of distal vessels seen; (d) contralateral uterine angiogram showing similar dilated and tortuous vessels; (e) postembolization with polyvinyl alcohol particles, significant reduction of the abnormal arterial channels noted. s/o, suggestive of.

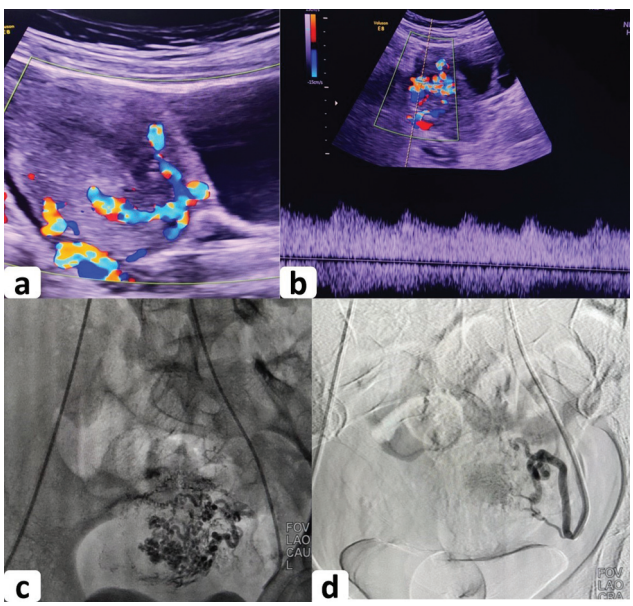

Fig. 2 Ultrasound and angiographic images of left uterine artery embolization performed for uterine non-arteriovenous malformation (AVM) in 24-year-female patient. (a) Color Doppler ultrasound image showing dilated myometrial vessels reaching up to the endometrium; (b) spectral Doppler showing low resistance high-velocity waveform; these findings correspond to uterine AVM; (c) contralateral uterine angiogram showing tortuous and hypertrophied vessels, without early draining vein; (d) postembolization with polyvinyl alcohol particles, significant reduction of the abnormal vessels noted with preserved proximal main artery.

The patients were followed up for a mean of 13.5 ± 1.8 months (range: 6–21 months). Three patients (13.5%) had recurrence of bleeding symptoms after a mean of 4.2 months for which they underwent repeat embolization. All these three patients had hypertrophied vessels on initial angiography and had undergone unilateral UAE. Six patients (27%) became pregnant during the follow-up period, among which two patients delivered healthy neonates, one patient was in the third trimester, and three patients had spontaneous abortions (13.6%).

Discussion

Uterine vascular pathologies, for the most part, are largely misunderstood entities often confused or misdiagnosed for retained products of conception, routine menstrual changes postpregnancy/abortion, or infection of the endometrium. With advances in diagnostic imaging, more of such vascular pathologies are identified, the most common being AVMs and PsAs. Almost all cases of uterine acquired AVMs and/or PsAs are seen in reproductive age group women with at least one pregnancy.[10–12] Around 85% of acquired AVMs are usually secondary to some iatrogenic procedures related to pregnancy, such as uterine curettage, uterine manipulations during deliveries such as forceps or vacuum assisted, pelvic surgeries, cesarean surgeries, or myomectomy.[12] Even in our study, all our patients had a history of pregnancy prior to the

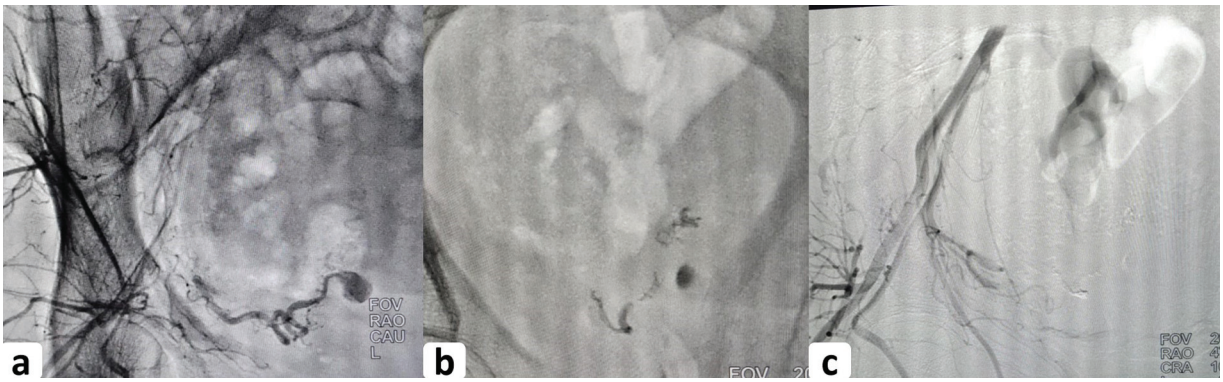

Fig. 3 Angiographic images of right uterine artery embolization performed for uterine pseudoaneurysm (PsA) in a 23-year-female patient. (a) Right uterine angiogram showing PsA arising from distal main uterine artery; (b) selective cannulation of uterine artery with microcatheter followed by embolization with 33% glue. Glue cast can be seen within the PsA and distal and proximal segments of artery; (c) postembolization, obliteration of PsA with preservation of proximal main uterine artery.

