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# CT and MRI features following Uterine Fibroid Embolization

Sachit Verma MD

*Thomas Jefferson University*

Carin F. Gonsalves MD

*Thomas Jefferson University*

Oksana H. Baltarowich MD

*Thomas Jefferson University*

Donald G. Mitchell MD

*Thomas Jefferson University*


Anna Lev-Toaff MD

*Thomas Jefferson University*

*See next page for additional authors*

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**Authors**

Sachit Verma MD, Carin F. Gonsalves MD, Oksana H. Baltarowich MD, Donald G. Mitchell MD, Anna Lev-Toaff MD, and Diane Bergin MD

# **Spectrum of imaging findings on MRI and CT after uterine artery embolization**

## **Abstract**

Uterine artery embolization (UAE) is an effective treatment for symptomatic uterine fibroids. Magnetic resonance (MR) imaging is typically employed to evaluate the uterus following UAE for fibroid infarction, size, location change, persistent enhancement, changes in adenomyosis and uterine necrosis. Variable pattern of calcification on computed tomography (CT) can differentiate embolic particles and fibroid involution. CT following UAE may be requested because of acute pelvic pain or chest discomfort or pyrexia and/or for complications that may require treatment in acute phase. Visualization of gas in uterus and uterine vessels following UAE is an expected finding that should not be misinterpreted as a sign of infection. The MRI and CT appearances vary depending upon the time interval after UAE and success of the procedure. Radiologists should be familiar with the range of post UAE appearances on MRI and CT to better aid clinicians in correct diagnosis and treatment. The main purpose of this pictorial review is to identify the spectrum of findings on MRI and CT performed after UAE, to illustrate UAE associated common and uncommon MRI and CT appearances and discuss post UAE complications that requires urgent medical or surgical intervention

**Keywords:** CT • Embolization • Fibroid • MRI • Uterine artery

## **Introduction**

Uterine artery embolization (UAE) is an effective treatment for symptomatic uterine fibroids, as good alternative to surgical management [1, 2]. The technique uses tris-acryl gelatin microspheres or polyvinyl alcohol (PVA) material injected into the uterine arteries to occlude the blood flow through end arterial branches which perfuse fibroids. UAE attempts to infarct and secondarily shrink fibroids by cutting off their blood supply [1]. Major complications following UAE are rare. About 8.5% short term and 1.25% serious complication rate have been reported till date [3]. Post procedural imaging is routinely performed to evaluate effectiveness of treatment and to identify potential post UAE complications. In our practice magnetic resonance (MR) imaging is used to evaluate patients before UAE and subsequently three month following UAE. Given the limitation of ultrasound, MRI is readily used to assess UAE effects including fibroid infarction, persistent fibroid vascularization, change in size and location of fibroids, recurrence and effects on adenomyosis when present [4, 5].

Variable pattern of calcification on computed tomography (CT) can differentiate embolic particles and fibroid involution [6]. CT is infrequently used in diagnosing conditions following UAE but may be performed for evaluating patients with acute symptoms. Thus the main aim of this pictorial essay is to identify the spectrum of findings on MRI and CT performed after UAE, to illustrate UAE associated common and uncommon MRI and CT appearances and discuss post UAE complications that requires urgent medical or surgical intervention

### **Typical post procedural appearance**

Routine follow up MRI after successful UAE will ideally show infarction of fibroids as complete lack of enhancement (Fig. 1). This is sometimes associated with T1-shortening effects of methemoglobin (Fig. 2) and variable signal intensity on T2-weighted images, depending upon age of hemorrhage within fibroid known as hemorrhagic infarction [7]. With increased interval between 3 months to one year following embolization, there is progressive liquefaction of necrotic fibroids with increased signal intensity on T2 weighted images [8] (Fig. 3). With successful infarction, some decrease in size of fibroid may be apparent. As the embolic particles used for embolization are not paramagnetic, susceptibility is not seen on post UAE MR images as may be associated with embolization coils elsewhere. CT following embolization may show increased attenuation of fibroids on precontrast images because of hemorrhage within fibroids (Fig. 4).

### **Fibroid location changes**

Pretherapeutic imaging defines the baseline location of uterine fibroids before embolization to predict potential complications that result from UAE. Change in fibroid location after UAE occurs in 1–5% of cases. Submucosal fibroids with a large endometrial interface (Fig. 5A) can become endocavitary following UAE (Fig. 5B). The majority of these are expelled spontaneously. In rare cases when they become obstructive, they are associated with infection of the uterus [9]. An endoluminal fibroid (Fig. 6) communicating with the endometrial cavity can result in prolonged sterile vaginal discharge and bleeding [9]. Subserosal fibroid with a broad based pedicle (Fig.

7A) can develop an intramural or submucosal component (Fig. 7B) following UAE. While a pedunculated subserosal fibroid with stalk diameter of less than 2cm is considered a relative contraindication for UAE because of rare occurrence of separation from the uterus and subsequent intraperitoneal adhesions or infection [9, 10].

### **Fibroid vascularity**

The aim of the embolization is complete infarction of the fibroid following UAE. Persistent enhancement of fibroids after UAE is a sign of treatment failure that may need additional treatment including repeated UAE or surgery depending on patient's symptoms. MRI with gadolinium enhancement is the imaging modality of choice to assess post UAE enhancement and/or necrosis of fibroids [4] (Fig. 8).

### **Patterns of calcification**

Fibroid calcification, which typically occurs 6 months after UAE, can be peripheral or central [6]. It is better appreciated on CT or ultrasound rather than MRI. On MRI, the calcification appears as areas of low signal on T1 and T2 weighted images with blooming on gradient echo images [11] (Fig. 9). Calcification within fibroids following UAE is often sequelae of precipitated embolization material or degenerative involuting fibroids. Peripheral calcification may result from retention of PVA particles which aggregate in peripheral fibroid arteries associated with reduction of fibroid volume [6] (Fig. 10). Globular calcification reflects dystrophic calcification because of hyaline necrosis and typically occurs within the substance of the fibroid [11] (Fig. 11).

