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Case Report
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Post-Partum Acquired High-Risk Uterine Arteriovenous Malformation: Complete Embolization with PHIL 25

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Abstract

Uterine Arteriovenous Malformation (AVM) are mostly acquired after pregnancy; they normally have a high risk of bleeding due to their high-flow nature. Color-Doppler Ultrasound (US) permits an early diagnosis and is crucial to define the Peak Systolic Velocity (PSV) to plan the treatment. Embolization is, at the present time, the less invasive treatment for patients wishing to preserve fertility especially in high flow AVM without myometrial and endometrial integrity. A variety of embolic agents are used: among them, PHIL 25 is a good option as it allows the embolization of the AVM nidus without proximal embolization nor non-target venous embolization.

In conclusion, acquired uterine AVMs caused by placenta accreta need to be embolized prior to scraping, even in the absence of bleeding. In general, urgent treatment of uterine AVMs may be necessary in cases of bleeding, while elective treatment could be appropriate for high flow AVMs, absence of myometrial integrity, and lack of postpartum menstruation.

Introduction

Uterine Arteriovenous Malformation (AVM) is characterized by the presence of abnormal connections or shunts between the myometrial arteries and veins and can be either congenital or acquired. Most are acquired after some form of damage to the uterine tissue, such as miscarriage, voluntary pregnancy termination, cesarean section, diagnostic or therapeutic curettage, myomectomy, cervical or endometrial cancer, uterine infection, trophoblastic disease, or endometriosis. Especially in postpartum US, gynecologists play a pivotal role in making a differential diagnosis between placenta accreta and uterine AVM because they have different treatments [1].

Uterine AVMs symptoms may start with lower abdominal pain, dyspareunia, menorrhagia, and metrorrhagia that do not respond to medical treatment for anemia, but in 84% of patients, massive bleeding and hypotension represent an indication for urgent treatment [2].

Some uterine AVMs are initially asymptomatic; hence, imaging plays a pivotal role in diagnosis and follow-up.

Hysterectomy was the treatment of choice for several years and remains the reference treatment especially for post-menopausal patients or in emergency life-threatening situation but in young women with or without the desire of future pregnancy AVM embolization is a valued option.

Currently, embolization is commonly used both in emergency settings and in elective treatments, especially in young childbearing women [3].

The treatment of uterine AVMs is mandatory in cases of bleeding; however, there are other conditions that increase the risk of bleeding: High flow is considered a predictive index of rupture, loss of myometrial integrity reduces its hemostatic role during a possible hemorrhage, and a lack of postpartum period may increase the risk of AVM rupture [4].

Case Presentation

A 35 years-old female with a medical history of acute myeloid leukemia in 2012 and uterine septum removal in 2017 was pregnant with *in vitro* fertilization in 2018. In 2019, she underwent a cesarean section for anterior placenta previa with a small area of accretism. The procedure was complicated by blood loss (1.5 L) treated with Bakri balloon hemostasis; therefore, the surgeons decided not to remove the small area of accretion and to follow it up with ultrasound to plan a further scraping treatment. She underwent weekly color-Doppler US check-up, and a month later, a small hypervascular area corresponding to the placental residual was noted. Further US follow-

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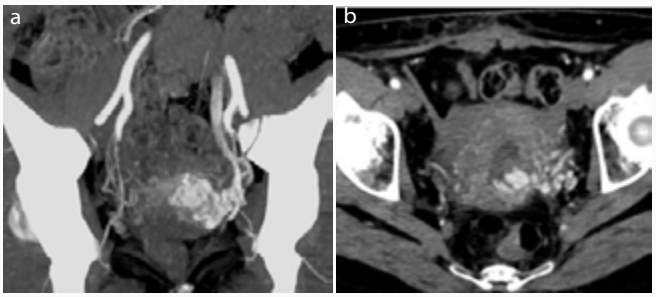

Figure 1: (a) Angio-CT in arterial phase showing uterine AVM with dilated arteries in the posterolateral left portion of the uterus. (b) MIP reconstruction highlights tortuous feeding arteries of the AVM and plexiform nidus.

