Uterine Artery Embolization for Treatment of Symptomatic Fibroids

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ABSTRACT

Over the past decade, uterine artery embolization (UAE) has become a popular alternative treatment for women with symptomatic fibroids who desire uterine preservation and/or the avoidance of surgical intervention. In this article, the history of UAE, preprocedure patient evaluation and patient selection, procedure technique, and expected UAE outcomes are reviewed.

KEYWORDS: Uterine artery embolization, fibroids, tris-acryl microspheres, spherical PVA, acrylamido PVA microspheres

Objectives: Upon completion of this article, the reader will be able to identify the indications and contraindications for uterine artery embolization, the importance of patient selection, technique, expected outcomes, and suggested thresholds for complications.

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Uterine fibroids or leiomyomas are estrogen-responsive, benign neoplasms composed of uterine smooth muscle cells and fibrous connective tissue.^{1,2} Fibroids are the most common tumor of the female reproductive tract occurring in greater than 40% of premenopausal women.³ Twenty-five to 30% of women will have symptomatic uterine fibroids, which is the most common indication for hysterectomy accounting for at least 30% of the 600,000 hysterectomies performed each year in the United States.^{3,4}

Fibroid-related symptoms are most commonly divided into menstrual disturbances and bulk-related symptoms. Prolonged and excessive uterine bleeding (menorrhagia) or frequent menstruation occurring every 21 days or less (polymenorrhagia) are the most common symptoms associated with uterine fibroids.³ Although

metromenorrhagia or intermenstrual bleeding can occur with uterine fibroids, this type of dysfunctional uterine bleeding requires investigation to exclude malignancy or other endometrial pathology (Fig. 1).³ Bulk-related symptoms, most often caused by an enlarged fibroid uterus, include leg and back pain; pelvic pressure, heaviness or discomfort; abdominal bloating; urinary frequency or incontinence, and constipation.⁵

Fibroids are categorized by their relationship to the uterus as submucosal, intramural, or subserosal. Subserosal and submucosal fibroids may be described as exophytic or pedunculated. Exophytic fibroids have a broad-based attachment to the uterus; pedunculated fibroids are attached to the uterus by a stalk narrower than 50% of the diameter of the fibroid (Fig. 2). All types of fibroids can cause menstrual disturbances or

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Women's Issues in Interventional Radiology; Guest Editor, Martha-Grace Knuttinen, M.D., Ph.D.

Semin Intervent Radiol 2008;25:369–377. Copyright © 2008 by Thieme Medical Publishers, Inc., 333 Seventh Avenue, New York, NY 10001, USA. Tel: +1(212) 584-4662. DOI 10.1055/s-0028-1103001. ISSN 0739-9529.

Figure 1 Gadolinium-enhanced, fat-suppressed T1-weighted, sagittal magnetic resonance imaging (MRI) of the pelvis demonstrates a heterogeneous enhancing mass filling the endometrial cavity and causing thinning of the myometrium in the region of the fundus. Findings are compatible with endometrial carcinoma. Ultrasound findings suggested uterine fibroids and the patient had a negative endometrial biopsy.

bulk-related symptoms; however, submucosal fibroids are more commonly associated with abnormal uterine bleeding whereas subserosal fibroids are more likely to cause bulk-related symptoms.

Figure 2 Gadolinium-enhanced, fat-suppressed T1-weighted, coronal magnetic resonance imaging (MRI) of the pelvis demonstrating a pedunculated subserosal fibroid arising from the fundus of the uterus.