### **Fibroid recurrence and regrowth**

Fibroid recurrence is not considered as a complication but a late failure with a reported incidence of 10% [12]. Symptomatic recurrence is seen 2 years after UAE. Many believe particle size or type and/or normal reperfusion of myometrium following UAE leads to fibroid regrowth [13]. Periodic MR examination based on clinical symptoms may be performed if fibroid recurrence is suspected (Fig. 12). Longer follow-up is required to predict the risk factors for fibroid recurrence

### **Gas after uterine artery embolization: sterile and infectious**

Various patterns of gas are seen in the uterine cavity and fibroids after UAE. A branching serpiginous linear distribution of gas may be seen in uterine vessels up to one month after UAE without associated clinical signs to suggest infection [14] (Fig. 13). Gas that fills the potential spaces occurs as a result of fibroid tissue infarction quite similar to post chemoembolization or ethanol ablation therapy for hepatocellular carcinoma [15]. This appearance should be well differentiated from localized collection of gas in a necrotic infarcted fibroid that appears as globular foci on CT (Fig. 14) and signal void on MRI following UAE (Fig. 15) with clinical signs of underlying infection. The presence of active pelvic infection is an absolute contraindication for UAE and therefore should be excluded to obviate further uterine infection. About 40% of women may develop fever, increasing pelvic pain, and a vaginal discharge following UAE. This combination of symptoms is called post-embolization syndrome [16, 17]. Post-embolization syndrome will typically resolve after 24 to 48 hours. If the symptoms get worse then infection should be considered [16, 17]. Infection following UAE has been reported in 2% of cases after UAE [18]. The pathogenesis of pelvic infection following UAE remains debatable.

Some theorize that subsequent superimposed infection results from ischemia of the fallopian tubes, others suggest that particle size less than 500  $\mu\text{m}$  used for the embolization leads to occlusion of small uteroovarian anastomotic vessels predisposing to uterine infection [19]. Despite periprocedural prophylactic antibiotic, pyometra is responsible for most postembolization hysterectomies associated with septicemia [17]. CT is frequently the imaging modality of choice in acute presentation. Imaging findings include uterine enlargement, gas within the endometrial cavity with or without fluid levels [20] (Fig. 16). Thus a good communication between the gynecologist and interventional radiologist will be helpful to differentiate between post-embolization syndrome and infection. Rarely pyosalpinx may develop from a hydrosalpinx after UAE [21]. Pyosalpinx shows similar attenuation to hydrosalpinx with prominent wall enhancement, internal septations with edema, fluid and stranding in the adjacent fat (Fig. 17). To prevent infection, premedication with prophylactic antibiotics is often needed before and after embolization. Treatment of postembolization pelvic infection depends on patient clinical status and includes conservative treatment with antibiotics or laparotomy and hysterectomy in more extreme cases.

### **Uterine necrosis**

Uterine necrosis is rare complication with few case descriptions in the literature [22, 23]. One proposed explanation thought to be compromised blood supply to the endometrium and myometrium especially inner myometrium as it has few number of collaterals which are more prone to infarction or other suggest that small PVA particles reaches farther into smaller vessels causes infarction [23]. Gadolinium enhanced MRI is the modality to assess the viability and vascularity of the uterine tissue [23]. It shows near complete



absence of enhancement of the uterus (Fig. 18). Hysterectomy is the recommended treatment with antibiotics to prevent septicemia.

### **Adenomyosis following uterine artery embolization**

Adenomyosis characterized by the ectopic endometrial glands and stroma within the myometrium that causes symptoms indistinguishable from those of fibroids [24]. UAE causes reduction in the junctional zone thickness at least transiently treating adenomyosis [24]. The true mechanism of action of UAE in adenomyosis remains unclear. It is however suggested that the post embolization effect is related to reduction in vascularity and thickness of the junctional zone [25]. MRI is the best non-invasive method of detecting adenomyosis. Residual islands of decreased T2 signal on MRI after embolization represent infarcted smooth muscle hypertrophy as a result of thrombosis [25]. The decrease in junctional zone after UAE on MRI best correlates with the severity and the depth of the myometrium involved and subsequently reduction in bleeding and other symptoms [25, 26] (Fig. 19)

### **Ovarian dysfunction and infertility**

Loss of ovarian function or failure as a complication of UAE for symptomatic uterine fibroids has raised concerns about the procedure. Incidence of immediate failure is upto 1-5% [27], while the development of premature menopause has been reported in 1–14% of women [1, 27]. The cause of ovarian failure after UAE has been due to reduction in ovarian blood flow, compromised by unintended embolization to the ovarian arterial vasculature via uterine artery anastomoses [27]. Ovarian arteries need to be at least 1.5

mm in diameter to be visible on a flush aortogram. MR angiography with maximum intensity or volumetric analysis can depict the ovarian vessels adequately if present before UAE which is otherwise difficult to delineate without ovarian supply to the uterus [28]

### **Pulmonary embolism**

Pulmonary embolism is rare life threatening complication seen in about 0.25% of cases after UAE [29]. It may occur almost immediately or even few hours to months following UAE. Patients are symptomatic; may presents with shortness of breath and pleuritic chest pain. Dynamic contrast-enhanced (multi– detector row) CT is preferred non invasive imaging modality in diagnosing pulmonary embolism as alternative to conventional angiography [30]. CT shows filling defects in pulmonary arteries and its branches at various levels (Fig. 20). 3D MR angiography also provides excellent depiction of the pulmonary arterial tree in cases where iodinated contrast material is contraindicated [30]. Thrombolytic treatment is a potentially lifesaving therapy when used in conjunction with standard anticoagulation in acute pulmonary embolism.

### **Conclusion**

The MRI and CT findings following UAE vary with the interval from embolization and success of the procedure. MRI with its mutiplanar capabilities is typically employed to evaluate the uterus following UAE for fibroid infarction, size, location change, persistent enhancement, fibroid recurrence, changes in adenomyosis and unexpected complications

that may require surgical intervention or identify women who would benefit from repeated UAE. CT is not routinely performed following UAE but may be requested because of acute pelvic pain or pyrexia or chest discomfort and/or for an unrelated indication. Visualization of gas in uterus and uterine vessels following UAE is an expected finding that should not be misinterpreted as a sign of infection. Radiologists should be familiar with the range of post UAE appearances on MRI and CT to better aid clinicians in correct diagnosis and treatment.