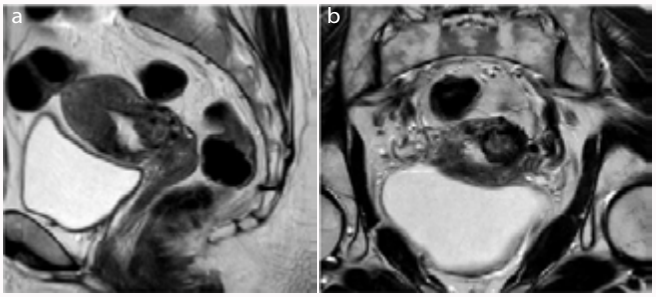

Figure 2: (a) MRI shows multiple serpentine flow-related signal voids typically seen in the uterine wall on T2 weighted images in sagittal view (a) and axial view (b). Note the absence of myometrium around the AVM.

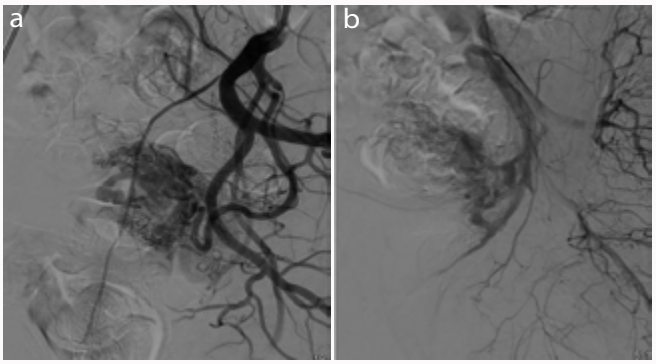

Figure 3: Digital Substraction Angiography (DSA) shows hypervascular lesion with arterial feeders arising from left uterine artery (a) with early venous run-off (b).

up documented the growth of the hypervascular area; therefore, a more detailed imaging study is required. Angio-CT and MRI were performed to confirm the diagnosis; angio-CT (Figure 1) showed a large uterine Arteriovenous Malformation (AVM) in the left lateral myometrium with multiple bilateral feeders from the right uterine artery. MRI was necessary for morphologic assessment of the lesion since it clarified the relationship between the AVM and myometrium/endometrium. MRI highlighted a protrusion of the AVM in the uterine lumen with no surrounding endometrial or myometrial integrity, and a greater risk of bleeding due to the lack of hemostatic action of the myometrium (Figure 2).

As the arteriovenous malformation was characterized by high-flow on doppler US and the patient had yet to menstruate following her pregnancy with no myometrial integrity, the interventional radiologist, in collaboration with the gynecologists, opted to treat the

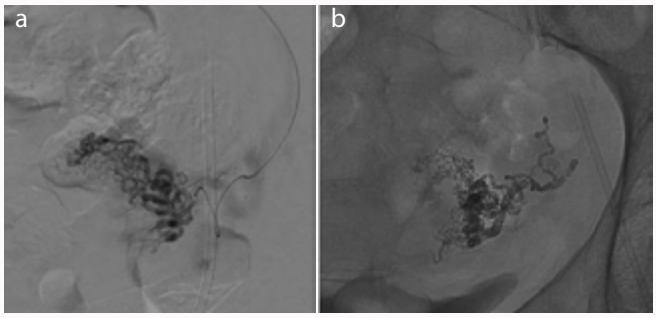

Figure 4: (a) indicates the DMSO-compatible microcatheter distally in the uterine feeding vessel and (b) during PHIL injection: note the stack of the embolic agent in the AVM nidus and feeding arteries.

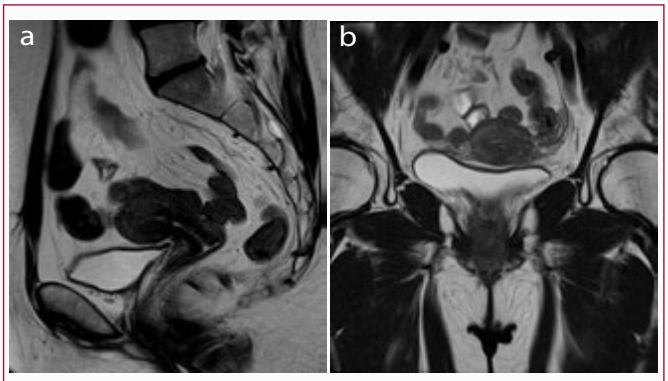

Figure 5: T2w MRI sequences three months after the procedure, shows a small uterine scar in coronal plane (a) and axial plane (b) with no vascularization.

arteriovenous malformation due to the heightened risk of bleeding.

