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6
7 **Acquired Uterine Vascular Anomaly**

8 *Experience from a tertiary care center in Pakistan*

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15
16 **Abstract**

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

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 hypervasculär 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.¹ 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.¹⁻³ AVMs are the most reported uterine
52 vascular anomaly although their true incidence is unknown.^{4,5} These may be either congenital or
53 acquired, the latter being far more common.^{4,6} 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.^{4,7,9}

57

58 Rare causes of uterine AVM include endometrial or cervical carcinoma, leiomyoma, uterine
59 infection, gestational trophoblastic diseases or endometriosis.⁹⁻¹¹ Direct communication between
60 artery and vein results in arteriovenous fistulas.^{1,12} 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.² Patients with acquired uterine vascular anomaly present with
64 acute heavy bleeding, which may be intermittent or continuous.^{5,8} 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.¹¹ 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.^{8,12} 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.¹³⁻¹⁶

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 μm , 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 per vaginal
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.¹⁷ 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.¹⁸
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.²

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.^{1,2}
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.^{12,19} The specificity is increased by Duplex
185 US/ spectral analysis which reveals high velocity, low resistance arterial flow.¹⁷

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.^{1,11} 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.²⁰ 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.¹³ Many case reports and studies have shown successful
206 pregnancy outcomes post angioembolization.^{13,20,21} 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^{13,15,16,18,22,23}. 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.²³

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.^{13,22,23} 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

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

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

314

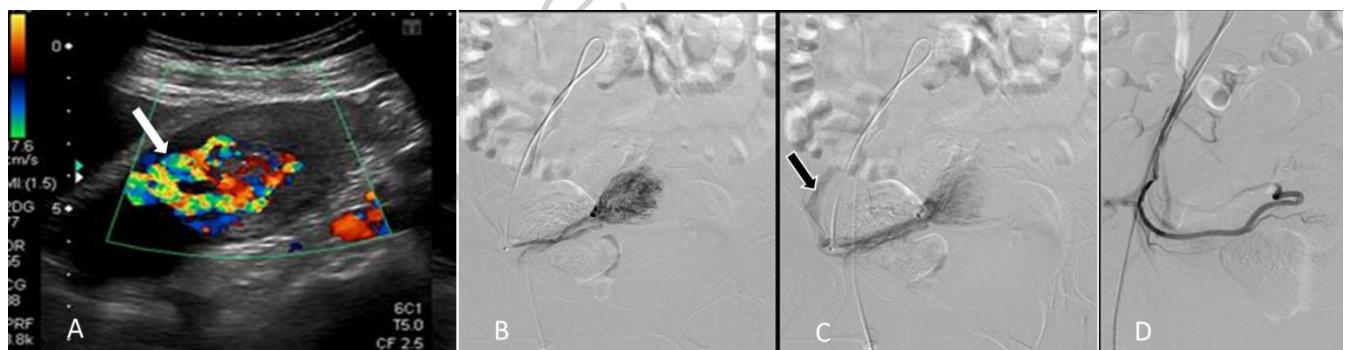
315 **Table 2.** Details of the Embolization procedure

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

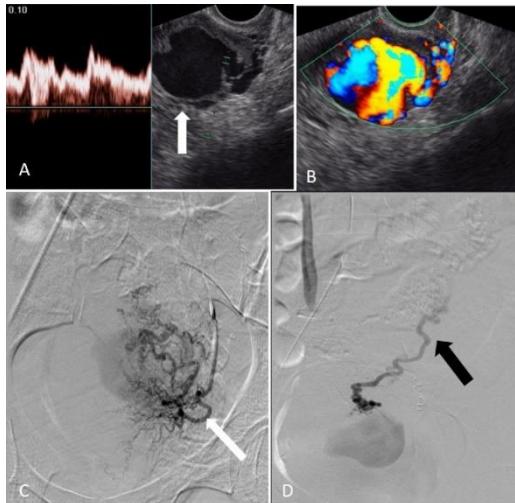
316 AVM: arteriovenous malformation, B/L: bilateral, U/L: unilateral, PVA: polyvinyl alcohol

317



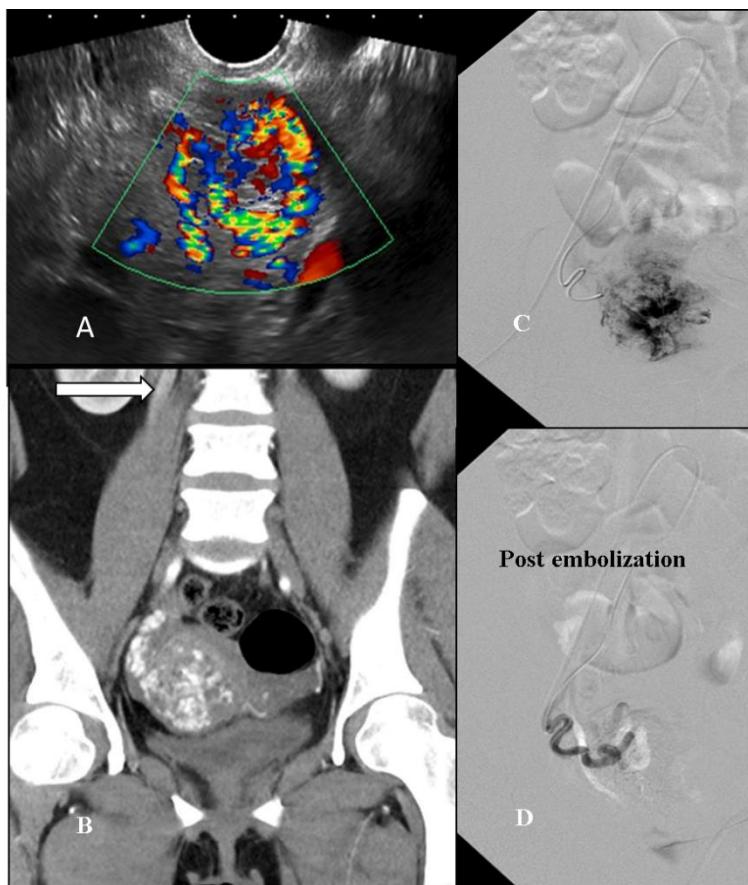
318

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

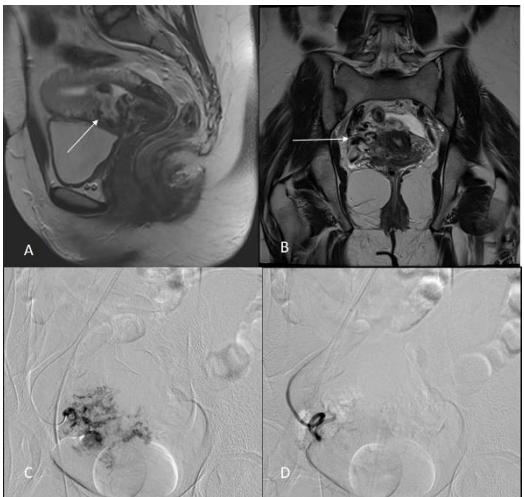


331

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

337

338



339

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.