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ABDOMINAL RADIOLOGY

Asherman syndrome in adenomyosis treated with uterine artery embolization: incidence predictive factors

Yaguang Wang[1,3] · Weifu Lyu[2] · Wencui Xu[3] · Yongqiang Yu[1]

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Abstract

Purpose To investigate Asherman syndrome (AS) related to potential factors during uterine artery embolization (UAE) treatment of adenomyosis.

Materials and methods This is a retrospective analysis of 195 women with adenomyosis who underwent UAE treatment from 2009 to 2016. All preoperative and intraoperative risk-related potential factors of AS were recorded. And AS events were carefully monitored during follow-up (range, 0–15 months). Potential risk-related factors of AS events were determined via univariate and multivariate logistic regression analyses.

Results The rate of AS events after UAE for adenomyosis was 12.82% (25/195). The univariate and multivariate analyses revealed the association of low vascularity with a significant risk for AS ($P=0.019$).

Conclusion Patients with low vascularity of adenomyosis at the time of UAE are more likely to have AS. And adenomyosis patients with low vascularity should be carefully selected to undergo UAE treatment.

Keywords Adenomyosis · Asherman syndrome · Angiography · UAE

Introduction

Recent studies suggest that uterine artery embolization (UAE) is an effective treatment for adenomyosis [1–4]. However, there are reports of adverse events associated with UAE, although it is still considered a safe treatment [5, 6]. For instance, the use of UAE leads to lower pregnancy rates compared to other treatment methods [7–10]. This indicates that the outcomes of the UAE procedure on the reproductive function need to be clarified [11]. The decline of pregnancy rates after UAE is generally ascribed to the impaired endometrial function or ovarian function [12]. Several studies show that UAE has little effect on ovarian function [13–16]. It has been reported that the incidence of Asherman syndrome (AS) in uterine myoma UAE is about 10.2%–13.7% and AS arises from partial or complete endometrial damage or adhesions caused by uterine invasive diagnosis and treatment. AS is mainly manifested as hypomenorrhea, amenorrhea, infertility and miscarriage, etc. [17, 18]. So far, few studies have evaluated the incidence of AS after UAE treatment for adenomyosis. Therefore, the clinical profile of AS after UAE is poorly understood. We postulate that the identification of factors that lead to the occurrence of AS will provide information that will guide decision-making concerning the application of UAE in adenomyosis.

The objective of this study was to investigate the factors that predict the incidence of AS after the application of UAE in patients with adenomyosis.

Materials and methods

Patient population and selection criteria

This is a retrospective and non-randomized study in which the medical data of 195 consecutive women with pure

✉ Yongqiang Yu
csirwyg85@yeah.net

1 Department of Radiology, The First Affiliated Hospital, Anhui Medical University, 218 Jixi Street, Hefei 230022, PA, People's Republic of China

2 Department of Radiology, The First Affiliated Hospital, University of Science and Technology of China, 17 Lujiang Street, Hefei 230022, PA, People's Republic of China

3 Department of Radiology, Women and Children Health Care Hospital Affiliated Hospital, Anhui Medical University, 15 Yimin Street, Hefei 230022, PA, People's Republic of China

symptomatic adenomyosis (mean age, 40.42 ± 4.67 years) who underwent UAE from 2009 to 2016 were analyzed. The inclusion criteria included patients with adenomyosis diagnosed by either magnetic resonance imaging (MRI) or ultrasonography (US) and clinical symptoms of menorrhagia and dysmenorrhea, and those who expressed the desire to preserve the uterus. The exclusion criteria included a current pregnancy, suspected gynecologic tumor or pelvic inflammatory diseases, endometrial hyperplasia, contrast allergy, or other severe diseases. Baseline demographic, type of adenomyosis, related symptoms, and history of therapy were recorded for each patient and summarized in Table 1.