Hysterectomy was excluded because of the patient's age, so the best option was endovascular approach with embolization by using iodine embolic agent (PHIL, MicroVention). Through 5F femoral access a pre-procedural angiography was performed showing the main feeders of the AVM deriving from the left uterine artery, with a small portion from the contralateral side: the left uterine artery was then catheterized, and the AVM nidus and its left feeders were embolized using 2 ml of iodinated embolic agent through a DMSO-compatible microcatheter (Figure 3). Embolizing the nidus with non-resorbable fluid was sufficient to guarantee a complete devascularization of the AVM, with no need to embolize the contralateral uterine arterial feeders.

Post-procedure one-month Doppler US follow-up showed no vascularization of the placental residual and with a progressive size reduction after two months: Three months later, the residual tissue underwent scraping with no complications.

A six-month MRI was performed, showing a small uterine wall scar with no enhancement, which was considered as a complete response (Figure 4).

Since the patient underwent *in vitro* fertilization, she could not have more pregnancies; however, her uterus was preserved with no major surgery (Figure 5).

Discussion

The first imaging techniques used for the diagnosis of AVM are B-mode and Color Doppler ultrasound. A hypoechoic or anechoic

pseudocystic structure within the myometrium may be seen on B-mode imaging, while color Doppler imaging is more specific and reveals thickened vessels with turbulent flow [5].

Although other conditions, such as retained products of conception, hemangioma, gestational trophoblastic disease, multilocular ovarian cysts, or hydrosalpinx, may present with a similar appearance to AVM, it is crucial to utilize color and spectral Doppler ultrasound for more precise information. AVMs are characterized by intense vascular flow in multiple tortuous vessels oriented in different directions, resulting in juxtaposed red and blue regions [6].

Spectral Doppler ultrasound reveals high-velocity flow (mean peak systolic velocity: 136 cm/s), low resistance (mean resistance index: 0.3), and low pulsatility of the arterial waveform. Additionally, it shows a pulsatile high-velocity venous waveform. However, differentiation between venous and arterial waveforms can be challenging, and the pelvic veins situated beyond the AVM may exhibit pulsatile flow instead of the typical monophasic flow.

Timmerman et al. observed that a Peak Systolic Velocity (PSV) value of ≥ 0.83 m/s could be labeled as potentially dangerous and could lead to treatment. Conversely, PSV values <0.83 m/s may indicate less dangerous vascular malformations and PSV values <0.39 m/s appear safe [7].

Angio-CT using Maximum Intensity Projection (MIP) and Volume Rendering (VR) reconstructions could help in the diagnosis of tortuous vessels and identifying feeder arteries; pelvis MR is an adjunct to CT in the evaluation of vascular malformations, as it provides precise morphological assessment of these lesions. Specifically, MR enables the examination of the relationship between malformations and the myometrium and endometrium, which is crucial for limiting hemorrhage in cases of bleeding [8].

However, angiography is the best imaging technique because it permits precise analysis of the arterial anatomy of the uterus. Understanding the course of the feeder arteries allows embolization of the right vessel and sparing of other vessels, thus preserving the uterus. Moreover, angiography is useful for planning the procedure, and is a more appropriate embolic agent. According to the literature, a wide variety of embolic agents are used to treat acquired AVMs; in most cases, large particles (PVA) or glue are used.

PHIL 25 (MicroVention) is an embolic agent with proper density that permits embolization of the AVM nidus without a proximal embolization and minimizing the risk of non-target embolization of the venous component, which was previously challenging to avoid using particles, particularly larger particles.

PHIL 25 (MicroVention) is an embolic agent that possesses a unique property in its proper density that allows the embolization of AVM nidus without proximal embolization. This characteristic significantly lowers the risk of non-target embolization of the venous component, a challenge that was previously difficult to overcome using particles, particularly larger ones. The principal goal to treat AVMs is to embolize the nidus in order to spare the principal feeders' arteries, allowing to spare the left uterine artery and part of the right artery in our patient.

PHIL is a suitable option for managing high-flow AVMs that do not exhibit bleeding but exceed PSV value at Color-Doppler US.

Conclusion

For patients with placenta accreta remnants who have acquired AVMs, it is crucial to undergo embolization of the AVM prior to scraping, even in the absence of bleeding. In most cases, uterine AVMs can be treated both urgently and electively. Urgent treatment may be necessary in cases of bleeding, while elective treatment may be appropriate for AVMs with high flow, absence of myometrial integrity, and lack of postpartum menstruation.

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