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## 6 **Acquired Uterine Vascular Anomaly**

### 7 *Experience from a tertiary care center in Pakistan*

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#### 15 **Abstract**

16 **Objective:** To retrospectively review imaging findings and the outcomes of uterine artery  
17 embolization (UAE) in symptomatic uterine vascular anomalies. **Methods:** We identified 15  
18 cases of acquired uterine vascular anomaly from 2010 to 2020 who were evaluated with  
19 ultrasound, computed tomography, and magnetic resonance imaging, either alone or in  
20 combination. All patients had history of dilatation and curettage or uterine instrumentation. They  
21 underwent angiography and embolization of the uterine arteries. Primary outcome post  
22 embolization was assessed clinically and/or in combination with ultrasound. Post procedure  
23 pregnancies were also recorded. **Results:** Non-invasive imaging was abnormal in all patients,  
24 however this pre intervention imaging was unable to accurately classify the type of vascular  
25 anomaly except in the case of pseudoaneurysm. Conventional angiography showed uterine artery  
26 hyperemia in 6, arteriovenous malformation in 7 and pseudoaneurysm in 2 patients. The  
27 technical success rate was 100% with no repeat embolization needed. Follow up ultrasound in 12  
28 patients revealed resolution of abnormal findings, remaining three were normal on clinical  
29 follow up. Seven patients (46.7%) had a normal pregnancy, 15.7 months after the procedure  
30

31 (range 4-28 months). **Conclusion:** UAE is a safe and effective management option for intractable  
32 severe bleeding in patients with uterine vascular anomaly post instrumentation and is seen not to  
33 impair future pregnancy.

34 **Keywords:** Uterine artery embolization; Pseudoaneurysm; Arteriovenous malformation;  
35 Ultrasound; Computed tomography; Magnetic resonance imaging.

36

### 37 **Advances in Knowledge**

- 38 • All hypervascular lesions in the uterus on ultrasound are not true arteriovenous  
39 malformations. Placental subinvolution theory should be kept in mind when assessing  
40 patients for suspected uterine vascular anomaly post-abortion on imaging.

41

### 42 **Application to Patient Care**

- 43 • Pelvic artery embolization prevents hysterectomy in cases of severe vaginal bleeding.  
44 Embolization of the uterine artery does not preclude successful future pregnancy

45

### 46 **Introduction**

47 Uterine vascular anomalies (UVA) are classified into two main types, a) vascular malformations,  
48 and b) vascular neoplasms, according to the International Society for the Study of Vascular  
49 Anomalies classification system.<sup>1</sup> The first category includes several entities such as venous  
50 malformations, arteriovenous fistulas, pseudoaneurysms, arteriovenous malformations (AVMs),  
51 and rarely a combination of pseudoaneurysm and AVM. <sup>1-3</sup> AVMs are the most reported uterine  
52 vascular anomaly although their true incidence is unknown.<sup>4,5</sup> These may be either congenital or  
53 acquired, the latter being far more common.<sup>4,6</sup> Acquired uterine AVMs are most commonly  
54 secondary to uterine trauma, such as curettage or uterine surgery, which results in abnormal  
55 communication of uterine artery branches with the myometrial venous plexus and lack a true  
56 nidus.<sup>4,7,9</sup>

57

58 Rare causes of uterine AVM include endometrial or cervical carcinoma, leiomyoma, uterine  
59 infection, gestational trophoblastic diseases or endometriosis.<sup>9-11</sup> Direct communication between  
60 artery and vein results in arteriovenous fistulas.<sup>1,12</sup> Pseudoaneurysms constitute another rare  
61 acquired vascular anomaly. These are focal areas of confined defects communicating with the

62 vessel lumen through a traumatic defect, frequently post pelvic/uterine surgery or a curettage  
63 procedure, and lack a true wall.<sup>2</sup> Patients with acquired uterine vascular anomaly present with  
64 acute heavy bleeding, which may be intermittent or continuous.<sup>5,8</sup> Other symptoms such as lower  
65 abdominal pain, urinary frequency or incontinence, dyspareunia, and hypotension or  
66 hypovolemia secondary to blood loss have also been described.<sup>11</sup> All suspected cases of uterine  
67 AVM initially undergo ultrasound evaluation for diagnosis, supplemented by computed  
68 tomography (CT) or magnetic resonance imaging (MRI) in cases where ultrasound is  
69 inconclusive.<sup>8,12</sup> Although conventional angiography is the gold standard for diagnosis, it is  
70 reserved for cases that are unresponsive to conservative management and in whom a therapeutic  
71 embolization is planned.<sup>13-16</sup>

72  
73 The purpose of our study was to review the diagnostic accuracy of imaging in identifying uterine  
74 vascular anomalies in symptomatic patients and to assess the technical success of percutaneous  
75 uterine artery embolization (UAE) in the management of this patient cohort.