Table 1 Baseline data ($n = 195$)

Category	Value
Median age, y (range)	41 (24–51)
Median(range) uterine size, cm^3	314.90 (197.65–2241.21)
Type	
Diffuse	84 (43.08%)
Focal	111 (56.92%)
Secondary anemia	
Normal	118 (60.51%)
Mild	40 (20.51%)
Moderate	37 (18.97%)
Previous medical therapy	
Yes	161(82.56%)
No	34 (17.44%)
Previous gynecological invasive therapy	
Yes	23 (11.79%)
No	172 (88.21%)

Procedure and angiographic endpoint of embolization

The common right femoral approach under local anesthesia was used to perform catheterization on all patients using a 4- or 5-Fr Cobra (Cook, Bloomington, IN, USA) catheter and selective catheterization of the bilateral uterine arteries under digital subtraction angiography (DSA). A non-ionic contrast medium (300 mg iodine/mL; Omnipaque; GE, Shanghai, China) was used as the injection medium. Angiography was performed using high-pressure injector at 68 kPa of pressure (abdominal aortography: 10 ml/s, 20–25 ml; uterine arterial angiography: 1–2 ml/s, 6–8 ml), during which the vascular characteristics of adenomyosis were observed. Angiographic images were assessed using a digital post-processing workstation.

The primary endpoints of embolization treatments included lesion occlusion, stasis of the distal end of the uterine artery, and decrease in flow to the proximal end of the uterine artery, at constant patency of the uterine artery.

Classification of vascular types

The vascular characteristics of adenomyosis were categorized by interventional radiologists as detailed by Tang, Zhou, and Chen [19–21]. These include levels 1, 2, and 3, according to the vascularity grade. Level 1 lesions, the hypervascular subgroup, exhibit abundant peripheral and central blood (Fig. 1a). Level 2 lesions, the isovascular subgroup, exhibit peripheral blood flow but less blood flow on the center of the lesions (Fig. 1b). Level 3 lesions, the hypovascular subgroup, do not have blood flow at both the periphery and the center of the lesions and only a mild staining signal (Fig. 1c). Subgroups of uterine artery supply are graded as either equal or unequal. The equal subgroup has equal blood supply from

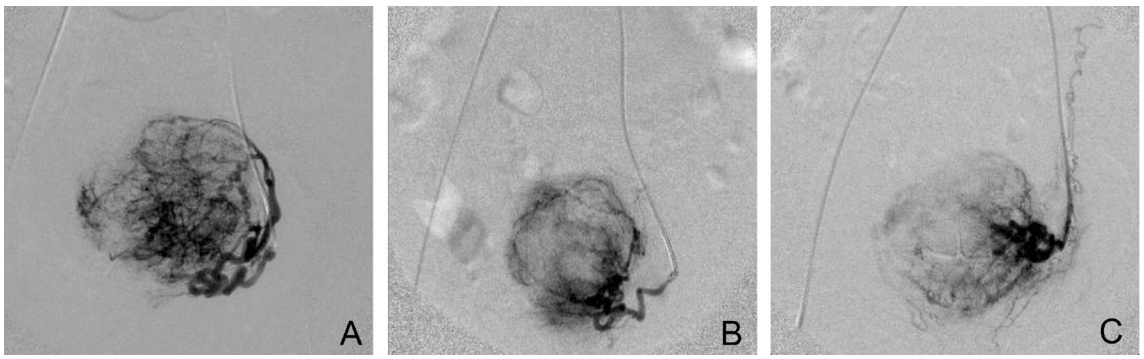

Fig. 1 DSA imaging for vascularity grades of adenomyosis. **a** Hypervascular, which shows abundant peripheral blood flow and central blood flow of the lesions; **b** an isovascular lesion with less blood flow on the center; **c** a hypovascular lesion lack of vessels at either the periphery or the center