HISTORY OF UTERINE ARTERY EMBOLIZATION FOR SYMPTOMATIC FIBROIDS

In 1974, in Paris, Jean-Jacques Merland, a neuroradiologist, successfully performed the first uterine artery embolization (UAE) for treatment of intractable menorrhagia in a severely disabled woman with uterine fibroids.³ Several years later, Dr. Merland began performing UAE in concert with Dr. Jacques Ravina, a gynecologist prior to myomectomy to reduce blood loss during surgery and decrease transfusion requirements.³ In 1993, Drs. Ravina and Merland started a multicenter trial looking at the efficacy and safety of UAE as a minimally invasive treatment alternative for symptomatic fibroids. The results of the first 16 UAE cases using polyvinyl alcohol (PVA) particles were published in *Lancet* in 1995.⁶ In this report, 11 out of 16 patients experienced symptom resolution, 3 had partial improvement in symptoms, and 2 patients required surgery for persistent symptoms following UAE.⁶ These results initiated worldwide interest in UAE as a treatment option for uterine fibroids. In 1997, Goodwin et al published results of the first 11 UAE patients treated in the United States.⁷ In this report, 8 patients experienced significant improvement in symptomatology following UAE, 1 patient had no improvement due to the inability to embolize both uterine arteries, and 1 patient developed endometritis and pyometra necessitating hysterectomy. Goodwin also reported an average reduction in uterine volume of 40% and an average of 60 to 65% reduction in dominant fibroid size, 3 months following UAE. Since these reports, results of numerous research studies have been published supporting the efficacy and safety of UAE making this procedure a viable treatment option for women with symptomatic fibroids.

PATIENT SELECTION OF UTERINE ARTERY EMBOLIZATION

Ideal UAE candidates include women with symptomatic fibroids who express the desire for uterine preservation and/or the avoidance of surgical intervention. Preprocedure evaluation for UAE should include a comprehensive history and physical examination, a recent gynecologic examination performed by an OB/GYN specialist, a recent Pap smear, an endometrial biopsy for patients with dysfunctional uterine bleeding, and imaging documenting the presence of uterine fibroids. Exclusion criteria include pregnancy; patients with severe renal insufficiency not receiving dialysis; history of pelvic irradiation; ovarian, endometrial, uterine or cervical carcinoma; pelvic inflammatory disease or other pelvic infection and endometritis.⁸ Relative contraindications include severe allergy to iodinated contrast and uncorrectable bleeding diathesis.⁸ The desire to maintain fertility is a relative contraindication

because of procedure-related complications such as the need for hysterectomy or the potential for ovarian failure. In addition, the effects of UAE on fertility have not been well established in the literature despite several reports of uncomplicated pregnancies and normal deliveries.^{9,10} However, the desire to maintain fertility should not preclude UAE, especially if all other therapies and treatment options have been exhausted. In this situation, the decision to perform UAE should be a collaborative one between the interventional radiologist, the gynecologist, and most importantly, the patient.

IMAGING EVALUATION PRIOR TO UTERINE ARTERY EMBOLIZATION

When fibroids are suspected by physical examination, ultrasound (US) is usually the first imaging study performed to confirm the presence of uterine fibroids. However, magnetic resonance imaging (MRI) is the imaging modality of choice prior to UAE to establish patient eligibility for the procedure, and to exclude other etiologies of abnormal uterine bleeding and pelvic pain. In a recent study by Speilmann et al, MRI and US were compared in 49 patients prior to UAE for uterine and fibroid size, fibroid location, and total number of fibroids.¹¹ The authors demonstrated a significant discrepancy in uterine size, fibroid location, and number of fibroids between the two imaging modalities. In addition, MRI affected clinical management in 11 of 49 (22%) patients, which led to procedure cancellation in 4 patients. Furthermore, 7 patients were deemed unsuitable UAE candidates based on US findings; however, subsequent MRI imaging contradicted the US reports allowing UAE to be performed. The authors concluded that MRI provides a significant amount of additional information compared with US and affects clinical management in a substantial number of patients, making MRI the imaging modality of choice prior to UAE.

