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ORIGINAL ARTICLE

Efficacy of uterine artery embolization (UAE) for uterine fibroids according to FIGO classification: a single-center experience

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Abstract

Objective This study aims to retrospectively evaluate the outcomes of uterine artery embolization (UAE) for uterine fibroids (UFs), specifically submucosal UFs, according to the International Federation of Gynecology and Obstetrics (FIGO) classification of UFs.

Materials and methods Forty-two patients with symptomatic UFs underwent UAE with Embosphere® between July 2016 and November 2021. MRI was performed before, at 3 and 6 months after the UAE. At each examination, the volume of UF was measured, and the percentage volume reduction rate (VRR) was calculated. The technical success rate (TSR), symptom improvement rate (SIR), regrowth rate (RR) after 6 months, and adverse events (AEs) were examined; VRR was compared between patients with submucosal UFs (FIGO types 0–2, group A), those with submucosal contacts (FIGO type 3, group B), and those without submucosal UFs (FIGO types 4–7, group C). Statistical analysis was performed on the difference in VRR between groups A, B, and C at 3 and 6 months after UAE. The relationship with hormone levels before UAE and VRR was evaluated.

Results Thirty-seven of the 42 patients were evaluated. Overall, VRR was 37.0% at 3 months and 52.1% at 6 months; TSR, SIR, and RR were 100%, 95.2%, and 5.4%, respectively; VRR at 6 months was 80.7% for group A ($n=7$), 57.8% for group B ($n=13$), and 37.1% for group C ($n=17$). Significant differences were found between A and C ($p<0.001$) and B and C ($p=0.023$). Hormone levels before UAE had no effect on VRR. There was no significant AEs other than grade 3 pulmonary embolism in one patient.

Conclusion UAE was effective for submucosal FIGO types 0–3. UAE was especially useful as an option for FIGO type 3 with a low protrusion rate that is difficult to treat with transcervical resection.

Keywords Magnetic resonance imaging · Submucosal uterine fibroid · Uterine artery embolization · FIGO classification

Introduction

Uterine fibroids (UFs) are the most common benign disease in women, affecting 70% of women by the age of 50 [1]. Most of these tumors are found incidentally and are asymptomatic or do not require treatment, but up to 35% of women will experience symptoms [2]. Treatment is appropriate for symptomatic UFs with excessive menstruation, irregular bleeding, dysmenorrhea, pelvic pain, dysuria, and bowel dysfunction and UF associated with infertility and recurrent miscarriages.

In recent years, many patients prefer minimally invasive procedures, such as laparoscopic or hysteroscopic surgery [transcervical resection (TCR)] [3]. Uterine artery embolization (UAE) is the most established uterus-sparing treatment other than laparoscopic or hysteroscopic surgery among minimally invasive procedures [4, 5].

Ravina et al. [6] reported UAE for UF in France, and Pelage et al. [7–9] reported early that it was effective with a few complications. However, in terms of pregnancy complications, the UAE has a higher incidence rate of miscarriage, premature delivery, and placental adhesions [10]. UAE is an option for patients who are symptomatic but refuse surgery

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for various reasons, including complications. The goal of UAE is to alleviate patient symptoms by reducing size. UF-related symptoms can be reduced or eliminated by decreasing volume.

The safety of UAE for submucosal UF remains controversial. Despite the fact that UAE has long been shown to be effective for submucosal UF [11], it is not the first choice of treatment in the guidelines.

In this study, we compared the rate of volume reduction and hormonal trends among the groups divided according to International Federation of Gynecology and Obstetrics (FIGO) classification, to evaluate the efficacy of UAE for submucosal UF (FIGO type 0–3).

Materials and methods

The protocol for this retrospective study was approved by the Research Ethics Committee of our institute.