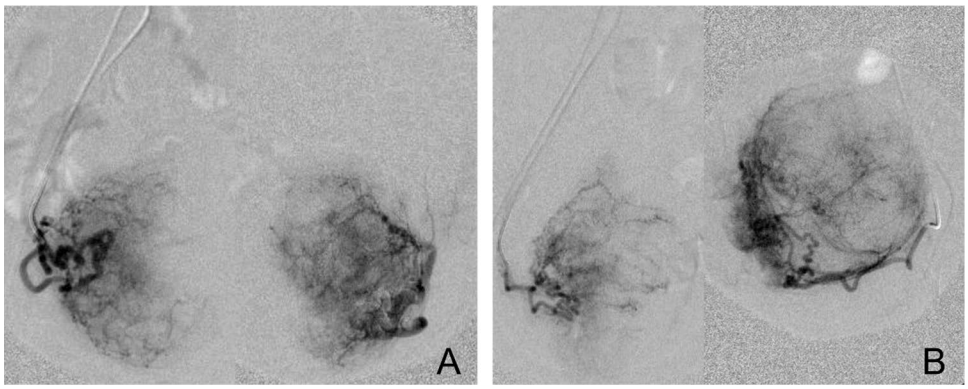

Fig. 2 DSA imaging for classification of the blood supply of the adenomyosis. **a** Equal subgroup, bilateral balanced; **b** unequal subgroup

Table 2 Reprinted with permission from [22]

The American Fertility Society classification of intrauterine adhesions:			
Extent of cavity involved	< l/3	1/3–2/3	> 2/3
	1	2	4
Type of adhesions	Filmy	Filmy and dense	Dense
	1	2	4
Menstrual pattern	Normal	Hypomenorrhea	Amenorrhea
	0	2	4
Prognostic classification			
Stage I (mild) 1–4			
Stage II (moderate) 5–8			
Stage III (severe) 9–12			

both uterine arteries (Fig. 2a), while the unequal subgroup has one uterine artery supplying more than 60% of the uterus (Fig. 2b). The development of the ovarian branch is classified as either unilateral, bilateral, or none. All angiograms were analyzed and determined by two experienced radiologists.

Follow-up

Following successful procedures, a series of follow-ups were done on the patients. These included outpatient gynecological evaluation of complications, questionnaire on adenomyosis-related symptoms, gynecological examination, and imaging (MRI or US) for up to 15 months. In patients with hysterectomy due to serious adverse events from the UAE during follow-up, the timing was recorded. Patients who experienced oligomenorrhea or amenorrhea underwent a hormonal evaluation and hysteroscopy at 3 to 6 months. All intrauterine adhesions (IUA) were evaluated based on the American Fertility Society (AFS) scoring system and divided into three levels (Table 2) [22].

Statistical analysis

In both univariate and multivariate analyses, age, uterine size, type, secondary anemia, previous medical therapy, previous gynecological invasive therapy vascularity grade, vascular supply, ovarian branch development, uterine size, and PVA vial dose were included to assess the factors affecting AS. Univariate and multivariate analyses were performed using logistic regression analysis. All statistical analyses were performed using SPSS version 20.0 (IBM, Armonk, NY, USA). $P < 0.05$ was considered statistically significant.

Results

A total of 195 patients who successfully underwent bilateral uterine artery embolization for symptomatic adenomyosis and were available for analysis during the period were included. The vascularity of the lesions was identified through DSA. All vascular subtraction maps were distinguished by vascularity density, blood supply, and ovarian branch artery development, as shown in Table 3.

The 15-month follow-up indicated that a total of 113 of the 147 patients (76.87%) with dysmenorrhea and 136 of 159 patients (85.53%) with menorrhagia experienced improvement after UAE. The overall mean uterine volume decreased with 37% (from 330.79 to 208.40 cm^3). Three patients had severe persistent pelvic pain, and one of these three patients underwent a hysterectomy. Four patients had severe menorrhagia, and one of these four patients underwent a hysterectomy. Three patients had severe uterus infection, and two of these three patients underwent a hysterectomy.

