Updates on Uterine Artery Embolization

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Semin Intervent Radiol 2018;35:48–55

*CME credit is not offered for this article.

Abstract

Uterine fibroids (leiomyomas) are the most common benign neoplasm of the female pelvis and have a lifetime prevalence exceeding 80% among African American women and approaching 70% among Caucasian women. Approximately 50% of women with fibroids experience symptoms which may include menorrhagia that may result in anemia, bulk symptoms with bladder and bowel dysfunction and abdominal protrusion, dysmenorrhea, and infertility. Hysterectomy remains the most common treatment option for fibroids and concerns have been raised about the overuse of this procedure. Uterine artery embolization (UAE) is now a well-established uterine preserving and minimally invasive therapy for symptomatic fibroids. Since its introduction, strong evidence for safety and efficacy of UAE has been generated with low rates of complications. This review will discuss UAE for the management of symptomatic uterine fibroids with special focus on emerging technical approaches and novel periprocedural patient care.

Keywords
- fibroid
- uterus
- embolization
- menorrhagia
- interventional radiology

Objectives: Upon completion of this article, the reader will be able to describe the current state of uterine artery embolization in the treatment of fibroids, including patient selection, technical approaches, and clinical outcomes.

Uterine fibroids (leiomyomas) are the most common benign neoplasm of the female pelvis and have a lifetime prevalence exceeding 80% among African American women and approaching 70% among Caucasian women.[1] Approximately 50% of women with fibroids experience symptoms which may include menorrhagia that may result in anemia, bulk symptoms with bladder and bowel dysfunction and abdominal protrusion, dysmenorrhea, and infertility.[2] Hysterectomy remains the most common treatment option for fibroids and concerns have been raised about the overuse of this procedure.[3]

First reported in 1995 by Ravina et al,[4] uterine artery embolization (UAE) is now a well-established uterine preserving and minimally invasive therapy for symptomatic fibroids. Since its introduction, strong evidence for safety and efficacy of UAE has been generated with low rates of complications.[5] This review will discuss UAE for the management of symptomatic uterine fibroids with special focus on emerging technical approaches and novel periprocedural patient care.

Patient Selection

The majority of patients with symptomatic uterine fibroids who are candidates for myomectomy or hysterectomy are also candidates for UAE. The interventional radiologist can best determine if UAE is a recommended treatment option for a patient. However, the decision to recommend UAE should not be made in isolation, but in collaboration with a gynecologist who has already discussed the various medical and surgical options with the patient.[6]

Most interventional radiologists prefer to see a patient for a clinic consultation prior to UAE to determine whether she is a candidate for the procedure. During the clinic visit, the interventional radiologist will review the patient's history,

Issue Theme Women's Health; Guest Editors, Kimi L. Kondo, DO, FSIR and Laura K. Findeiss, MD, FSIR

DOI https://doi.org/10.1055/s-0038-1636521.
ISSN 0739-9529.

including her symptoms, age, prior fibroid therapies, patient's preference regarding uterine sparing therapy, desire for future pregnancy, assess patient's risks for the procedure, and make a recommendation as to whether she is a candidate for UAE.[6]

The most common indications for UAE include heavy or prolonged menstrual bleeding (menorrhagia); severe menstrual cramping (dysmenorrhea); pelvic pressure, discomfort, excessive bloating, fullness, or bothersome abdominal wall distortion; pelvic pain; pain during intercourse (dyspareunia); and urinary urgency, frequency, nocturia, or retention.[7]

Absolute contraindications for UAE include viable pregnancy, active infection, and suspected uterine, cervical, or adnexal malignancy. While not contraindications, there are some conditions including severe contrast agent allergy, renal impairment, and coagulopathy, which require special caution, but all of which can often be ameliorated with appropriate management.[7]

Review of recent fibroid imaging is extremely important prior to proceeding with UAE. While most patients with fibroids will likely have a pelvic ultrasound (US), a contrast-enhanced magnetic resonance imaging (MRI) has been shown to be more accurate than US for characterizing uterine fibroids.[8] As a result, MRI has become the preferred method of assessing the uterus and pelvis prior to UAE as it evaluates for fibroid location, enhancement characteristics, and the presence of ovarian artery (OA) supply to the fibroid, in addition to determining other uterine pathologies which may mimic fibroid symptoms such as adenomyosis.[9] It may also help detect leiomyosarcoma if characteristic imaging parameters are present, as discussed in a subsequent section below.