Subjects and study design

From July 2016 to November 2021, 42 patients with symptomatic UFs were treated at our institution with UAE using Embosphere® (500–700 μm particles). All patients were fully informed about hormonal, surgical, and UAE therapies by their gynecologists, and the decision was made jointly by the gynecologist and the patient, taking into account the patient's age, desire to give birth, and social background. Patients who had previously been denied malignant disease by ultrasound, magnetic resonance imaging (MRI), and cervical and endometrial cytology within the past 12 months were identified as candidates for UAE. UAE was then performed on patients after their gynecologist and radiologist explained the procedure and obtained their consent.

Patients were interviewed and evaluated before UAE and after 1, 3, and 6 months of outpatient visits. Patients with a thrombotic or gynecological malignancy or abnormal laboratory tests, such as creatinine, coagulation status, blood count, or C-reactive protein, before UAE, were excluded. MRI was used to calculate the rate of protrusion into the mucosal surface as submucosal protrusion area/maximum segmental area at the maximum segmental plane. UFs were categorized as follows: UF with a pedunculated intracavity extension (FIGO type 0), UF with a protrusion rate of 50% or greater (FIGO type 1), and UF with a protrusion rate of less than 50% (FIGO type 2) were classified as submucosal UF. UF in which lesions are entirely extracavitary but are adjacent to the endometrium (FIGO type 3) and UF without contact with the endometrium or extension into the uterine cavity or serous surface (FIGO type 4) were considered as intramural UF. UF with an intramural extension of 50% or greater along with a subserosal extension of less than 50% (FIGO type 5), UF with an intramural extension of less than 50% along with a subserosal extension of 50% or greater (FIGO type 6), and UF with a subserosal pedunculated extension (FIGO type 7) were defined as subserosal UF [12].

UAE procedures

UAE was performed under conscious sedation in our angiography center. Extracellular fluid was administered through the forearm superficial veins. Peri- and post-procedural pain was managed by intravenous infusions of fentanyl citrate using a syringe infusion pump. The pain was controlled with a continuous intravenous infusion of 1 mL per hour of fentanyl citrate, a synthetic opioid, from immediately before to 24 h after UAE. If pain was continued even after 24 h (after the end of fentanyl citrate), oral medication (Acetaminophen) was used.

Bilateral selective catheterization and embolization of the uterine arteries were performed under local anesthesia by interventional radiologists. After a 4-Fr. sheath (Terumo Co., Tokyo, Japan) was inserted into the right femoral artery, pelvic angiography was performed with a pigtail catheter (Medikit, Tokyo, Japan) to determine the running direction and origin of the uterine artery from the internal iliac artery (IIA). Then, a 4-Fr. a catheter (RC2, Terumo Co.) was inserted into the contralateral IIA. The uterine artery was accessed with high selectivity using a 2.7-Fr. high-flow microcatheter (Carnelian, Tokai Medical, Aichi, Japan). Prior to the uterine artery embolization (UAE), all patients underwent uterine arteriography to confirm the absence of visible ovaries and any abnormally dilated uterine–ovarian anastomoses to the ovaries. Subsequently, the uterine artery was embolized beyond the cervico-vaginal branch using Embosphere® microspheres ranging in size from 500 to 700 μm, considering that the utero-ovarian anastomosis is less than 500 μm, the perifibroid plexus ranges from 500 to 800 μm, and Embosphere® microspheres are recommended in the sizes of 500–700 μm and 700–900 μm [13–15]. The embolic agent and angiographic endpoint were entrusted to the discretion of the expert interventional radiologists. UAE was performed in all cases by embolizing the left uterine artery first, followed by embolization of the right uterine artery. Usually, there was laterality in the arterial blood flow to the fibroids, and the dose of Embosphere differed according to the blood flow of the fibroids. Embolization was performed until characterized by a "pruned tree appearance" or until the contrast medium was stagnant in the uterine artery under fluoroscopy for 5 cardiac beats [16, 17]. Thereafter, the contralateral uterine artery was similarly embolized.