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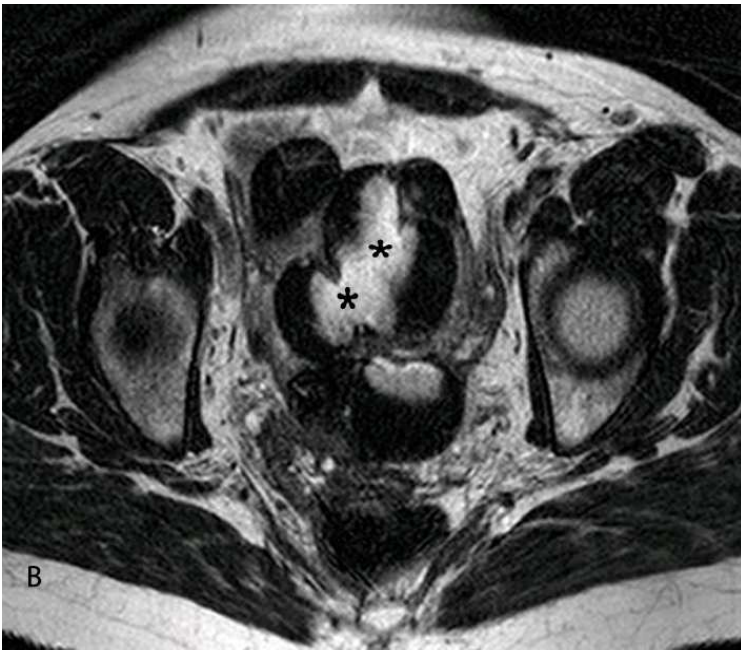
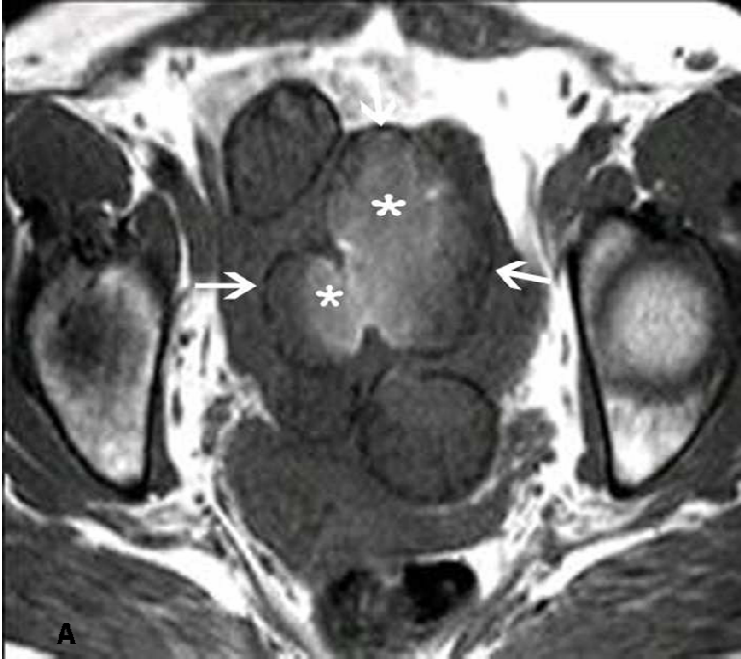
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## Figure Legends



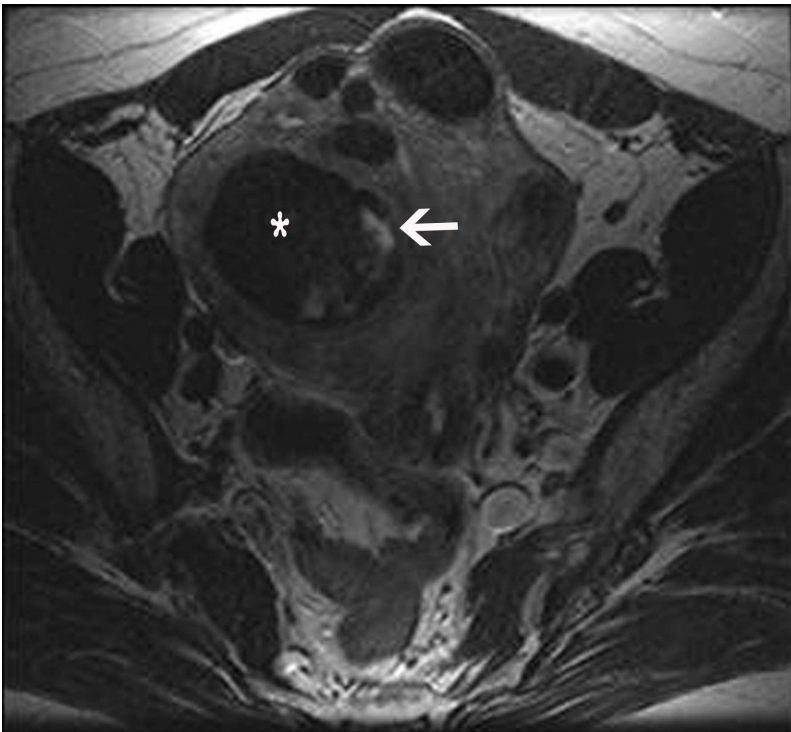
**Fig. 1.** 42-year-old woman 3 months after uterine artery embolization. Axial gadolinium-enhanced gradient-echo T1-weighted MR image (160/4.1, 80° flip angle) reveals non enhancing fibroid (*asterisk*) consistent with successful infarction





**Fig. 2.** 49-year-old woman with fibroids showing hemorrhagic infarction 3 months after uterine artery embolization. (A) Axial T1-weighted (TR/TE, 500/18) and (B) Axial T2-weighted (TR/TE, 4000/90) MR images shows areas of increased signal intensity within