Uterine Artery Embolization and Adenomyosis

Adenomyosis is characterized by the diffuse or local growth of endometrial tissue within the muscular layer of the uterus and has a prevalence of 5 to 70% among women between 30 and 50 years of age.[10] This disease predominately affects the posterior uterine wall and can result in diffuse uterine enlargement, widening of the junctional zone, and often coexists with fibroids.[11] The symptoms of adenomyosis are similar to that of fibroids and include menorrhagia, dysmenorrhea, and bulk-related symptoms such as pelvic pressure or urinary frequency.[12]

The presence of adenomyosis is not a contraindication to UAE. In fact, UAE has been shown to result in clinical and symptomatic improvement for patients with isolated adenomyosis. Long-term symptomatic relief may range from 64.5 to 82.4%.[7,10,12] In a subgroup of patients with adenomyosis and uterine fibroids, 82.4% of patients reported symptom improvement at 34.2-month follow-up.[11]

UAE outcomes for adenomyosis are variable and depend on the extent and vascularity of the adenomyosis, the degree of necrosis following UAE, and the presence and absence of fibroids.[6,10] Better outcomes have been demonstrated in cases of adenomyosis with lower signal intensity on T2-weighted imaging, focal areas of adenomyosis, and use of smaller particle size for embolization.[2] While prospective, randomized trials evaluating the role of UAE for adenomyosis are warranted, the current literature demonstrates durable symptom improvement in patients with adenomyosis following UAE.

Uterine Artery Embolization and Intrauterine Device

An intrauterine device (IUD) is one of the most widely used methods of long-acting reversible contraception.[13] The presence of an IUD may be considered a risk factor for post-procedural infection and some physicians may prefer to remove the IUD prior to UAE. The combination of a foreign body within the uterine cavity and necrotic fibroid tissue following UAE was thought to increase the rate of infection for some time.[14] However, in large follow-up studies of women with IUDs, the risk of pelvic inflammatory disease attributed to the IUD is less than 1 in 1,300.[14] In addition, in a study of 20 women with IUDs undergoing UAE, Smeets et al[14] did not demonstrate any infectious complications after a mean follow-up of 20.5 months. The presence of an IUD should therefore not be a contraindication to UAE.

Leiomyosarcoma

Uterine leiomyosarcomas are extremely rare, comprising 1.3% of all uterine malignancies. Less than 1% of women with uterine fibroids have leiomyosarcoma[15] and the presumed incidence of an occult malignancy in a patient undergoing surgery or UAE is approximately 1 in 350 to 1,000 or less.[2]

Leiomyosarcoma can occur spontaneously or through malignant transformation of a preexisting uterine fibroid, mostly in postmenopausal women in the fifth decade.[16] Clinical symptoms are similar to that of fibroids and include irregular vaginal bleeding, abdominal pain, and palpable mass.[15]

On MRI, uterine leiomyosarcoma is a solid mass with irregular (not round), well-delineated margins in an enlarged uterus. On T2-weighted imaging, the mass displays intermediate-to-high signal intensity with bright signal on T1-weighted imaging, representing hemorrhagic changes. On diffusion-weighted imaging, leiomyosarcoma demonstrates restricted diffusion with hyperintensity at high b value and a low ADC value. There is also heterogeneous enhancement and signal voids due to foci of calcification.[15] Given the overlap in imaging features between leiomyosarcoma and fibroids, comparison to prior imaging is extremely important. A rapidly growing fibroid, specifically a fibroid that has doubled in size within 3 to 6 months, should raise concern for possibility of sarcoma. However, only approximately 0.27 to 2.6% of patients with a rapidly growing uterus have been shown to have leiomyosarcoma.[15] Lastly, serum levels of lactate dehydrogenase (LDH) and LDH isozyme are usually elevated in patients with uterine sarcomas.[16]