Measurement and evaluation method

Fibroid volume measurement and hormone test

The volume of UF was measured with MRI images before, 3 months, and 6 months after the UAE procedure using the measurement tools of the SYNAPSE SAI viewer (FUJIFILM Medical, Tokyo, Japan). For each examination, the volume reduction rate (VRR) was calculated. VRR was calculated by dividing the pre-UAE UF volume minus the post-UAE UF volume at 3 or 6 months by the pre-UAE volume and multiplying the result by 100.

Estradiol (E2) levels (pg/mL), follicle-stimulating hormone (FSH) levels (mIU/mL), and luteinizing hormone (LH) levels (mIU/mL) were measured before, 3 months, and 6 months after UAE and MRI.

Evaluation method

The relationship between VRR and estrogen before and after UAE was examined in this study. We examined ovarian function using the LH-to-FSH (LH/FSH) ratio, which was measured concurrently. The VRR of UFs was evaluated using the FIGO classification, with a focus on submucosal UFs. The VRR was evaluated based on classification according to the FIGO classification of UFs [12]. We classified types 0–2 as A, type 3 as B, and type 4–7 as C. In cases with multiple UFs, patients were classified based on the location of the UF with the largest size. If there were many UFs of the same size, patients were classified into groups based on the location with the largest number of UFs. Statistical analysis was performed at 3 and 6 months postoperatively for differences in VRR among the three groups, Group A, Group B, and Group C.

At 6 months, we evaluated the relationship between VRR and E2 values. The relationships between VRR and LH/FSH and VRR and E2/FSH were also examined. Technical success rate (TSR) was defined as smooth insertion of the catheter, injection of the embolic material, and completion of the planned embolization of the bilateral uterine arteries. Symptom improvement rate (SIR) was defined as the percentage of cases of which main symptoms before UAE improved 6 months after UAE. SIR was evaluated by patient interviews and questionnaires before and 6 months after the UAE. Re-growth rate (RR) was defined as the percentage of cases that increased compared to pre-UAE size, as assessed by MRI at 6 months. The size was calculated and evaluated by a radiologist. Adverse events (AEs) according to the Common Terminology Criteria for Adverse Events (CTCAE v6.0) were examined. Complications were also evaluated for all patients and those with submucosal UF. Patients were also monitored for pregnancy after the UAE.

Statistical analysis

The Student's *t* test was used to compare the two groups, and the Tukey HSD test was used to compare the three groups. The Pearson correlation coefficient was used to examine correlations. Significant differences were indicated at $p < 0.05$. Statistical analysis was performed using the Statistical Package for the Social Sciences version 28 (SPSS 28; SPSS, Inc., Chicago, IL).

Results

Of the 42 patients for whom UAE was performed, 37 patients (37–50 years old, mean of 45.2 yr) with available MRI and hormone test follow-up were evaluated after 3 and 6 months. The average number of vials used was 5.4 ± 2.9 (median: 5, range 2–17). The mean hospital stay was 4 days, and the TSR, SIR, and RR were 100%, 95.2%, and 5.4%, respectively.

The VRR of submucosal fibroid after UAE was 61.7 ± 20.0 at 3 months and 80.7 ± 11.5 at 6 months, whereas the VRR of patients without submucosal fibroid was 31.1 ± 19.6 at 3 months and 46.6 ± 21.9 at 6 months. Patients with and without submucosal fibroid had a significant difference ($p < 0.001$ for 3 months and $p < 0.003$ for 6 months) (Table 1).

The VRR classified and compared using the FIGO classification is shown in Table 2. There were significant differences in VRR between C and A and between C and B at 3 months ($p < 0.001$ and $p = 0.005$, respectively) and 6 months after the UAE ($p < 0.001$ and $p = 0.023$, respectively). VRR between A and B were not significantly different at 3 or 6 months ($p = 0.093$ or $p = 0.072$, respectively; Figs. 1, 2, 3).