## 76 77 **Methods**

78 This study was a retrospective analysis conducted at the Aga Khan University Hospital (AKUH),  
79 Karachi after taking approval from the institute's Ethical Review Committee (Ethical Review  
80 Number: ERC # 2020-3690-10189). We searched our Radiology database for patients  
81 undergoing UAE from January 2010 to May 2020. After excluding patients with known uterine  
82 tumors, retained products of conception, gestational trophoblastic disease, and post-partum  
83 hemorrhage, we identified 15 cases suspected of uterine vascular anomaly clinically and on  
84 imaging.

85  
86 A pre-structured proforma was used to record patient demographics including age, parity,  
87 pattern, and volume of vaginal bleeding, history of uterine surgery or dilatation and curettage  
88 (D&C), time interval since the intervention, findings on imaging and angiography, and patient  
89 outcome. The duration of hospital stays, post-procedure complication, follow-up ultrasound  
90 findings, and post-embolization fertility/pregnancy were also recorded. The patient's imaging  
91 was reviewed on picture archiving and communication system (PACS), Rogan Delft View Pro-

92 X, while additional data was collected from the Health Information Management Services  
93 (HIMS).

94

95 The pre angiography imaging modality was chosen at the discretion of the referring physician,  
96 which included ultrasonography with color Doppler Imaging, pelvic MRI, and CT, either alone  
97 or a combination. The referring physician decided on embolization after consulting with the  
98 interventional radiologist. In the angiographic suite of Aga Khan University Hospital,  
99 interventional radiologists performed embolization procedures. Consent was taken in every case  
100 to explain the benefits and risks. Under local anesthesia, the procedure was performed on a flat  
101 panel monoplane digital subtraction angiography machine Axiom-Artis, Siemens. The femoral  
102 artery was punctured and a 4F vascular access sheath was inserted. A 4Fr Simmons (SIM 1)  
103 catheter (Cordis), or a Cobra (C1) angiographic catheter (Cordis) was advanced over a 0.035-  
104 inch guidewire. An angiographic run was performed after selective catheterization of the uterine  
105 artery, followed by super-selective cannulation using a microcatheter (Progreat Terumo) which  
106 was placed coaxially as near as possible to the feeder vessel. The embolization materials used  
107 were polyvinyl alcohol particles (PVA), size 355-500  $\mu\text{m}$ , gel foam, glue, and coil, either in  
108 combination or isolation. In a few cases, the ovarian artery was also embolized. Clinical success  
109 was defined as resolution of vaginal bleeding and/or abnormal imaging findings on post  
110 embolization follow-up.

111

112 SPSS version 20 was used for statistical analysis. Quantitative data were expressed as mean  $\pm$   
113 standard deviation; qualitative data were expressed using frequencies (percentages). Descriptive  
114 analysis was done for all variables, including the demographic variables as well as the other  
115 categorical variables, and frequencies, proportions, and percentages were reported.

116

## 117 **Results:**

118 The mean patient age was 28.2 years (range: 20-35 years). Fourteen patients had undergone a  
119 prior uterine procedure. Twelve patients had a prior D&C, One patient had a repair of a uterine  
120 rupture and one patient had a C-section. The patient without prior D&C or surgery had a history  
121 of medical termination of pregnancy.

122

123 The clinical features are shown in Table 1. Main presenting complain was abnormal pervaginal  
124 bleeding. It was considered mild if there was only spotting, when there was continuous bleeding  
125 but no clots it was labelled as moderate and severe when there was passage of clots. The mean  
126 time interval of patient presentation after the intervention was 64.6 days (range: 1-365 days).  
127 All patients underwent pre-embolization US except one, who underwent only MRI examination.  
128 Greyscale ultrasound identified an abnormal area in the myometrium in 12 patients (85.7%) and  
129 an abnormal area in the endometrium in 2 patients. On Doppler imaging, eight patients showed  
130 mixed arterial/venous flow. Six of the eight were confirmed as AVM on angiography (figure 1)  
131 while the other two showed only uterine hyperemia on angiography. Four patients showed focal  
132 increased vascularity within the myometrium, one turned out to be an AVM on angiography  
133 while the other three just showed uterine artery hyperemia. Two patients showed  
134 pseudoaneurysms on Doppler that were confirmed on pre-embolization CT and angiography  
135 (figure 2). Two other patients had abnormal focal vascularity on arterial phase with prominent  
136 veins on pre-embolization CT suggesting AVM. Among these, one proved AVM on angiography  
137 (figure 3) while the other showed uterine hyperemia only.