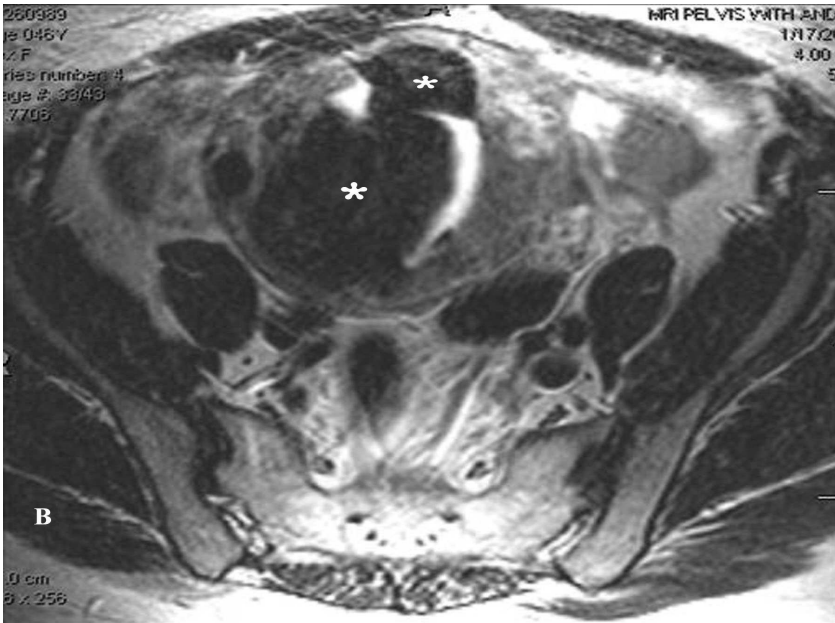
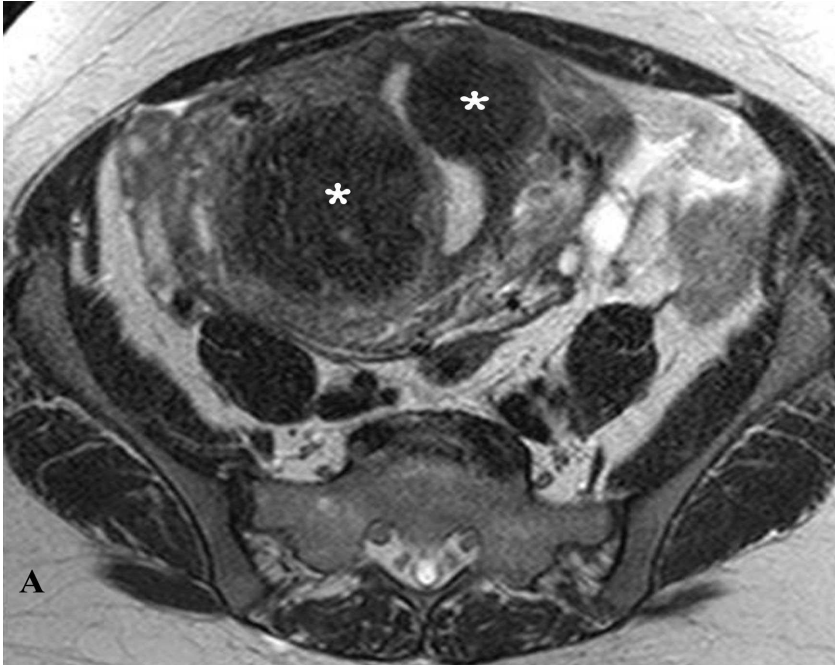
fibroids secondary to internal hemorrhagic necrosis (*asterisks*) with a low intensity rim consistent hemosiderin or calcification (*arrows*)



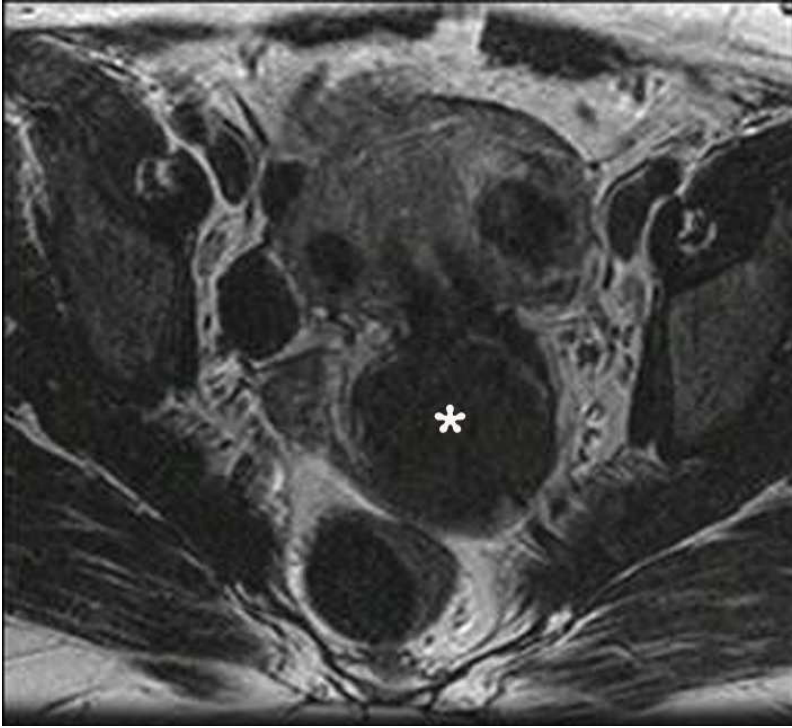
**Fig. 3.** 42-year-old woman with cystic degenerated fibroid 8 months after uterine artery embolization. Axial T2-weighted fast spin-echo MR image (TR/TE, 4000/90) reveals large low signal intensity fibroid (*asterisk*) with an ill defined internal areas of high signal intensity (*arrow*) consistent with partial liquefaction of an infarcted fibroid.