Table 1 Volume reduction rate of uterine fibroid after UAE

Period after UAE	Volume reduction rate (%)		*p* value
	Uterine fibroids with submucosal fibroids[a] $n = 7$	Uterine fibroids without submucosal fibroids[b] $n = 30$	
3 month (mean ± SD)	61.7 ± 20.0	31.1 ± 19.6	< 0.001
6 month (mean ± SD)	80.7 ± 11.5	46.6 ± 21.9	< 0.003

Statistical analysis was performed with Student's *t* test

UAE uterine artery embolization, *n* number of cases, *SD* standard deviation

[a]Type 0–2 fibroids by FIGO leiomyoma subclassification system

[b]Type 3–7 fibroids by FIGO leiomyoma subclassification system

Table 2 Volume reduction rate of uterine fibroids after UAE

Comparison of uterine fibroids between Type 0–2, Type 3, and Type 4–7[a]				
Period after UAE	Volume reduction rate (%)			*p* value
	Uterine fibroids with Type 0–2 fibroids (*n* = 7): A	Uterine fibroids with Type 3 fibroids (*n* = 13): B	Uterine fibroids with Type 4–7 fibroids (*n* = 17): C	
3 months (mean ± SD)	61.7. ± 20.0	44.1 ± 18.2	21.9 ± 15.2	A-B: 0.093 B-C: 0.005 C-A: < 0.001
6 months (mean ± SD)	80.7 ± 11.5	57.8 ± 20.5	37.1 ± 18.9	A-B: 0.072 B-C: 0.023 C-A: < 0.001

Statistical analysis was performed with Tukey HSD test

UAE uterine artery embolization, *n* number of cases, *SD* standard deviation

[a]FIGO leiomyoma subclassification system

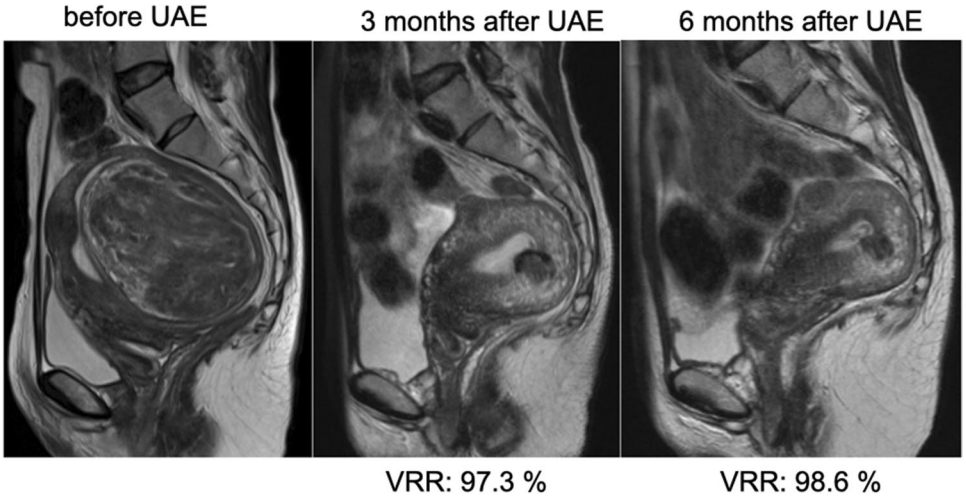

Fig. 1 Volume reduction case for FIGO Type 2. The largest uterine fibroid was an FIGO Type 2, but the fibroid was expelled spontaneously with fibroid expulsion 49 days after UAE. UAE: uterine artery embolization. *VRR* volume reduction rate, *FIGO* The International Federation of Gynecology and Obstetrics