A total of 27 patients had either oligomenorrhea or amenorrhea, two of which were an ovarian failure. And 25 (12.82%) patients had AS after UAE, of which three cases were mild, ten were moderate, and 12 were severe. Of seven patients (two cases were moderate and five cases were severe) who have fertility requirements undergoing

Table 3 Intraoperative potential factor for Asherman syndrome ($n = 195$)

Category	Value
Vascularity grades	
Hypervascular	85 (43.58%)
Isovascular	53 (27.18%)
Hypovascular	57 (29.23%)
Vascular supply	
Equal	149 (76.41%)
Unequal	46 (23.59%)
Number of PVA vials	
≤ 2	126 (64.62%)
> 2	69 (35.38%)
Ovarian branch development	
Unilateral	83 (42.56%)
Bilateral	43 (22.05%)
None	69 (35.38%)

PVA polyvinyl alcohol

hysteroscopic adhesiolysis, only three cases showed improvement in AFS scores and there is no case of a successful pregnancy.

Univariate logistic regression analyses showed that vascularity grades and uterine size were significantly associated with AS after UAE. The risk of AS progression was increased (Table 4) in patients with hypovascular lesions and uterine size ≥ 314.90 cm^3.

Following univariate analysis, the factors found to be significantly associated with disease progression were included in the multivariate analysis. After adjusting for all other factors, the multivariate analysis showed that the AS in patients with hypovascular lesions was significantly higher than that in other patients (Table 5).

Discussion

In the case of poor drug treatment of adenomyosis, including hormonal [23], UAE as a conservative treatment can effectively improve the symptoms of adenomyosis [24, 25]. However, the effect of adenomyosis on the fertility outcome after UAE treatment remains to be further explored; compared to myoma embolization, literature data as well as guidelines concerning the role of embolization in adenomyosis are still scarce, and whether it can replace hysterectomy depends on this [26].

This study retrospectively analyzed AS in 195 patients with adenomyosis after UAE treatment. The frequency of AS following UAE was 12.82%. Results showed that low vascularity was an independent risk factor for AS. Previous studies have shown that vascularity grades in uterine myoma are related to the clinical efficacy and complications of UAE and consider that the same procedures are applied to study adenomyosis [20, 27, 28]. Another research found that the development process and vascularity of adenomyosis are closely associated with estrogen concentration [29]. There is, therefore, a difference in the vascularity of adenomyosis lesions. Currently, many imaging studies on the vascularity of adenomyosis have focused on MRI [30–32]. However, DSA is the current "gold standard" for evaluating the distribution of blood flow to the lesion [33], and it can accurately identify the abundance of vessels in adenomyosis lesions. Angiography of adenomyosis also reflects its pathological features, and the distribution of embolic agents in the lesions after embolization depends on the degree of vascular abundance. The pathological examination of adenomyosis after UAE by Dundr et al. [34] revealed that embolic agents are randomly distributed throughout the myometrium, with partial or complete vascular destruction accompanied by inflammatory and foreign body granuloma reactions. Compared with the myoma, the embolic agent accumulated in the medium-sized vessels of the lesions after UAE. The cause is speculated to be as follows: (1) compared with the adenomyosis, lesions of myoma usually have a more abundant blood supply; (2) adenomyosis lesions often show an ill-defined margin and no regular pattern, and endometrial cells and focal angiogenesis undergo a progressive process similar to that of tumor metastasis. However, most uterine myoma has a pseudo-envelope [19, 30, 35].

The above speculations lead to reduced efficiency of embolic agents into the lesions and increase the likelihood of reflux, despite super-selective catheterization. We tried to avoid reflux during embolization. However, in order to achieve an endpoint of embolization, a small amount of embolic agent reflux is inevitable, resulting in ectopic embolization including normal myometrium, especially at the end of the embolization in the area with low vascularity, the injection of a higher-density contrast agent may displace the lower-density particles, causing embolic agent reflux [36]. By contrast, there are well-developed vessels in hypervascular areas, and the embolic agent reaches farther than the hypovascular regions, which results in the avoidance of the embolization of nontarget vessels.