138  
139 Six out of 15 patients underwent pre-embolization MRI. MRI findings demonstrated abnormal  
140 signal intensity areas in either the myometrium or endometrium with abnormal enhancement and  
141 multiple flow voids suggesting AVM. Three of these were confirmed as AVM (figure 4) on  
142 angiography, while the other three showed enlarged, prominent uterine arteries.

143 The details of the angiographic findings and procedures are shown in Table 2.

144  
145 The embolization procedure was technically successful in all 15 patients, and none required a  
146 repeat embolization or post embolization transfusion. None of the patients had an on-table  
147 procedure-related or puncture site complication. The mean duration of hospital stay was 2.73  
148 days, (range: 2 - 4 days). Nine out of fifteen patients had mild bleeding at the time of discharge  
149 from the hospital which resolved by the next clinic visit. Two patients had an episode of per  
150 vaginal bleeding a month later which responded to conservative management.

151  
152 Twelve patients underwent follow-up ultrasound examinations. The mean time of the follow-up  
153 ultrasound, after embolization, was 40.6 days (range- 15 to 90 days). In five patients, the follow-

154 up ultrasound was completely normal. Five patients showed persistent greyscale findings,  
155 however, abnormal vascularity had resolved. One patient showed a decrease in size of the  
156 abnormal area on ultrasound with persistent mild vascularity, although she was asymptomatic. In  
157 another patient, both greyscale and Doppler abnormality was demonstrated on initial follow-up  
158 ultrasound, but it resolved completely on repeat ultrasound two months later. Three patients did  
159 not have any follow-up imaging but were clinically asymptomatic.

160  
161 Seven patients (46.7%) had normal pregnancies that carried to term after the procedure. The  
162 mean time interval between the procedure and the pregnancy was 15.7 months (range- 4 to 28  
163 months). The remaining eight did not conceive to our knowledge.

## 164 165 **Discussion**

166 Our retrospective study at a tertiary referral center reviewed the spectrum of imaging findings in  
167 patients with suspected acquired vascular uterine anomalies and the outcomes of super-selective  
168 UAE. We found true AVMs in seven cases including one arteriovenous fistula. Additional  
169 anomalies that we found were uterine hyperemia and pseudo-aneurysm. Timmerman et al  
170 studied 30 cases of suspected uterine vascular malformations out of which eight underwent  
171 angiography. Their study showed true AVMs in three patients while the rest had only abnormal  
172 arterial blush.<sup>17</sup> Occasionally, the number of AVMs is purportedly higher on (conventional)  
173 angiography. Hugues et al did a study on 26 cases of suspected uterine AVMs, of which about a  
174 quarter showed uterine hyperemia, whilst true AVMs were observed in the remaining cases.<sup>18</sup>  
175 Also, a study of iatrogenic uterine arterial injuries, which were treated by UAE, found AVMs in  
176 the majority of cases (15 out of 24), either alone or in combination with pseudoaneurysm.<sup>2</sup>

177  
178 All of our cases showed abnormalities on both greyscale and color Doppler ultrasound  
179 examinations. Both pseudoaneurysms were accurately identified. Pseudoaneurysms appear as  
180 cystic spaces on greyscale ultrasound which show swirling multidirectional flow on color  
181 Doppler with varying degrees of turbulence, allowing for correct identification in most cases.<sup>1,2</sup>  
182 The greyscale appearances of AVMs, on the other hand, are non-specific, ranging from subtle  
183 myometrial inhomogeneity to linear, anechoic spaces in the myometrium which show color

184 filling on Doppler interrogation with a mosaic pattern.<sup>12,19</sup> The specificity is increased by Duplex  
185 US/ spectral analysis which reveals high velocity, low resistance arterial flow.<sup>17</sup>

186  
187 Unfortunately, the spectral analysis findings were not available in all our cases as mostly  
188 greyscale and color Doppler evaluation was done. It has been seen that low resistance abnormal  
189 vascularity often persists in the myometrium at the site of trophoblast/placental implantation and  
190 takes time to resolve.<sup>1,11</sup> This has been referred to as sub-involution of placental bed and may  
191 account for abnormal findings on ultrasound and MRI as seen in some of our cases which  
192 subsequently demonstrated only uterine hyperemia on angiography with no AVM. Nevertheless,  
193 angioembolization was justified as these patients presented with moderate to severe bleeding that  
194 had been resistant to conservative management. Symptoms completely resolved following a  
195 single session of embolization, with no discernable adverse effects.