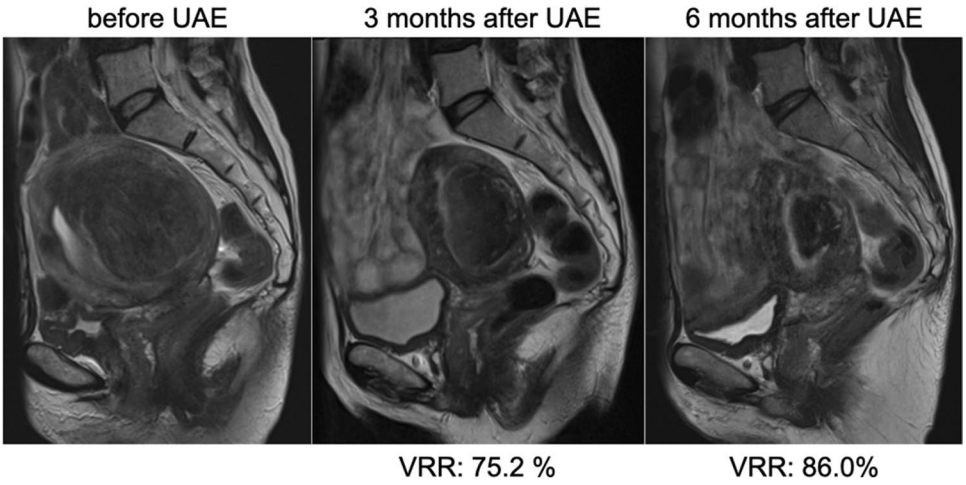

Fig. 2 Volume reduction case for FIGO Type 3. The largest uterine fibroid was FIGO Type 3 with a VRR of 75.2% at 3 months and 86.0% at 6 months after UAE. *UAE* uterine artery embolization, *VRR* volume reduction rate, *FIGO* The International Federation of Gynecology and Obstetrics

The mean values of LH, FSH, and E2 before UAE were 6.7 m IU/mL, 10.6 m IU/mL, and 127 pg/mL, respectively, and 6 months after UAE were 13.7 m IU/mL, 22 m IU/mL, and 141 pg/mL, respectively. Changes in hormone levels before and after the UAE were examined using E2, LH/FSH, and E2/FSH as indices, but no changes in hormone

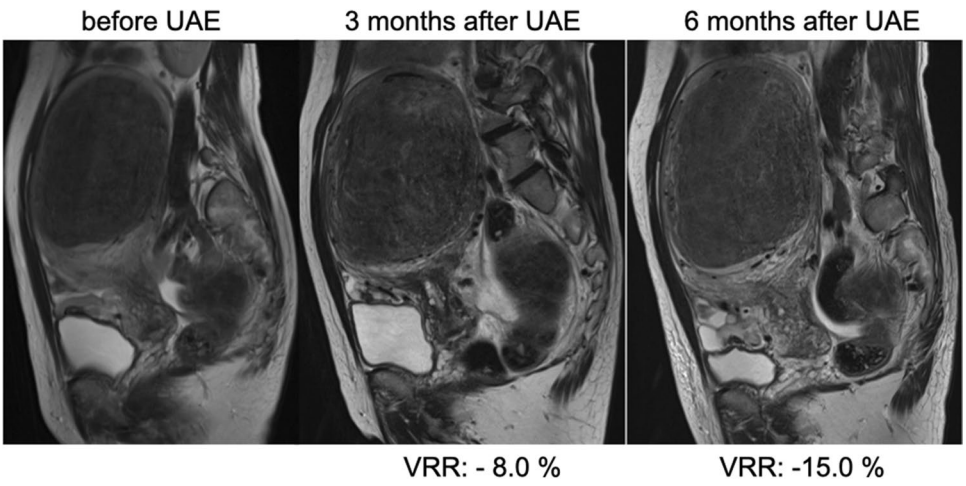

Fig. 3 Volume reduction case for FIGO Type 6. The largest uterine fibroid was FIGO Type 6 with a VRR of – 8.0% at 3 months and – 15.0% at 6 months after UAE. *UAE* uterine artery embolization. *VRR* volume reduction rate, *FIGO* The International Federation of Gynecology and Obstetrics