As previously mentioned, MRI is superior to US for determining the location of fibroids within the uterus, especially pedunculated fibroids where the stalk may be difficult to measure or identify using transabdominal or transvaginal US. Pedunculated submucosal or subserosal fibroids on a narrow stalk are important to diagnose prior to UAE. Embolization of pedunculated fibroids can lead to stalk necrosis and potential detachment of the fibroid from the uterus. Detachment of pedunculated subserosal fibroids from the uterus can lead to peritonitis, persistent pain, and/or infection.¹² Detachment of pedunculated submucosal fibroids into the endometrial cavity may result in transcervical expulsion of necrotic fibroid tissue. Furthermore, intracavitary necrotic debris may obstruct the cervix, become infected and require medical and/or surgical intervention.¹² In general, most interventionalist radiologists will proceed

with UAE if the stalk is greater than one-third to one-half the diameter of the fibroid,¹² which is best assessed by preprocedure MRI.

Occasionally, submucosal fibroids can become intracavitary following UAE. Preprocedure MRI evaluation can help predict which fibroids are more likely to become intracavitary postprocedure. In a recent report by Verma et al, MRI features of 39 submucosal fibroids were evaluated pre- and post-UAE.¹³ A ratio (I/D) of largest endometrial interface (I) to the largest submucosal fibroid dimension (D) was determined using preprocedure MRI. Postprocedure MRIs were evaluated for change in location of submucosal fibroids. Thirteen (33%) submucosal fibroids became completely (Fig. 3) or partially intracavitary following embolization. The mean I/D ratio of the submucosal fibroids was 0.65 (range: 0.55 to 0.83), which was significantly greater than the I/D ratio (0.32, range: 0.10 to 0.47) of fibroids that did not become intracavitary after embolization. Furthermore, the mean preembolization I/D ratio for submucosal fibroids that became completely intracavitary after UAE was higher, 0.81 (range: 0.76 to 0.83) than the mean preembolization I/D ratio for submucosal fibroids that became partially intracavitary (0.67, range: 0.55 to 0.69) after UAE. Four (31%) of these patients experienced significant postprocedural symptoms requiring further medical or surgical management. The authors concluded that the risk of submucosal fibroids becoming intracavitary following UAE can be determined by assessing the relationship of size of submucosal fibroids relative to their interface with the endometrium using preprocedure MRI. This information can be used by interventional radiologists to predict which patients may be at risk for potential fibroid expulsion or other postprocedural complications.

MRI is also superior for diagnosing adenomyosis, and evaluating the adnexa and endometrium for potential pathology especially when the uterus is enlarged and fibroids distort pelvic anatomy. In a study by Zawin et al, MRI and US findings were compared in 23 women with uterine fibroids.¹⁴ The endometrial stripe could not be adequately visualized in 21 of 23 US examinations whereas the endometrium was successfully identified in all patients by MRI. In addition, MRI identified 44 of 46 ovaries compared with 21 of 46 ovaries identified by US. In a study by Bazot et al, MRI was compared with transvaginal and transabdominal US for diagnosis of adenomyosis.¹⁵ The sensitivity and specificity for MRI and transvaginal US were significantly better than transabdominal US for diagnosing adenomyosis. However, the authors found the accuracy of MRI to be superior to transvaginal US for identifying adenomyosis in women with concomitant uterine fibroids. The presence of adenomyosis has been reported in 15 to 23% of patients with uterine fibroids.¹⁶⁻¹⁸ Identification of adenomyosis prior to UAE is important because this may affect the

Figure 3 (A) Sagittal magnetic resonance imaging (MRI), fast-spin echo of the pelvis prior to uterine artery embolization (UAE) demonstrates significant distortion of the endometrial cavity by several submucosal fibroids. (B) Gadolinium-enhanced, fat-suppressed T1-weighted, sagittal MRI demonstrates a conglomerate of necrotic fibroid tissue within the endometrial cavity 5 months following UAE.

clinical success of UAE. In a study by Pelage et al, 18 women with menorrhagia due to adenomyosis were treated with UAE.¹⁶ Six months following UAE, 15 of 18 (94%) women reported improvement in menorrhagia; however, 2 years later, 45% of patients had recurrent symptoms requiring additional treatment or hysterectomy. Therefore, it is important to inform patients of the presence of adenomyosis prior to UAE because adenomyosis may be a potential reason for UAE failure.