196  
197 Currently, digital subtraction angiography (DSA) is the gold standard for the diagnosis of uterine  
198 vascular anomalies; however, its use is not justified unless it is the precursor to an embolization.  
199 The management of uterine vascular anomalies depends on the clinical presentation as well as  
200 the severity of the anomaly. Patients who have minimal symptoms and/or are hemodynamically  
201 stable may be followed clinically and by ultrasound. Bleeding usually resolves spontaneously  
202 within weeks to months in milder cases.<sup>20</sup> UAE is offered to patients with severe intractable or  
203 recurrent bleeding. It avoids hysterectomy preserving chances of future fertility. UAE may  
204 theoretically result in reduced vascular supply to the uterus; however, the presence of rich  
205 collaterals prevents uterine infarction.<sup>13</sup> Many case reports and studies have shown successful  
206 pregnancy outcomes post angioembolization.<sup>13,20,21</sup> Nearly half of our cases had pregnancies that  
207 carried to term, post embolization.

208  
209 Several embolic agents have been used for the treatment of UVAs. These include gel foam, PVA  
210 particles, glue, coil, or a combination<sup>13,15,16,18,22,23</sup>. In our study, PVA particles were the most  
211 used embolization material, used in thirteen out of fifteen cases. It was the sole embolic agent in  
212 ten cases and used in combination with gel foam in one case and combination with histoacryl  
213 glue and coil in two patients. Gel foam was used as the sole embolic agent in one case. One

214 patient with a right uterine artery pseudoaneurysm was embolized with cyanoacrylate glue. The  
215 reported complication rate of pelvic artery embolization is low.<sup>23</sup>

216  
217 Minor complications such as puncture site pain or hematoma, fever, and transient lower limb and  
218 buttock claudication are more frequent than rare severe complications such as iatrogenic rupture  
219 of a pelvic artery, sloughing of perineal skin, vesicovaginal fistula, or major distal  
220 ischemia.<sup>13,22,23</sup> We did not encounter any major post-procedural complications. Only three  
221 patients experienced mild abdominal pain not requiring any treatment while fever was observed  
222 in two patients which resolved before discharge.

223

## 224 **Conclusion**

225 Ultrasound is the first-line imaging modality employed for the diagnosis of uterine vascular  
226 anomaly. It has high specificity for pseudoaneurysms but lacks specificity for AVMs. It is  
227 important to consider placental bed sub-involution whilst diagnosing AVMs on non-invasive  
228 imaging in cases with a history of a recent miscarriage. In summary, UAE is a safe and effective  
229 management option for intractable severe bleeding in patients with uterine vascular anomaly post  
230 instrumentation and does not limit future pregnancy outcomes.

231

## 232 **Conflict of Interest**

233 The authors declare no conflicts of interest.

234

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236 No funding was received for this study

237

## 238 **Author Contributions**

239 KF, RS and MA conceived the idea, KF and MZ collected the data, KF, MZ and RS analysed  
240 and interpreted the data, KF, RS and MZ drafted the article, MA critically reviewed the  
241 manuscript and supervised the study. All authors approved the final draft.

242

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311  
 312 **Table 1.** Baseline characteristics of the study population

<b>Age Years (mean)</b>	28.2, range (20-35)
<b>Parity</b>	
0	3
1-2	7
>3	5
<b>History of D&amp;C</b>	12
<b>Time since D&amp;C, days (mean)</b>	42.6, range (1-60)
<b>History of uterine surgery</b>	2
<b>History of MTP</b>	1
<b>Amount of bleeding</b>	
Moderate	6 (40%)
Severe	9 (60%)
<b>Pattern of bleeding</b>	
Intermittent	9 (60%)
Continuous	6 (40%)

