The Egyptian Journal of Radiology and Nuclear Medicine 49 (2018) 590–596

Contents lists available at ScienceDirect

The Egyptian Journal of Radiology and Nuclear Medicine

journal homepage: www.elsevier.com/locate/ejrnm

Original Article

# Role of color Doppler ultrasonography and multidetector computed tomography angiography in diagnosis of uterine arteriovenous malformations

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ARTICLE INFO

*Keywords:*
Uterine arteriovenous malformation
Color doppler ultrasonography
Multidetector computed tomography angiography

ABSTRACT

*Aim of work:* To assess the role of color Doppler ultrasonography and multidetector computed tomography angiography (MDCTA) in diagnosis of uterine arteriovenous malformations (AVMs).
*Methodology:* Twenty patients were referred to the radiodiagnosis and imaging department, faculty of medicine, Tanta University from obstetric and gynecology department. All patients were suspected clinically to have uterine arteriovenous malformations. All were subjected to history taking regarding clinical state, laboratory investigation and color Doppler ultrasonography and multidetector computed tomography angiography of the pelvis.
*Results:* Color Doppler ultrasound sensitivity was 100% in detecting a uterine hypervascular lesion and highly suggesting the diagnosis of uterine AVM and the sensitivity of MDCT angiography was 100% in diagnosing and evaluating uterine AVM.
*Conclusion:* Doppler US can strongly suggest the presence of AVM but patient should undergo CT angiography for definitive diagnosis and possible embolization, as CTA helps in providing valuable cross sectional anatomical details about the lesion, its extent and its surroundings.

## 1. Introduction

Uterine arteriovenous malformation is a rare vascular condition. It is a dilatation of the intervillous space deep in the myometrium, allowing direct flow from the arterial system towards the venous system, without participation of capillary vessels [1]. There are 2 different types of uterine AVM; the most common is the acquired version, the second is the congenital one, which is more rare [2]. Abnormal differentiation of primitive vascular structures during embryogenesis leads to development of congenital uterine AVM. The common causes of acquired AVMs are iatrogenic resulting from prior dilation and curettage (D&C], uterine surgery or therapeutic abortion, direct uterine trauma, uterine malignancy and gestational trophoblastic disease [3,4]. Although AVMs involving the uterus are rare, if present, they can be a serious cause of recurrent and intermittent menorrhagia [5].

A complete clinical history combined with radiological investigations such as color Doppler ultrasonography and CT angiography can help in making accurate diagnosis and reducing patient mortality [6,7]. Uterine AVM should be kept in mind if there is an unexpected, excessive, intermittent vaginal bleeding, especially after delivery or surgical procedures to the uterus [8]. This is secondary to the high vascular flow across the involved lesion due to the differential pressure gradient across the arterial and venous systems [9].

The diagnosis of AVM is troublesome because it is a rare malformation and could not be diagnosed in a routine examination [10]. Color Doppler ultrasonography has become the preferred diagnostic modality in the last two decades. However, angiography remains the gold standard method for diagnosing uterine AVM, as it is required for definitive diagnosis and also for treatment [8].

Doppler US is an excellent noninvasive and widely available

*Abbreviations:* AVM, arteriovenous malformation; cc, cubic centimeter; CDS, color Doppler sonography; C.S., caesarean section; CT, computed tomography; CTA, computed tomography angiography; 3D, 3 dimensional; D&C, dilation and curettage; HCG, human chorionic gonadotropin; kv, kilo volt; mA, milli amper; MDCT, multidetector computed tomography; mg I/ml, milli gram iodine/ milliliter; MHz, mega Hertez; mm, millimeter; MIP, maximam intensity projection; n, number; RPOCs, retained products of conception; s, sec, second; UAE, uterine artery embolization; US, ultrasonography; VR, volume rendering

Peer review under responsibility of The Egyptian Society of Radiology and Nuclear Medicine.

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https://doi.org/10.1016/j.ejrnm.2018.03.007
Received 21 November 2017; Accepted 7 March 2018
Available online 08 May 2018

diagnostic method [11]. Application of color Doppler ultrasonography will reveal abnormal hypervascularity within the lesion with color mosaic of aliasing and flow reversal [12]. Spectral Doppler ultrasound shows low resistive index values with high velocity flow [12]. Spectral analysis may predict the degree of the vascular lesion arterializations and help in the definition of treatment [11]. The identification of uterine high velocity blood flow with low impedance by Doppler ultrasound is highly suggestive of a uterine AVM [5]. Although Doppler US can strongly suggest the presence of AVM, its ability to accurately determine the lesion extent in the pelvis may be limited [11].