UTERINE ARTERY EMBOLIZATION TECHNIQUE

Although there may be minor differences in UAE technique among interventional radiologists and between institutions, the goal of the procedure is the same, to shrink uterine fibroids by subselectively embolizing bilateral uterine arteries. At Thomas Jefferson University Hospital (Philadelphia, PA), the technique for UAE is the same for all patients unless the uterine arteries are difficult to catheterize and all procedures are performed under conscious sedation with rare exceptions. Using a unilateral common femoral artery approach and a 4F sheath, a 4 F Cobra-1 catheter is manipulated into the left internal iliac artery and road-mapping is performed in the 30-degree ipsilateral oblique projection. A 3 French Renegade HI-Flo (Boston Scientific, Natick, MA; Medi-Tech, Miami, FL) microcatheter and a 70-degree gold-tip 0.018" glide wire (Terumo Medical Corp., Somerset, NJ) are passed coaxially through the Cobra-1 catheter and into the left uterine artery. The microcatheter is advanced into the transverse or horizontal portion of the uterine artery

several centimeters beyond the uterine artery origin distal to cervicovaginal branches. Digital subtraction arteriography is performed in the posterior-anterior (PA) projection. Embolization is performed using tris-acryl microspheres (Embosphere; Biosphere Medical, Rockland, MA) (500 to 700 microns and if needed, 700 to 900 micron particles) until slow antegrade flow is present in the main uterine artery without visualization of the perifibroid arterial plexus (Fig. 4). Toradol (Ketorolac; Roche Pharmaceuticals, Nutley, NJ), 15 mg is administered into the left uterine artery after the first syringe of Embospheres. A Waltman loop is formed with the Cobra-1 catheter and used to select the right internal iliac artery. The microcatheter is advanced into the right uterine artery in the 30-degree ipsilateral oblique projection followed by digital subtraction arteriography in the PA projection. The right uterine artery is embolized with Embospheres and 15 mg of Toradol is administered during embolization.

Flush abdominal aortograms with a pigtail catheter positioned at the level of the renal arteries may be performed following UAE to identify collateral ovarian artery supply to the fibroid uterus. At our institution, this is no longer routinely performed based on its limited value reported in the literature.^{19,20} In a series of 51 patients, Binkert et al demonstrated ovarian arteries in 25% of patients during flush abdominal aortography; however, ovarian artery detection influenced treatment in only 6% (3/51) of patients.¹⁹ Pelage et al found similar results in a series of 294 flush aortograms where 75 ovarian arteries (25%) were identified in 59 (20%) patients; however, only 2 patients (1.1%) underwent ovarian artery embolization.²⁰ Although flush abdominal aortograms may be

Figure 4 (A) Prior to embolization, right uterine arteriography demonstrates opacification of the perifibroid arterial plexus. (B) Following embolization, right uterine arteriography demonstrates blood flow in the main uterine artery, but absence of the perifibroid arterial plexus.

unnecessary on a routine basis, we still perform aortograms for patients with absence of one or both uterine arteries or when a portion of the uterus fails to opacify during selective uterine arteriography (Fig. 5). Under these circumstances, we have found significant blood supply to the fibroid uterus from ovarian artery collaterals. Although these collaterals may be a reason for clinical failure, at our institution, ovarian artery embolization is usually not performed at the same time as UAE because of the potential for ovarian failure. Instead, ovarian artery embolization is performed at a later date if clinical symptoms persist and after thorough discussion with the patient.