levels before and after the UAE were observed for all UFs and FIGO-classified fibroids (Table 3). The FIGO classification and hormone levels had no causal relationship with the results of this study. There was also no relationship with VRR. There was no correlation between E2/FSH and VRR at 6 months (−0.138, $p=0.491$). The correlations between E2, LH/FSH, and VRR after 6 months were −0.303 ($p=0.125$) and −0.244 ($p=0.220$), indicating a weak negative correlation (Table 4). In any case, there was no correlation between hormone levels and the UAE reduction rate after 3 or 6 months.

AEs were observed in 7 of 42 patients (16.7%): 5 of 26 patients (19.2%) with submucosal UFs and 2 of 16 patients (12.5%) without submucosal UFs. Fever occurred in three patients (two with submucosal UFs and one without submucosal UF), and nausea occurred in two patients (one each with and without submucosal UF). Fever was observed on the day after UAE and the following day. The fever was treated with antipyretics. None of the patients had elevated C-reactive protein (CRP), or decreased hemoglobin (Hb) levels. Nausea occurred in two patients on the day of UAE and the day after. It was determined to be a Fentanyl-induced side effect, because it occurred during Fentanyl injection. The CTCAE grades for these AEs of fever and nausea were all grade 1, mild. Expulsion of UF was observed in three patients: two (FIGO types 2 and 3) spontaneously expelled with a small amount of bleeding; one (FIGO type 3) spontaneously expelled before surgery, although TCR was planned due to increased water-like bleeding. They did not require medical intervention such as blood transfusion.

An FIGO type 6 patient experienced one CTCAE grade 3 complication. This patient with pulmonary embolism (PE)

Table 3 Changes in hormone levels before and after UAE[a]

Type of fibroids	No. of cases	Factors	Hormone levels (mean ± SD[b])			*p* value
			Before UAE	3 months after UAE	6 months after UAE	
All fibroids	37	E2	127 ± 108	151 ± 103	141 ± 119	0.661
		LH/FSH	0.7 ± 0.4	0.8 ± 0.5	0.8 ± 0.5	0.754
		E2/FSH	30 ± 33	28 ± 27	32 ± 46	0.889
Uterine fibroids with Type 0 to 2 fibroids ($n=7$)	7	E2	116 ± 83	135 ± 63	211 ± 114	0.162
		LH/FSH	0.7 ± 0.3	0.7 ± 0.2	0.8 ± 0.3	0.519
		E2/FSH	23 ± 19	28 ± 22	55 ± 55	0.253
Uterine fibroids with Type 3 fibroids ($n=13$)	13	E2	89 ± 73	163 ± 116	129 ± 120	0.258
		LH/FSH	0.6 ± 0.5	0.7 ± 0.5	0.9 ± 0.5	0.513
		E2/FSH	34 ± 44	23 ± 22	16 ± 18	0.393
Uterine fibroids with Type 4 to 7 fibroids ($n=17$)	17	E2	158 ± 114	148 ± 109	123 ± 118	0.696
		LH/FSH	0.8 ± 0.5	0.9 ± 0.6	0.8 ± 0.5	0.394
		E2/FSH	30 ± 31	31 ± 32	34 ± 54	0.953

Statistical analysis was performed by one-way analysis of variance (ANOVA)

[a]Uterine artery embolization

[b]Standard deviation

Table 4 Correlation between preoperative hormone levels and fibroid reduction rate

Type of fibroid	No. of cases	Factors to compare	Correlation coefficient with fibroid reduction rate			
			3 months after UAE[a]		6 months after UAE[a]	
			Correlation coefficient	*p* value	Correlation coefficient	*p* value
All fibroids	37	E2	0.055	0.756	−0.303	0.125
		LH/FSH	0.217	0.240	−0.244	0.220
		E2/FSH	0.079	0.658	−0.138	0.491