If AVM is suspected by US, the patient should undergo CT angiography for definitive diagnosis and possible embolization [9,13]. CT angiography helps in confirming the diagnosis of uterine AVM and provides beneficial cross sectional anatomical details in patients planned for surgery or embolization [12]. The role of three dimensional CT angiography is to define the extent of involvement, to rule out extrauterine extension, to differentiate between congenital and acquired uterine AVM noninvasively and to delineate the feeder vessel/uterine arteries [14,15]. Recently, the noninvasive technique of four dimensional CTA (4D-CTA) was applied, combining the traditional three dimensions with the fourth dimension of time to create a stereoscopic image continuously displaying blood vessels within the short interval of time taken for one investigation [16]. The typical findings of a uterine AVM by angiography involve high arterial flow with early venous filling. A single direct fistulous communication to the venous structures may be defined [5]. In patients considered for embolization, CT angiography can shorten the study time, reduce radiation dose and decrease contrast required for the procedure and it is also useful for anatomical conceptualization to the gynecologist in patients planned for surgery [17].

## 2. Patients and methods

A total number of 20 patients were included in this study for Doppler ultrasonography and multidetector computed tomography angiography over a period of one year from October 2016 till October 2017. Those patients were referred to diagnostic radiology and medical imaging department at Tanta University Educational Hospital from Obstetric and Gynecology Department (see Figs. 1–3). All patients were suspected clinically to have uterine arteriovenous malformations (most commonly menorrhagia or menometrorrhagia).

### 2.1. Inclusion criteria

- Patients clinically suspected to have uterine arteriovenous malformation (most commonly menorrhagia or menometrorrhagia).

### 2.2. Exclusion criteria

- Patients who are contraindicated to perform CT with contrast:
  - Impaired renal functions (serum creatinine is more than 1.5 mg/dl).
  - Patients with known allergy to contrast media.
  - Pregnant female patients to avoid the hazards of ionizing radiation to the fetus.
- Patients who refuse the examination and uncooperative patients.

All patients were subjected to the following:

- Short history taking regarding clinical state to confirm the clinical data reported in referral request.
- Laboratory investigations.
- Abdominal and transvaginal color Doppler ultrasonography of the pelvis.
- Multi detector computed tomography angiography of the pelvis.

### 2.3. Ultrasonography

Ultrasound examination was performed using Toshiba, Aplio 500, using both (1.4–5.0 MHz curvilinear) and (2.9–9 MHz vaginal) multifrequency probes.

A preliminary transabdominal ultrasound was done for all patients to give provisional information on the endometrial and myometrial conditions and comparison between transabdominal and transvaginal ultrasound findings. Transabdominal Doppler mapping was performed for all patients with evaluation of pathologies; diffuse or focal. Further transvaginal ultrasound scans were performed for all married referred patients and further correlation between transabdominal and transvaginal findings was done. Further transvaginal Doppler mapping was preformed. Systematic approach was done to the pelvis and then Doppler mode (color and pulsed Doppler) was switched on and the endometrium, subendometrium and myometrium were then evaluated thoroughly for any Doppler signals detected. The Doppler color scale was adjusted to avoid aliasing and artifacts. Then sample gate was placed on the desired area where a sample of the detected vascularity was evaluated for the blood flow and pattern of wave. Resistive index values and blood flow velocity were measured at the site of AV malformation.

### 2.4. MDCT angiography

All CTA examinations were performed using 320 rows MDCT scanner (Aquilion One, Toshiba Medical Systems, Otawara, Japan). The acquisition was done using volume scanning with 16.0 cm z axis coverage per gantry rotation to include iliac crests superiorly down to symphysis pubis inferiorly. The scan was started automatically 15 s after contrast injection using intermittent acquisition mode with 3 s interval and was terminated manually after the end of venous phase. Acquisition parameters: 0.5 s gantry rotation, 100 kv with variable mA according to patient body habitus. Using a dual head power injector, 100 cc of non ionic contrast (Optiray350 mg I/ml) was injected at 5.0 cc/s followed by 40 cc saline. The first acquisition shows no contrast which acts as a mask for bone subtraction. Images were reconstructed at 0.5 mm slice thickness and 0.25 mm interval to form multiple volumes representing all phases of the scan followed by automatic bone subtraction. The subtracted images used to generate MIP and 3D volume rendered images at different projections. Finally, a dynamic movie was made using all phases to show real time contrast passage through pelvic arteries, veins and AVM nidus inbetween if present. In principle, the vascular information could be visualized by using a VR or MIP methods including arterial supply to the uterus including ovarian and uterine arteries with anastomosis in between. The feeding arteries to vascular malformations were seen ectatic and tortuous with enlarged caliber. Dilated vascular bed, early arteriovenous shunting and dilated uterine veins could also be detected.

## 3. Results

The present study evaluated 20 female patients suspected clinically to have uterine AVMs. All patients had negative results of serum beta HCG. The age of the examined patients was 18–49 years with mean of (29 ± 4.23 years.). The most common age for uterine AVM ranged between 25 and 40 years. The patients presented clinically by different complaints but the main and most common complaint was vaginal bleeding as 17 patients (85%) were referred due to complaining of intermittent or progressive vaginal bleeding, in the form of menorrhagia or menometrorrhagia, other 3 patients complained of other symptoms, recurrent spontaneous miscarriages (5%) and pelvic pain (5%), that may or may not be associated with vaginal spotting. Another one patient (5%) had no gynecological related complaints (asymptomatic) and was discovered accidentally. Mean time interval between obstetric events and symptom presentation was 6 weeks. Recent surgical