Following UAE, patients are observed for 6 hours under direct nursing supervision and placed on a Dilaudid (Abbott Laboratories, Abbott Park, IL) patient-controlled analgesic pump. The majority of our patients are discharged the same day as the procedure. If necessary, patients are admitted to the hospital overnight for medical management of postembolization syndrome and discharged the following morning. Two weeks later, patients are evaluated in our interventional radiology clinic and MRI is obtained 3 months later to determine reduction in fibroid size and uterine volume, as well as the percentage of fibroid infarction (Fig. 6).

EMBOLIC AGENTS

Particulate or nonspherical PVA was the first embolic agent used for UAE producing successful results for the treatment of uterine fibroids.⁶ However, uncontrolled devascularization of the myometrium, ovaries, and surrounding nontarget tissues became a concern due to nonuniformity of the PVA particles.²¹ In 2002, Pelage et al evaluated the effect of embolic particle size on the uterus and ovaries using an animal model anatomically similar to women.²¹ UAE was performed with particulate

PVA and calibrated microspheres (Embospheres) of various sizes in 26 sheep. MRI imaging and histopathologic evaluation of the ovaries and uterus were performed after UAE to determine the degree of necrosis, the diameter of occluded arteries, and particle size. Pelage et al found that particulate PVA produced significantly more uterine necrosis compared with Embospheres ($p < 0.001$) and demonstrated a greater degree of clumping within arteries. In addition, Embospheres < 500 microns and particulate PVA < 400 microns caused greater uterine necrosis compared with larger-size particles. Pelage et al also demonstrated a significant correlation between Embosphere size and arterial diameter; there was no correlation between particle size and arterial diameter using particulate PVA. Furthermore, any type of particle smaller than 500 microns traversed utero-ovarian anastomoses and caused ovarian infarction. Most importantly, it was determined that perifibroid arteries ranged between 500 to 800 microns in a majority of cases.^{21,22} Therefore, this study concluded that utilization of Embospheres > 500 microns produced fibroid infarction while limiting unwanted ischemia to the myometrium and ovaries.²¹

Although there are three different calibrated microspheres available (Embospheres, spherical PVA microspheres [Contour SE; Boston Scientific, Natick, MA] and acrylamide PVA microspheres [Beadblock; Biocompatibles, Farnham, UK]), Embospheres have proven to be the most reliable and efficacious embolic material for UAE. In 2005, Spies et al reported the first results comparing 36 UAE patients treated with either spherical PVA or Embospheres.²³ In this report, patients treated with Embospheres reported a greater improvement in quality of life score compared with patients treated with spherical PVA. In addition, pelvic MRI at 3 months following UAE showed a significantly higher fibroid infarction rate and a lower mean percentage of

Figure 5 (A) Flush aortogram demonstrates an enlarged right ovarian artery (arrow). (B) Delayed imaging demonstrates right ovarian artery blood supply to a fundal fibroid (arrow). The ovarian artery was not embolized in this patient with menorrhagia and no significant bulk-related symptoms. (C) Gadolinium-enhanced, fat-suppressed T1-weighted, sagittal magnetic resonance imaging (MRI) following uterine artery embolization (UAE) demonstrates a necrotic intramural fibroid and an enhancing fundal fibroid due to blood supply from the right ovarian artery. The patient's symptom resolved following UAE and therefore, the right ovarian artery was not embolized.

residual perfused fibroid tissue in patients treated with Embospheres (9.6%) compared with those treated with spherical PVA (44.3%).²³ Because of the high failure of tumor infarction using spherical PVA, the study was prematurely terminated based on the knowledge that patients with incomplete fibroid infarction were more likely to have recurrent symptoms related to growth of uninfarcted fibroid tissue.²⁴ Subsequent studies determined that spherical PVA was more compressible than tris-acryl microspheres.²⁵ Therefore, after embolization, spherical PVA assumes a smaller profile allowing embolic material to disperse within arteries more distally after a presumed satisfactory embolization endpoint when in

fact, additional embolization was necessary to achieve complete fibroid infarction.²⁵ Due to these findings, a "refined protocol" was suggested when using spherical PVA for UAE.²⁶ This protocol recommended the use of Contour SE 700 to 900 micron size particles and a more aggressive embolization endpoint nearing arterial stasis followed by a 5-minute waiting period providing time for embolization endpoint reassessment before removing the catheter from the uterine artery.²⁶ In 2008, Siskin et al published a prospective, randomized study comparing fibroid infarction using spherical PVA and Embospheres.²⁷ In this report, treatment failure occurred in 29.6% of patients treated with spherical PVA with the