313 *D&C: Dilatation and curettage, MTP: Medical Termination of Pregnancy*

314

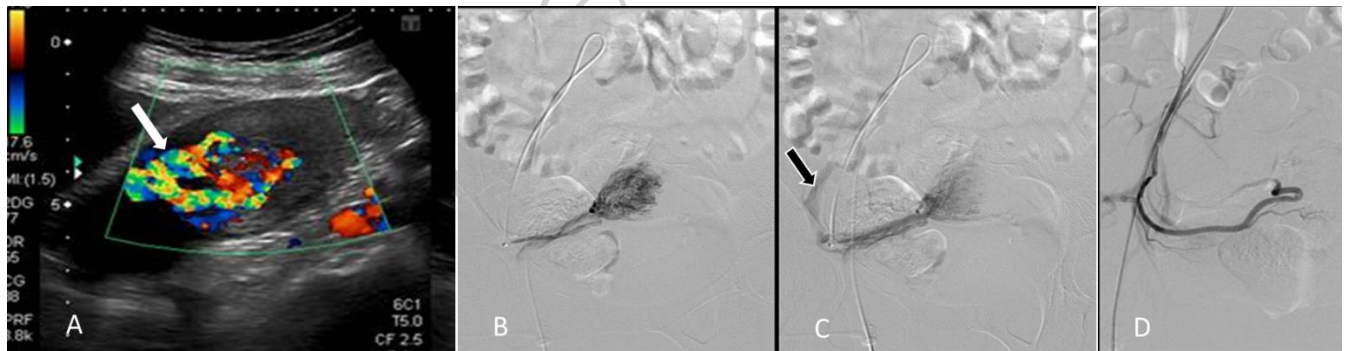
315 **Table 2.** Details of the Embolization procedure

Case	Angiographic Finding	Vessels embolized	Embolization material used	Complications	Duration of hospital stay	Post embolization pregnancy
1	Hyperemia	B/L Uterine Artery	PVA	None	2	No
2	Hyperemia	B/L Uterine Artery	PVA	None	3	No
3	Hyperemia	B/L Uterine Artery	PVA + gel foam	None	2	Yes
4	Hyperemia	U/L Uterine Artery	PVA	Fever	3	No
5	Hyperemia	B/L Uterine Artery	PVA	None	4	Yes

6	Hyperemia	B/L Uterine Artery	PVA	None	4	No
7	AVM	B/L Uterine Artery	PVA	None	2	No
8	AVM	B/L Uterine Artery	PVA	None	4	Yes
9	AVM	B/L uterine artery	PVA	None	2	No
10	AVM	B/L uterine artery	Gel foam	None	3	Yes
11	AVM	B/L uterine artery	PVA	Fever	4	Yes
12	AVM	B/L uterine artery	PVA	None	2	No
13	AVM	B/L uterine artery+ ovarian	PVA + coil + glue	None	2	No
14	Pseudoaneurysm	U/L uterine artery	Glue	None	2	Yes
15	Pseudoaneurysm	B/L uterine + ovarian	PVA + coil + glue	None	2	Yes

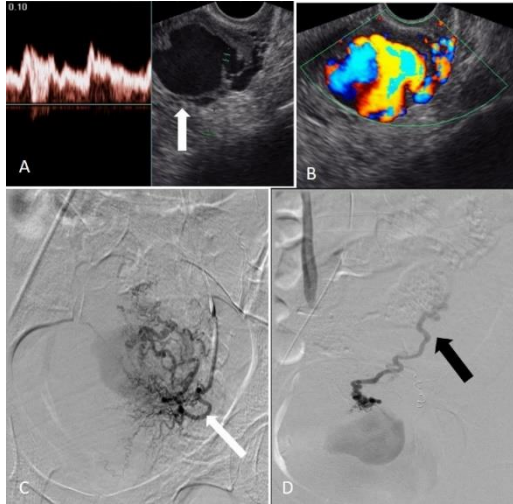
316 *AVM: arteriovenous malformation, B/L: bilateral, U/L: unilateral, PVA: polyvinyl alcohol*