Statistical analysis was performed by Pearson's product moment correlation coefficient

[a]Uterine artery embolization

was 49 years old and had no pre-existing medical conditions or comorbidities. The UFs were FIGO type 3.4.6 with 5 or more multiple myomas, the main one being type 6. The volume before treatment was 3,564 cm^3, the largest in the study. Eleven vials of Embospheres® were used. The next day, a decrease in oxygen saturation of 92% was observed during ambulation. An emergency CT immediately after the event revealed PE with minor thrombus in the left lower pulmonary artery and in the pelvic vein. After taking Edoxaban Tosylate Hydrate, the patient was uneventful and was discharged 7 days after UAE.

Symptoms prior to UAE included excessive menstrual flow in 29 patients, frequent urination in 9, menstrual cramps in 6, abdominal distention in 5, back pain in 3, abdominal tumor in 3, abdominal pain in 2, abdominal pressure in 2, urinary urgency in 1, and residual urine in 1 (one patient had multiple symptoms). Symptom improvement was observed in 95.2% of patients, and the most common symptom improvement at 6 months was decreased bleeding in 26 patients (65%), followed by frequent urination, abdominal distention, and menstrual pain in six patients each.

During follow-up, four patients had a total hysterectomy: one because the UF enlarged again, one because the UF shrank but ovarian cancer was suspected on a follow-up MRI, one because the uterus shrank and symptoms improved but her family doctor recommended surgery, and one because her UF did not enlarge, but she urinated more frequently. No patient became pregnant after UAE, although no patient wished it.

Discussion

In this new trial, we classified uterine fibroids using the FIGO classification and examined the effectiveness of UAE treatment. The results showed that UAE is also useful in FIGO type 3 UFs in contact with the endometrium, which are difficult to treat with TCR. Currently, UAE is not the first choice for submucosal UF. One reason is that TCR has better outcomes for FIGO type 0–2 submucosal UFs. However, FIGO type 3 submucosal UFs, which do not protrude into the uterine cavity, demand high skills for TCR.

The presence or absence of submucosal UF was a useful predictor of UAE's effective reduction rate. The submucosal protrusion has a higher reduction rate.

VRR with submucosal fibroid is higher than without submucosal fibroid. Submucosal UFs have long been reported to benefit from UAE [18]. The uterine vascular structure has blood flow to preferentially flow to the interior of the uterus, as described by Sampson [19] in 1912. Jha et al. similarly explain this phenomenon in terms of the distribution of uterine arteries [18]. Toor et al. [11] further analyzed the characteristics of the UF by location and noted that subserosal UFs showed less volume loss in the failure group. Aziz et al. [20] also showed that when embolic material was injected into the uterine artery, there was less embolic material outside the myometrium. Thus, it may be speculated that the uterine artery supply to the submucosal and intramural UFs is greater, resulting in a greater amount of embolic material flowing in these UFs, and, conversely, the less to the outer UFs.

In the UAE, treatment success is defined as the improvement or complete disappearance of patient-specified (UF-related) symptoms and a decrease in the volume of the dominant UF or the entire uterus after treatment. In this study, UAE achieved good VRR and SIR in submucosal UF cases, implying that UAE may be one of the safe treatments for submucosal UF. Having found UAE useful for submucosal fibroids, we next focused on whether there are differences by type. As a result, patients with submucosal UF types 0–2, and type 3, where the UF is in contact with the uterine mucosa, had a significant volume reduction compared with other UF (types 4–7). There was no significant difference between types 0 and 1 and type 2 groups when types 0 and 1 with more than 50% protrusion and type 2 with less than 50% protrusion were examined separately. Type 3 UF without uterine mucosa protrusion should be treated with the risk of anemia if the myoma is larger than 60 mm or the patient has dysmenorrhea [21]. However, TCR is typically difficult to perform [22], and

treatment requires surgical intervention. Our findings suggest that in such type 3 cases, UAE could be an alternative to surgical treatment.