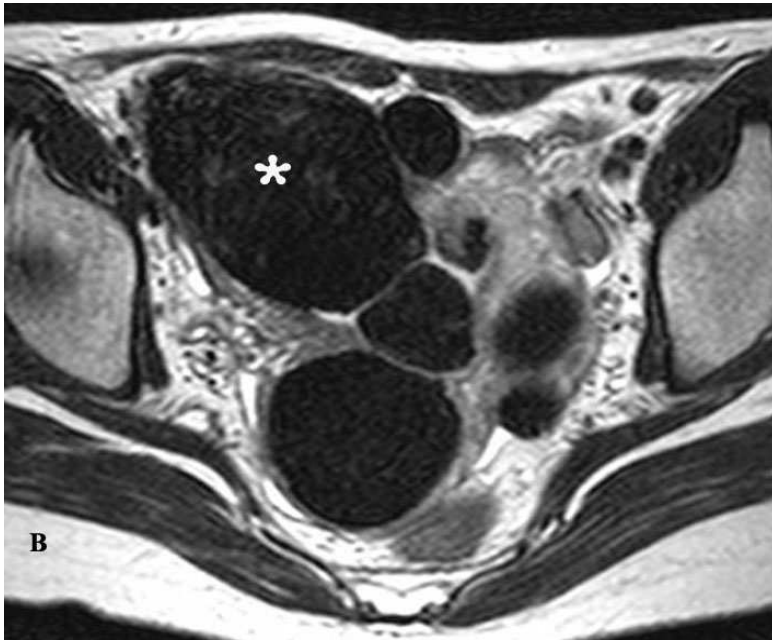
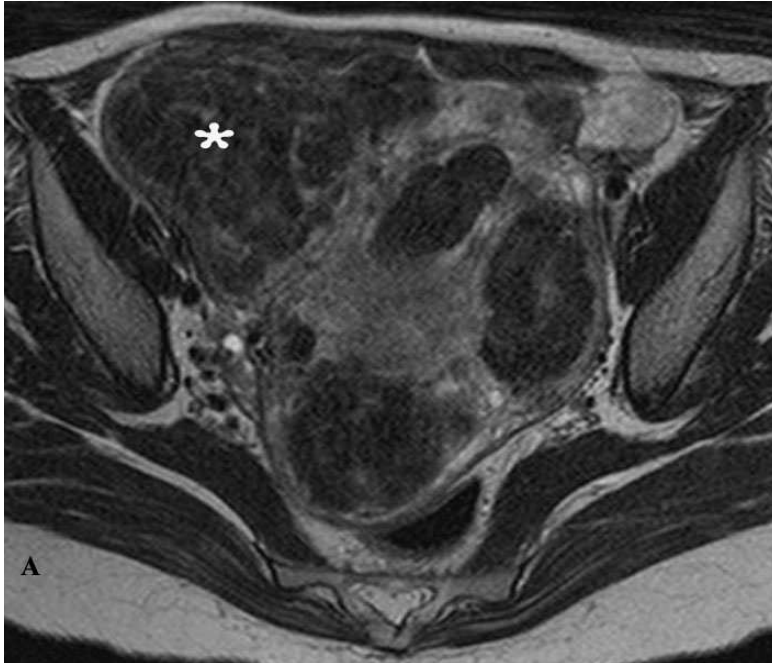
**Fig. 4.** 49-year-old woman with hemorrhage within fibroid one month after uterine artery embolization. Axial non contrast CT image of the pelvis reveals increased attenuation within fibroid representing hemorrhage (*asterisk*)



**Fig. 5.** 43-year-old woman with submucosal fibroid. **(A)** Axial T2-weighted fast spin-echo image (TR/TE, 4000/90) before uterine artery embolization (UAE) demonstrates submucosal fibroids (*asterisks*). **(B)** Axial T2-weighted fast spin-echo image (4000/90) after UAE shows submucosal fibroids that become endocavitary (*asterisk*)



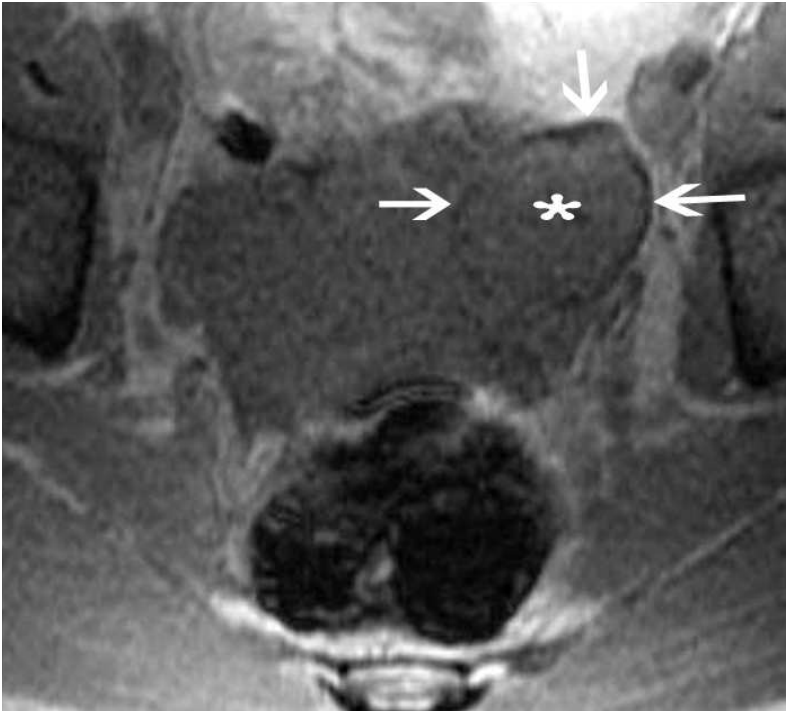
**Fig. 6.** 49-year-old woman with endoluminal fibroid after uterine artery embolization. Axial T2-weighted fast spin-echo image (TR/TE, 4000/90) shows a large endoluminal fibroid in the proximal vagina (*asterisk*) splaying the lower third of the cervix



**Fig. 7.** 46-year-old woman with subserosal fibroid. **(A)** Axial T2-weighted fast spin-echo MR image (TR/TE, 4000/90) before uterine artery embolization (UAE) shows subserosal fibroid (*asterisk*) with broad connection to the uterus (5.1 cm in diameter). **(B)** Axial T2-weighted fast spin-echo MR image (4000/90) after UAE shows the subserosal fibroid that subsequently become partly submucosal (*asterisk*)



**Fig. 8.** 42-year-old woman 4 months after uterine artery embolization (UAE). **(A)** Axial contrast enhanced CT image of the pelvis shows persistent enhancement of fibroid in the anterior portion of the lower uterine segment (*asterisk*) following UAE. **(B)** Axial gadolinium-enhanced gradient-echo T1-weighted MR image (160/4.1, 80° flip angle) shows persistent enhancement of fibroid in the anterior portion of the lower uterine segment (*asterisk*) following UAE