317



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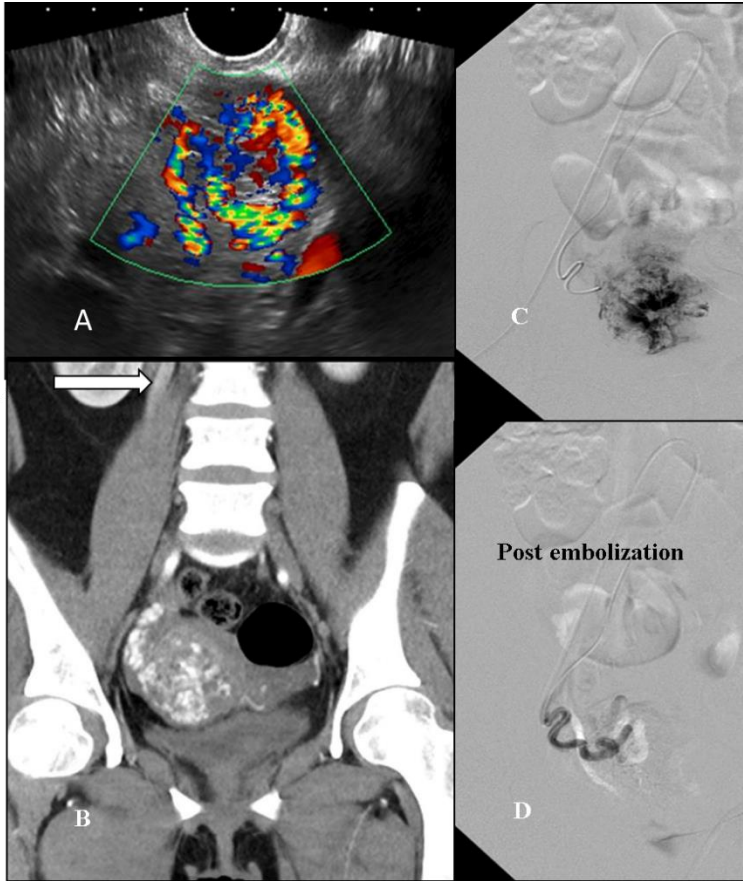
319 **Figure 1:** A 25-year-old with moderate vaginal bleeding. (A) Doppler ultrasound shows a  
 320 mosaic color pattern in the myometrium on the right side extending into endometrium indicating  
 321 both arterial and venous flow (arrow), (B) digital subtraction angiography (DSA) image shows  
 322 the AVM supplied by right uterine artery, (C) DSA image shows the early draining vein (black  
 323 arrow), (D) post embolization shows resolution of the AVM.



324

325 **Figure 2:** A 29-year-old with moderate vaginal bleeding post uterine surgery. **(A)** Greyscale  
326 transvaginal ultrasound image shows an irregular anechoic area in the myometrium (arrow) with  
327 the turbulent arterial flow on spectral analysis, **(B)** Doppler image shows heterogeneous color  
328 filling in the pseudoaneurysm, **(C)** and **(D)** digital subtraction angiographic images, left uterine  
329 artery (long white arrow) and left ovarian artery (black arrow) supplying the pseudo-aneurysm.

330

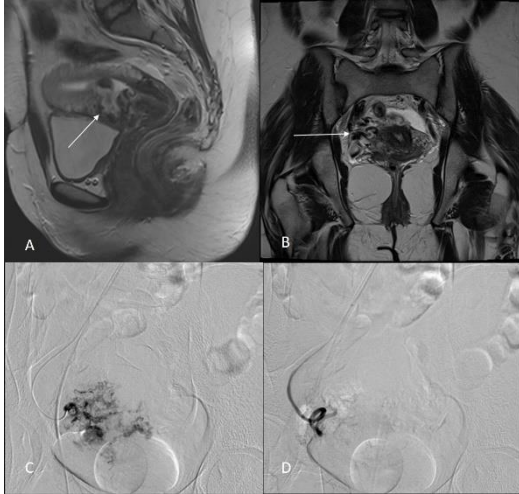


331

332 **Figure 3:** A 25-year-old with continuous vaginal bleeding. Transvaginal ultrasound Doppler  
333 images (A) show abnormal vascularity in the uterine myometrium, (B) Coronal contrast-  
334 enhanced CT image confirms abnormal myometrial vascularity and dilated draining gonadal vein  
335 (white arrow), (C) DSA image shows an abnormal bunch of vessels supplied by right uterine  
336 artery, (D) post embolization image showing complete resolution of the AVM

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340 **Figure 4:** A 31-year-old with severe vaginal bleeding. **(A)** T2 weighted sagittal MRI shows a  
341 heterogeneous bulging mass with serpentine signal voids involving the lower uterine cavity and  
342 anterior myometrium (white arrow). No myometrium is seen between the urinary bladder and  
343 this mass. **(B)** Coronal T2 weighted image shows multiple serpentine signal voids (white arrow).  
344 **(C)** Digital subtraction angiographic image shows dilated tortuous right uterine artery supplying  
345 AVM **(D)** post embolization image showing complete resolution of the AVM.