No morphological or functional criterion in imaging can discriminate between a degenerating fibroid and a uterine leiomyosarcoma. Therefore, transcervical image-guided biopsy may be considered as a problem-solving tool in cases of atypical imaging and careful follow-up of such patients

treated with UAE may be indicated to diagnose this extremely rare malignancy.[16]

Uterine Artery Embolization in Postmenopausal Women

Uterine fibroids are thought to be hormonally responsive and typically regress after menopause.[1,17] However, a subset of postmenopausal women continues to have symptomatic uterine fibroids. Hormone replacement therapy and obesity have been linked to persistent or new fibroid symptoms in the postmenopausal state.[17,18]

UAE for the treatment of bulk symptoms in postmenopausal women has been shown to be safe and effective, resulting in 88.8 to 92% symptom improvement.[17,18] Fibroid-related bleeding in the postmenopausal state may also occur. However, in this setting, prompt evaluation for underlying malignancy or endometrial hyperplasia should be considered through an endometrial biopsy prior to proceeding with UAE.[1] In carefully selected postmenopausal women with symptomatic uterine fibroids, UAE is a viable treatment option.

Uterine Artery Embolization for Large Fibroids

For some time, UAE was not recommended for patients with fibroids greater than 10 cm, especially those located in the submucosal area and in women with uterine size greater than 24 weeks.[19] The reasoning behind this was from a few case reports where UAE in patients with large fibroid size and submucosal location resulted in infection, uterine injury, sepsis, and death.[19] However, in the more recent years, several reports have demonstrated the safety and efficacy of UAE in fibroids larger than 10 cm.[19–21] In fact, the safety and efficacy of UAE has also been demonstrated in patients with a "megauterus," measuring greater than 1,600 mL in volume.[2]

Gonadotropin-Releasing Hormone Agonists Prior to Uterine Artery Embolization

Gonadotropin-releasing hormone (GnRH) agonists may be used for short-term preoperative treatment of uterine fibroids. Fibroid volume reduction (30–50%) and symptom improvement is typically observed after GnRH agonist therapy for 3 to 6 months.[22] Due to the hypoestrogenic state, patients often experience menopausal symptoms such as hot flashes, vaginal dryness, mood changes, and reduced bone density.[22] Following cessation of GnRH agonist therapy, fibroids typically regrow within 3 months and symptoms recur.

Treatment with GnRH agonist may cause a decrease in uterine vasculature which may compromise the efficacy of UAE.[23] Prior reports have described deferring UAE for at least 3 months to allow for the uterine arteries (UAs) to return to their normal caliber.[23,24] Kim et al[25] used GnRH agonist therapy for patients with large fibroids (>10 cm) and performed UAE once the fibroid diameter had decreased to 8 cm. The authors demonstrated pre-UAE GnRH agonist therapy of large fibroids was safe and did not compromise the UAE procedure. Further studies are required to determine the effects of GnRH agonist therapy on the uterine vasculature and whether simultaneous UAE can be performed without compromising clinical efficacy.

Uterine Artery Embolization for Pedunculated Subserosal Fibroids

The presence of pedunculated subserosal fibroids, particularly those with an attachment less than 50% of the diameter of the fibroid, had once been a relative contraindication for UAE. This was due to the theoretical risk of stalk necrosis with fibroid detachment from the uterus resulting in bowel or peritoneal inflammation requiring surgical intervention.[26] Katsumori et al[27] demonstrated that UAE can be safe and effective for patients with pedunculated subserosal fibroids with a stalk diameter of 2 cm or greater. Margau et al[28] reaffirmed the safety and efficacy of UAE in patients with pedunculated subserosal fibroids, including patients with stalk diameters less than 2 cm. Finally, Smeets et al[29] demonstrated that UAE was safe and effective in the treatment of patients with pedunculated subserosal fibroids with stalk diameters ranging from 1.6 to 5.2 cm. The authors did not have any complications attributed to the pedunculated nature of the fibroid in long-term follow-up of 33 months. In fact, the authors illustrated that the vascularity of the fibroid stalk remained unchanged and unaffected by the UAE in all patients who underwent postprocedural MRI. Based on the current evidence, pedunculated subserosal fibroids are not a contraindication for UAE.