Despite concerns that UAE could impair ovarian function [23], we did not experience ovarian dysfunction. FSH, LH, and E2 have been used to assess ovarian function after the UAE. The hormone estrogen is commonly associated with UFs, but estrogen is cyclical and does not have constant values. However, in the present study, MRI and blood tests were performed at 1, 3, and 6 months after the UAE, so blood sampling did not coincide with the menstrual cycle. Because estrogen alone is insufficient for an accurate assessment of ovarian function, and because estrogen is regulated by FSH, we examined the estrogen-to-FSH ratio in this study. LH/FSH is an indicator of ovulation. Although LH/FSH > 1 indicates ovarian dysfunction, all patients had menstruation after UAE; therefore, we judged that there was no clinical ovarian dysfunction after UAE. Additionally, there was no relationship between VRR and hormones. Although we inform patients about the loss of ovarian function prior to treatment with UAE, we discovered in this study that UAE does not affect hormone levels, and it is unrelated to the reduction rate. In other words, the sufficient reduction was achieved, while hormone levels are maintained.

Silberzweig et al. noted that blood vessels' caliber in the peri-myoma plexus typically falls within the range of 500–800 µm microspheres [13, 14], serving as the rationale for opting for particles of 500–700 µm or 700–900 µm. Given that both Japanese guidelines and the Japanese medical package insert recommend microspheres of 500 µm or larger, we consider the use of 500–700 µm microspheres as the standard practice in Japan. Similarly, Ruuskanen et al. [24] and Marret et al. [25] also utilized 500–700 µm microspheres. However, in cases where achieving the angiographic endpoint was challenging with only 500–700 µm microspheres, Katsumori et al. [26, 27] and Siskin et al. [15] opted for 700–900 µm microspheres. Katsumori et al. [26] explained that if the desired endpoint was not attained even after approximately 5 syringes per side were administered, they introduced particles of 700–900 µm. In our PE case, a total of 11 vials were employed on both sides. The endpoint was achieved using 5 syringes on the left side and 6 syringes on the right, utilizing 500–700 µm microspheres. Beyond this point, we believe that considering a switch to 700–900 µm microspheres might be prudent. Hamada et al. [28] documented a fatal PE case following UAE, where one vial with particles sized 350–500 µm polyvinyl alcohol microspheres and two vials with particles sized 510–700 µm polyvinyl alcohol microspheres were used; however, the quantity employed was not substantial. Similarly, Czeyda-Pommersheim et al. [29] reported a nonfatal PE after UAE using 8 mL of 500–700 µm and 2 mL of 700–900 µm trisacryl gelatin microspheres. In both instances, no definitive causal connection between PE and the size of the embolized material was investigated.

The present study has several limitations. First, this was a single-center, retrospective study with small population and short-term follow-up. Second, estrogen and other menstruation-related hormones fluctuate cyclically, but in the present study, complicated procedures, such as MRI and outpatient visits, made it impossible to perform the examinations in accordance with the menstrual cycle. Finally, due to the complexity of the subject, we used the area of the maximal plane to define the submucosal UF rather than volume.

Conclusions

UAE was effective for submucosal FIGO types 0–3. UAE was especially useful as an option for FIGO type 3 with a low protrusion rate that is difficult to treat with TCR.

Author contributions All authors have contributed significantly to the study conception and design. HI and MN had the idea for the article and the literature search. The first draft of the manuscript was written by HI and edited by MN.

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Declarations

Conflict of interest The authors declare that they have no conflicts of interest and nothing to disclose.

Ethical approval For this type of study, formal consent is not required. The study was approved by the Institutional Review Board of Tokyo Medical University Hospital (T2020-0102).

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