Table 1 Prevalence of uterine vascular injuries post various iatrogenic procedures encountered in our study

	Uterine curettage	Manual vacuum aspiration	Cesarean surgery
Arteriovenous malformations	7	–	–
Hypertrophied vessels	4	1	–
Pseudoaneurysms	1	–	3

bleeding with 73% of them having undergone uterine procedures.

Uterine AVMs are likely an abnormality of the regressing placenta during pregnancy, whereby the venous sinuses become incorporated within the myometrium.[7] Iatrogenic trauma to the endometrium during curettage causes an immune response-like reaction with the release of myometrial vascular endothelial growth factors resulting in angiogenesis.[7,13–15] Similarly, damage to the myometrium during surgeries or hysteroscopy might cause disruption of the uterine arterial wall, causing blood to dissect the adjacent tissue, and forming a pseudoaneurysmal sac which communicates with the vessel lumen.[16] In our study, 100% of AVMs and 80% of non-AVMs were seen postcurettage, and 75% of PsAs were seen after cesarean surgeries.

Ultrasound is the usual initial modality for diagnosis of abnormal uterine bleeding. The findings favoring AVM include dilated hypoechoic spaces within myometrium which show color aliasing on Doppler with low resistance high-velocity arterial flow on spectral analysis. PsAs are seen as anechoic sac-like structures with color aliasing and to-and-fro flow on color Doppler. CT and MRI might show the dilated tortuous vessels or flow voids within the uterus with dilated venous channels in the pelvis and the laterality of PsA, which might help decide the target uterine artery for embolization.[1] Angiography is still the gold standard for diagnosis, especially for AVMs, which appear as complex tangle of vessels, usually with early draining veins. Timmerman et al classified the uterine vascular malformations into two main groups: (1) true AVMs—typical ultrasound and angiographic findings and (2) non-AVMs—ultrasound and angiographic findings of dilated and tortuous vessels but without early draining vein—could represent either "low-flow" type of AVM or subinvolution of placental bed vessels in the absence of retained products.[10] Both these types warrant treatment if they present with increased menstrual bleeding.

The choice of treatment has slowly shifted from surgical methods involving hysterectomy or ligation of uterine/internal iliac arteries to minimally invasive percutaneous transarterial embolization, which is safe and effective and provides a chance to retain fertility.[4–9] The surgical options can be considered when there is massive bleeding with hemodynamic compromise and rapid embolization is not available.[12] In a systematic review of UAE for AVMs by Ruiz Labarta et al, the success rate postembolization was 88.4% with a repeat embolization rate of 14%.[2] The major complication rate was 1.6%, which was mainly pulmonary embolism and dissection of internal iliac artery. No mortality was recorded. Minor complications occurred in 15%, mainly postembolization syndrome, which can be managed conservatively. The clinical success postembolization in our study was 86.4%, similar to the global rates, with similar recurrence rates of 13.5%. The patients in whom recurrences were noticed had undergone unilateral UAE for non-AVMs. The initial angiography showed abnormality only on a single side with normal appearing myometrial vessels on the contralateral side. However, as these vascular malformations are due to biological aberration, occluding one artery can lead to recruitment of new vessels from the opposite side. Hence, it is always advisable to do bilateral UAE for AVMs or non-AVMs.

The pregnancy rates post-UAE reported in that systematic review was 20.7% with the average time interval between embolization and pregnancy varying from 2 months to 5 years.[2] In another review by Peitsidis et al, the pregnancy rate was 29%.[12] The most common complication during pregnancy reported was spontaneous abortions. We also found a similar pregnancy outcome (27%) with three abortions. The ischemic injury to the endometrium might have a role in subsequent pregnancy loss, although Soro et al in their review on long-term outcomes post-UAE for postpartum hemorrhage stated that embolization had no direct effect on placental blood supply and fetal growth as the collateral circulation develops very early after UAE.[17]

The limitations of this study include a heterogeneous treatment group with different choice of embolic materials. The effectiveness of UAE among different embolic materials could not be studied. Our study is also limited by a shorter duration of follow-up as pregnancy has been reported up to 5 years post-UAE.

Conclusion

Prompt and accurate diagnosis of iatrogenic uterine vascular pathologies is essential to prevent any life-threatening bleeding complications. Strong clinical suspicion of vascular malformations and PsAs should be considered when addressing patients with abnormal uterine bleeding postpregnancy (either delivery or abortion) or any uterine procedures or surgeries. Ultrasound helps in clinching the diagnosis in majority of cases. Percutaneous UAE is a safe and effective treatment for uterine AVMs and PsAs with a success rate of 86% with minimal complications. This procedure also allows for the preservation of uterine function with the possibility of future pregnancy and should be considered as a primary treatment option.

Ethical Approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards.

Patient's consent was obtained during the procedures. Care has been taken not to disclose the patient's identity directly or indirectly in any form.

Conflict of interest

None declared.

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