AS events were significantly higher in the low vascular adenomyosis compared with the high vascular adenomyosis, which is like the above view, because the flow made it difficult for the embolic agent to reach the target vessel and reflux deposited more embolic agents into the surrounding myometrium. And there will be a series of ischemic, incomplete, or complete necrosis and inflammatory reactions after embolization [37, 38]. Some studies suggest that chronic endometritis, and the resulting endometrial fibrosis, is an essential factor in the formation of IUA [39, 40]. Of the 195 patients, 25 developed AS after UAE, 14 cases (56.0%) in

Table 4 Factors that influence Asherman syndrome after UAE: results of univariate analyses using logistic regression test

Clinical parameters	Asherman syndrome ($n=25$)	*P* value	HR (95% CI)
Age		0.539	0.767 (0.330–0–1.787)
< 41 years	11 (44.0)		
≥ 41 years	14 (56.0)		
Uterine size		0.021*	0.338 (0.134–0.850)
< 314.90 cm^3	7 (28.0)		
≥ 314.90 cm^3	18 (72.0)		
Type		0.337	1.511 (0.651–3.505)
Diffuse	12 (48.0)		
Focal	13 (52.0)		
Secondary anemia		0.867	1.047 (0.611–1.794)
Normal	16 (64.0)		
Mild	4 (16.0)		
Moderate	5 (20.0)		
Previous medical therapy		0.199	2.667 (0.598–11.894)
Yes	23 (92.0)		
No	2 (8.0)		
Previous gynecological invasive therapy		0.181	2.111 (0.706–6.311)
Yes	5 (20.0)		
No	20 (80.0)		
Vascularity grades		0.002*	0.432 (0.252–0.741)
Hypervascular	5 (20.0)		
Isovascular	6 (24.0)		
Hypovascular	14 (56.0)		
Vascular supply		0.343	1.723 (0.559–5.304)
Equal	21 (84.0)		
Unequal	4 (16.0)		
Number of PVA vials		0.705	0.841 (0.343–2.062)
≤ 2	8 (32.0)		
> 2	17 (68.0)		
Ovarian branch development		0.660	1.136 (0.644–2.002)
Unilateral	5 (20.0)		
Bilateral	10 (40.0)		
None	10 (40.0)		

UAE uterine artery embolization; values are presented as *n* (%); *OR* odds ratio; *CI* confidence interval

*Statistically significant

Table 5 Multivariate logistic regression analysis of variables related to Asherman syndrome at univariate analysis

Clinical parameters	*P* value	OR (95% CI)
Vascularity grades	0.019*	0.495 (0.275–0.891)
Uterine size	0.251	0.554 (0.202–1.519)

*Statistically significant

the hypovascular group. It is possible to over-embolic for the low vascular adenomyosis. Treatment of adenomyosis by UAE can lead to the destruction of parts of the uterine myometrium and the endometrial basal layer, secondary IUA, and endometrial atrophy resulting in AS. UAE had a worse prognosis in that, out of seven cases who had fertility requirements undergoing hysteroscopic adhesiolysis, only three cases showed improvement in AFS score. However, there was no case of a successful pregnancy, which concurred with the findings of Song et al. [12].

This study had some limitations. Our study did not include potential factors during the perioperative period and lacked long-term follow-up. Although the DSA is an accurate procedure, it is an invasive examination, and we should, therefore, explore an effective and noninvasive preoperative method of examination. Therefore, further research should consider these aspects.

In conclusion, the grades of vascularity were found to be an independent prognostic factor affecting AS after UAE for adenomyosis. According to this study, the treatment of adenomyosis with low vascularity by embolism should be performed with much caution. However, irreversible AS is a severe complication for patients with fertility requirements, and patients who have fertility requirements should, therefore, try other treatment options.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Consent for publication Consent for publication was obtained for every individual person's data included in the study.

Ethical approval All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation and with the Helsinki Declaration of 1975.

Informed consent Informed consent was obtained from all individual participants included in the study.

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