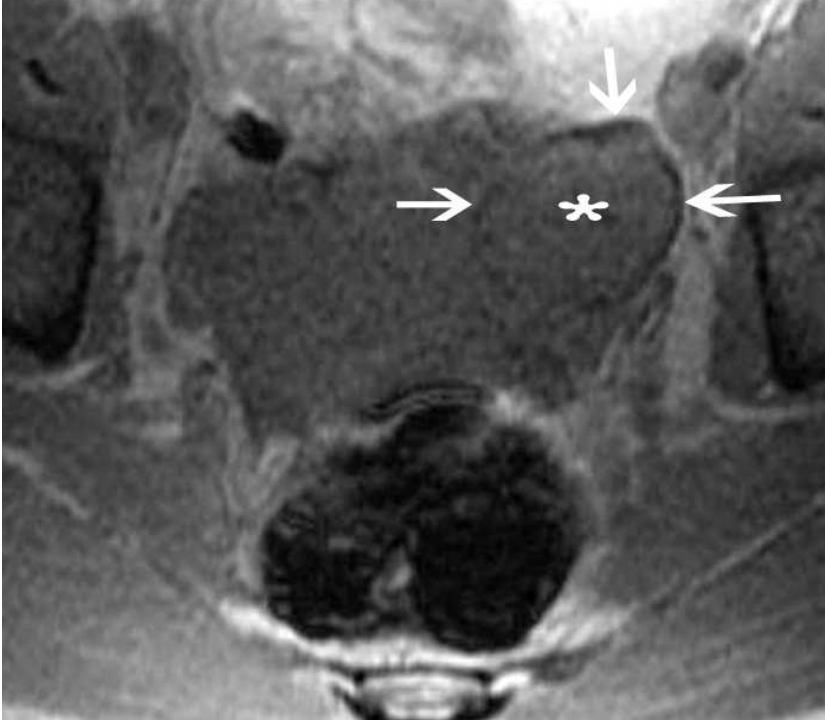


**Fig. 9.** Peripheral fibroid calcification 6 months following uterine artery embolization in a 39-year -old woman. Unenhanced axial T1-weighted spoiled gradient-echo MR image (150/4.1) shows peripheral hypointense rim (blooming effect) (*arrows*) around the fibroid (*asterisk*) consistent with calcification

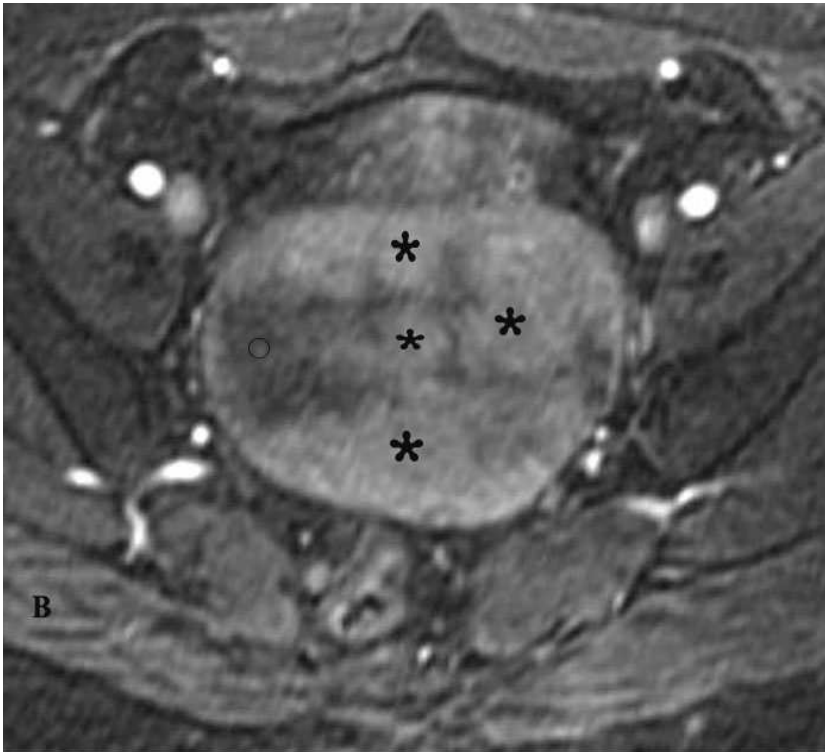
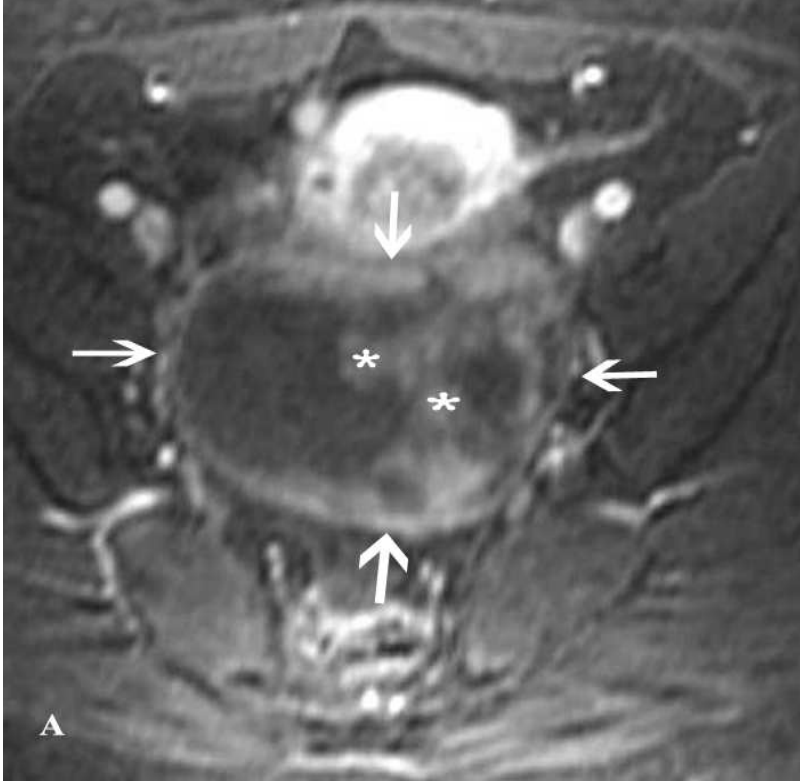




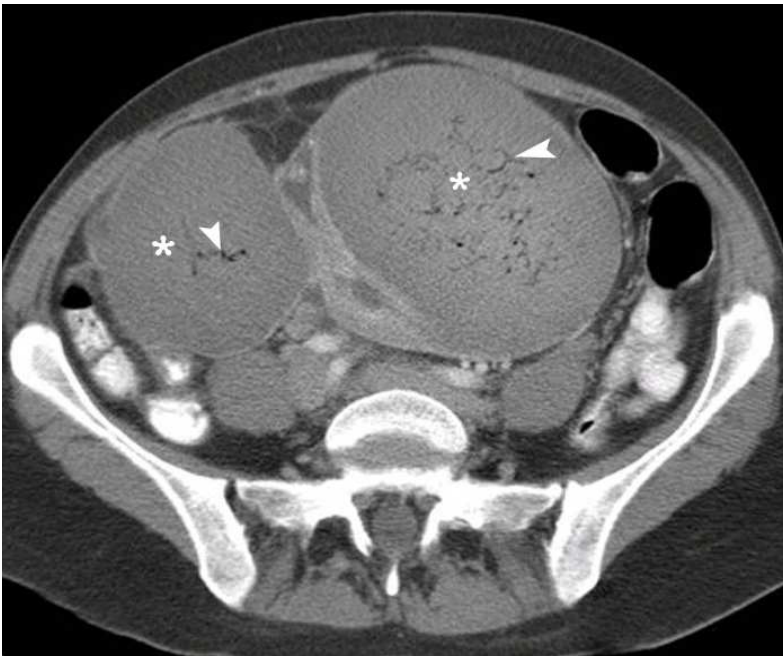
**Fig. 10.** Peripheral fibroid calcification 6 months following uterine artery embolization in a 50-year -old woman. Axial non contrast CT image of the pelvis reveals a smooth high attenuation rim consistent with peripheral calcification (*arrows*) of infarcted fibroid (*asterisk*)