Figure 6 (A) Gadolinium-enhanced, fat-suppressed T1-weighted, sagittal magnetic resonance imaging (MRI) pre-uterine artery embolization (UAE) reveals a large, subserosal fibroid extending from the anterior aspect of the uterus. (B) Gadolinium-enhanced, fat-suppressed T1-weighted, sagittal MRI post-UAE demonstrates complete necrosis and decrease in size of the subserosal uterine fibroid.

refined protocol compared with 3.8% of patients treated with Embospheres. Fibroid infarction rate was also evaluated and divided into 100%, 90 to 99%, 50 to 89%, and < 50% infarction rate. The spherical PVA group compared with the Embosphere group results were as follows: 100% infarction rate, 66% versus 92.3%; 90 to 99% infarction rate, 3.7% versus 3.8%; 50 to 89% infarction rate, 18.5% versus 3.8%, and < 50% infarction rate, 11.1% versus 0%, respectively.²⁷ Therefore, a significantly greater degree of fibroid infarction was achieved with Embospheres than with spherical PVA even with the newly refined protocol. The authors concluded that given the known risk of recurrence in patients with persistent fibroid enhancement, Embospheres should be the preferred embolic agent of choice for UAE.

As for using Beadblock (acrylamido PVA microspheres) for UAE, a recent article by Kroencke et al compared clinical efficacy and fibroid infarction rate using two different protocols for UAE.²⁸ Thirty-three patients underwent embolization with 500 to 700 micron Beadblock particles to near stasis and 36 patients underwent embolization with 700 to 900 micron particles to complete stasis. The authors demonstrated a significantly lower ($p < 0.05$) rate of completely infarcted fibroids in the group embolized with the smaller particles compared with those embolized using the larger particles. In addition, early clinical failures in patients treated with the smaller particles were due to incomplete fibroid infarction. The authors concluded that 700 to 900 micron particles are more effective for treating uterine fibroids when using acrylamido PVA microspheres. Further studies will be necessary to determine whether or not Beadblock can produce results similar to Embospheres, which is currently the most reliable embolic agent for UAE.

BRIEF LITERATURE REVIEW AND EXPECTED RESULTS

The efficacy of UAE for treatment of uterine fibroids has been confirmed by numerous institutional and multicenter studies for over a decade. In 2001, Spies et al reported the clinical and imaging follow-up (mean 21 months) of 200 consecutive UAE patients.²⁹ Menorrhagia and bulk-related symptoms improved in 90% and 91% of patients, respectively, at 12 month follow-up. Only one patient developed a major periprocedural complication, a pulmonary embolus which was treated with anticoagulation. The need for subsequent gynecologic interventions occurred in 10.5% of patients, including 9 (4.5%) elective hysterectomies. The mean reduction in uterine volume and mean dominant fibroid volume was 38% and 58%, respectively, at 12-month follow-up. The authors concluded that UAE is safe and provides relief of symptoms caused by uterine fibroids in a majority of patients.

In 2002, Walker and Pelage published the results of the largest prospective study, which included 400 UAE patients with a mean clinical follow-up of 16.7 months.³⁰ In this study, menorrhagia and menstrual pain improved in 84% and 79% of patients, respectively. Twenty-three (6%) patients experienced recurrent symptoms or failed to demonstrate clinical improvement. Three (1%) patients developed postprocedure infection requiring emergent hysterectomy. Twenty-six (7%) patients had permanent amenorrhea including 4 patients < 45 years of age, and 13 (4%) pregnancies occurred in 12 women. Ninety-seven percent of patients were satisfied with UAE outcome and would recommend the procedure to others with symptomatic fibroids.