**Fig. 11.** 42 year old woman with fibroids 6 months after uterine artery embolization. Axial non contrast CT image of the pelvis shows involuting fibroids with central globular calcification consistent with dystrophic calcification (*arrowheads*) as a sequelae to hyaline degeneration. Partial rim calcification (*arrow*) is seen of a second fibroid.



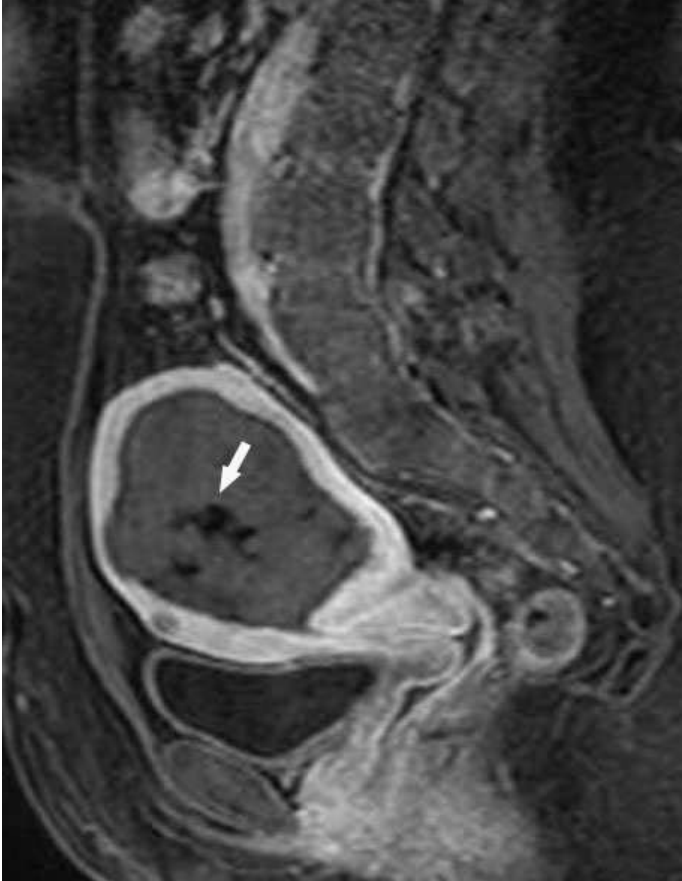
**Fig. 12.** 48-year-old woman with fibroid recurrence after uterine artery embolization (UAE). (A) Axial gadolinium-enhanced gradient-echo T1-weighted MR image (160/4.1, 80° flip angle) 7 months after UAE shows necrotic heterogenous fibroid (*arrows*) in the posterior body of the uterus with small nidus of enhancing viable tissue (*asterisks*). (B) Axial gadolinium-enhanced gradient-echo T1-weighted MR image (160/4.1, 80° flip angle) 24 months after UAE shows significant increase in enhancing tissue (*asterisks*) consistent with fibroid regrowth. Only a small areas of necrosis persist (*circle*) compared to 7 months post UAE



**Fig. 13.** 30-year-old woman 5 days after uterine artery embolization (UAE). Axial contrast enhanced CT image of the pelvis post UAE demonstrates large infarcted fibroids (*asterisks*) containing serpiginous gas with branching pattern (*arrowheads*) which is an expected finding following UAE. Laboratory and clinical findings showed no evidence of infection.



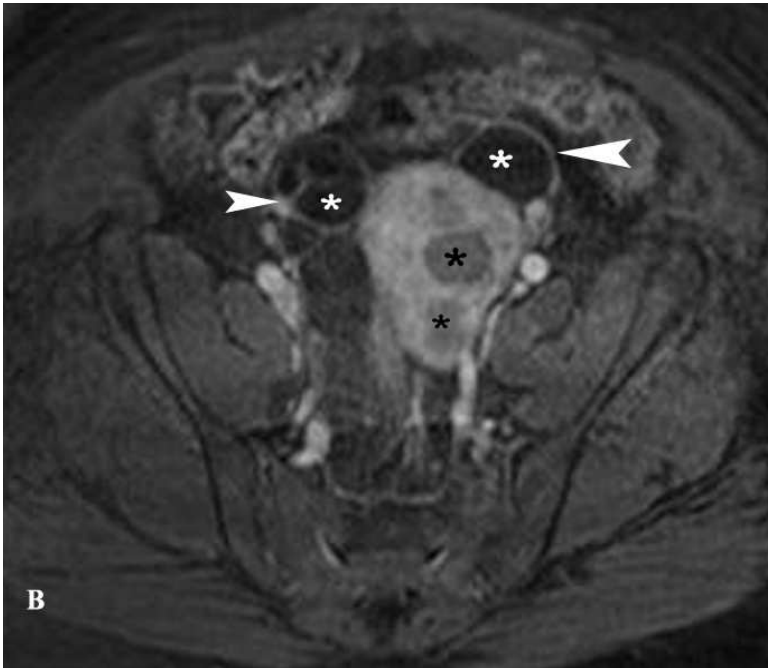
**Fig. 14.** 44-year-old woman 2 weeks after uterine artery embolization with worsening lower quadrant pain, dysuria and fever. Axial contrast enhanced CT image of the pelvis demonstrates infarcted intracavitary fibroid with globular foci of gas (*arrowheads*) consistent with infected endocavitary fibroid



**Fig. 15.** 45-year-old woman 3 weeks after uterine artery embolization with lower quadrant pain, dysuria and fever. Sagittal fat-suppressed fast spin-echo T2-weighted MR image (TR/TE, 2,800/85) demonstrates infarcted intracavitary fibroid with globular foci of signal void representing gas (*arrow*) consistent with necrosis and superimposed infection



**Fig. 16.** 44-year-old woman 3 weeks after uterine artery embolization with fever and pelvic pain. Axial contrast enhanced CT image of the pelvis shows distended endometrial canal with globular foci of gas (*arrowheads*). Clinical findings and positive growth on blood culture were consistent with infection

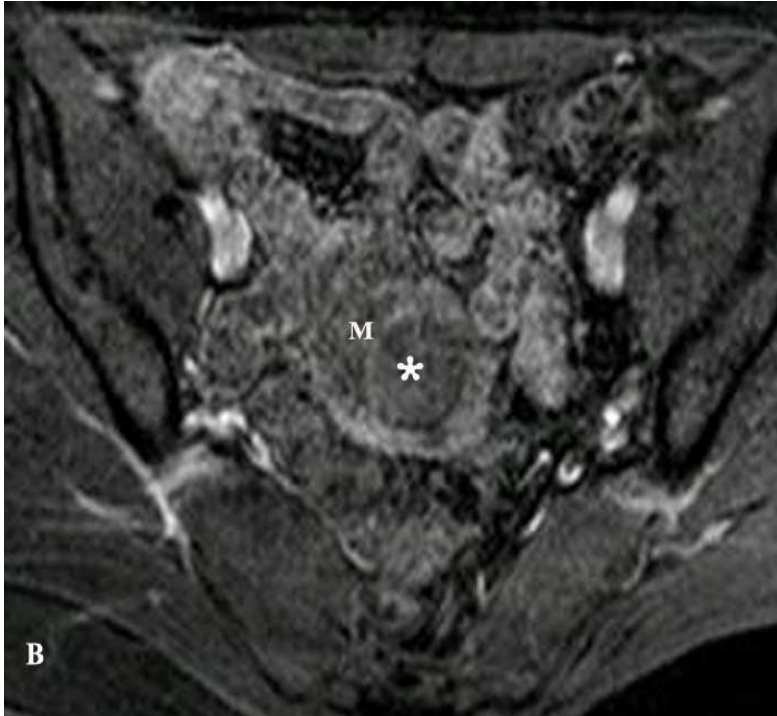


**Fig. 17.** 54-year-old woman who presented with severe abdominal cramps and fever 12 months after uterine artery embolization. (A) Axial T2-weighted fast spin-echo image (TR/TE, 4000/90) reveals hyperintense fluid-filled dilated tubular structure (*black asterisks*) with internal septations (*arrowheads*) consistent with chronic pyosalpinges.



Note low signal infarcted fibroids (*white asterisks*). **(B)** Axial gadolinium-enhanced gradient-echo T1-weighted MR image (160/4.1, 80° flip angle) clearly show increased enhancement of the walls and septations (*arrowheads*) of the dilated tubular structures (*white asterisks*) consistent with chronic pyosalpinges. Note non enhancing infarcted fibroids (*black asterisks*)



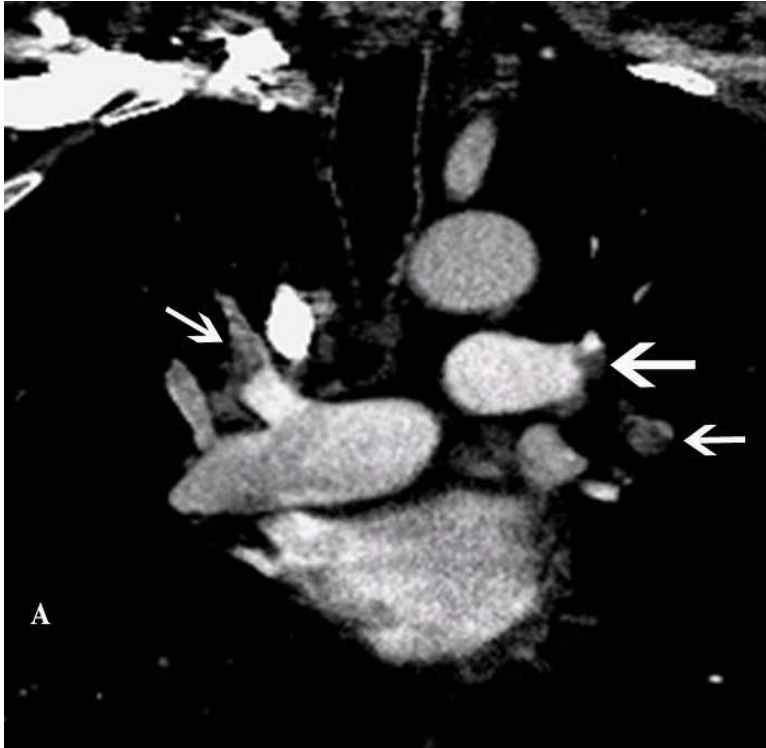


**Fig. 18.** 50-year-old woman with uterine necrosis after uterine artery embolization (UAE). (A) Axial gadolinium-enhanced gradient-echo T1-weighted MR image (160/4.1, 80° flip angle) obtained before uterine artery embolization (UAE) shows enhancing fibroid (*asterisk*) in the posteriolateral aspect of the uterus. Normal enhancing myometrium is also shown (*M*). (B) Axial gadolinium-enhanced gradient-echo T1-weighted MR image (160/4.1, 80° flip angle) after UAE reveals no enhancement of the fibroid (*asterisk*) and myometrium (*M*) consistent with uterine necrosis. Hysterectomy was performed subsequently



**Fig. 19.** 49-year-old woman with uterine fibroids and coexisting adenomyosis. **(A)** Axial T2-weighted fast spin-echo MR image (TR/TE, 4000/90) obtained before uterine artery embolization (UAE) shows uterine fibroids (*F*) and irregular thickening of the junctional zone (19mm in thickness) (*asterisks*) with associated myometrial cysts (*arrows*) representing asymmetric adenomyosis. **(B)** Axial T2-weighted fast spin-echo MR image

(4000/90) obtained 4 months after UAE shows decrease in uterine size and infarcted fibroids (*F*). Note diffuse thinning of the junctional zone (*arrow*) without evidence of adenomyosis





**Fig. 20.** 46-year-old woman with pulmonary embolism 5 days after uterine artery embolization. Coronal contrast enhanced CT shows numerous bilateral filling defects (*arrows*) distending segmental pulmonary arterial branches to the right upper lobe (**A**), right middle lobe (**A, B**), right lower lobe (**C**), lingula (**A, B**), and left lower lobe (**C**) compatible with multiple acute pulmonary emboli