The Ontario Uterine Fibroid Embolization Trial was a multicenter trial that enrolled 550 patients and

reported a 91% satisfaction rate following UAE.³¹ Significant improvements were reported for urinary frequency (86%), menorrhagia (83%), and dysmenorrhea (77%). In addition, mean menstrual duration decreased significantly from 7.6 to 5.4 days following UAE. This trial also reported a 42% and 35% mean volume reduction in the dominant fibroid and uterine volume, respectively. Larger fibroids were more likely to have a greater percentage of volume reduction compared with smaller fibroids (49% versus 23%) and the degree of uterine volume reduction was also greater for larger baseline uteri than smaller uteri (44% versus 11%). This trial concluded that UAE reduces fibroid uterine volume and provides significant relief of abnormal uterine bleeding with a high rate of patient satisfaction.

The well-known FIBROID Registry enrolled 3,160 patients at 72 participating sites.³² Primary measures of outcome were symptom and health-related quality-of-life scores from the Uterine Fibroid Symptom and Quality of Life questionnaire. A 3-year patient follow-up study was recently published; it reported a mean symptom score improvement of 41.41 points ($p < 0.001$) and a quality of life score improvement of 41.47 points ($p < 0.001$), close to normal range for this questionnaire.³¹ Kaplan-Meier estimates of hysterectomy, myomectomy, and repeat UAE were 9.79%, 2.82%, and 1.83%, respectively. In addition, 85.68% of patients stated that they would recommend UAE to family members and/or friends. The authors concluded that UAE is an effective and durable treatment for uterine fibroids with significant "improvement in symptoms and quality of life for a large majority of patients."³²

The previously discussed studies represent a small sampling of the numerous publications in the literature reporting results of UAE for treatment of symptomatic fibroids. In 2004, the Society of Interventional Radiology produced quality improvement guidelines for interventional radiologists performing UAE to summarize the literature and delineate expected outcomes of the procedure.³³ These guidelines were created by performing an in-depth literature search of peer-reviewed articles and the intended purpose of the guidelines was to "insure the standard of care expected of all physicians" who perform UAE. Expected outcomes were defined as a fibroid and uterine size reduction between 50 to 60% and 40 to 50%, respectively, a reduction in bulk-related symptoms ranging between 88 to 92%, elimination of dysfunctional uterine bleeding in $> 90\%$ of patients, and elimination of all fibroid-related symptoms in 85% of patients following UAE.³² As far as UAE complications, the guidelines produced suggested thresholds for various complications, including transient amenorrhea (10%), permanent amenorrhea (age < 45 years = 3%, age > 45 years = 15%), transcervical fibroid expulsion (5%), endometrial or uterine infection (2%), uterine necrosis (1%), and nontarget embolization (1%). Interventional

radiologists performing UAE should strive to meet these expected outcomes and thresholds for complications so that UAE remains a desirable and effective procedure for patients with symptomatic uterine fibroids.

Further review of UAE complications and patient management will be discussed in a separate article in this edition of *Seminars in Interventional Radiology*.

CONCLUSION

Over the past decade, UAE has become an increasingly popular nonsurgical treatment option for women with menorrhagia and bulk-related symptoms associated with uterine fibroids. The popularity of the procedure can be attributed to the safety and efficacy of the procedure as well as the high patient satisfaction reported in the literature. Proper patient selection, preprocedure evaluation, and meticulous procedural technique are essential for achieving UAE success. Interventional radiologists performing UAE should strive to meet the expected outcomes and complication thresholds put forth by the Society of Interventional Radiology to provide the best possible results for patients undergoing UAE.

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