That said, Lacayo et al[30] demonstrated that regardless of the embolic material used, pedunculated serosal fibroids were less likely to infarct than those deeper in the uterus (pedunculated serosal fibroids had an odds ratio for complete infarction of 0.24 [$p = 0.01$]). Therefore, while the embolization of pedunculated fibroids may be safe, the chance of successful treatment may be less compared with fibroids in other uterine locations.

Technical Aspects

Access

UAE is traditionally performed with moderate sedation via a right common femoral artery approach with embolization of bilateral UAs.[6] While most patients with fibroids have bilateral UA supply, a small subset does present with unilateral disease and can benefit from unilateral UAE. Stall et al[31] demonstrated that unilateral UAE in appropriately selected patients who have isolated unilateral UA supply to the entire fibroid has similar results when compared with bilateral UAE. In addition, the authors demonstrated that unilateral UAE is associated with reduced fluoroscopy time and postprocedural pain.

Bilateral femoral artery access with simultaneous angiography and embolization is an alternative technique which has been shown to reduce procedural and fluoroscopy time with no increase in complications.[32] More recently, transradial access (TRA) has gained popularity for UAE with the apparent advantage of allowing patients to move freely following the procedure to assume the most comfortable position.

Resnick et al[33] demonstrated that TRA UAE is safe and feasible with patent radial artery at 1-month follow-up evaluation in all patients. While the technique of left TRA access has been previously described,[34] some technical modifications for UAE are important to recognize prior to the procedure. The left radial artery is accessed for subdiaphragmatic interventions and because of the longer distance to the UAs from the wrist, an exchange length guidewire and a longer catheter, such as a 4-Fr 120-cm Glidecath (Terumo, Somerset, NJ) should be used to access the internal iliac arteries.[33] Conventional microcatheters such as the Renegade Hi-Flo (Boston Scientific, Natick, MA) or Progreat (Terumo) can still be used to catheterize the UAs. In cases of OA supply to the fibroid, the Sarah Radial catheter (Terumo) may be used for OA catheterization (Aaron M. Fischman, personal communication, April 2017).

Embolic Agents and Endpoints

In the United States and Europe, particulate material is the most common embolic agent used for UAE. Several embolic agents are approved by the Food and Drug Administration (FDA) for UAE, including tris-acryl gelatin microspheres (TAGM; Embospheres, Merit, South Jordan, UT) and nonspherical polyvinyl alcohol (PVA) particles (various manufactures). Spherical PVA which was developed in response to the extensive size variations of nonspherical PVA and its tendency to clump the catheter was shown in numerous studies to be less effective in fibroid necrosis and symptom improvement when compared with TAGM.[35] Gelatin sponge is also an effective agent for UAE and widely used in Asia; however, the inconsistent particle size due to its hand-preparation poses difficulties in quantitative comparisons with the other available agents.[35]

Acrylamido polyvinyl alcohol microspheres (a-PVAM; Bead Block, BTG, West Conshohocken, PA) are calibrated particles, which is FDA approved for UAE. Prior studies have demonstrated reduced rates of fibroid infarction when using 500 to 700 μm particles.[36,37] In a prospective, randomized control trial, Worthington-Kirsch et al[38] showed that 700 to 900 μm a-PVAM was not inferior to TAGM as an embolic agent for UAE.

Polyzene F–coated microsphere (Embozene, Boston Scientific) is the most recent addition of embolic agents for UAE. This agent consists of a hydrogel core of polymethylmethacrylate and a flexible shell of polyphosphazene which is a synthesized inorganic biostable and biocompatible polymer.[39] The microspheres are also sieved to a high uniformity with narrow size range, are color-coded, and available in sizes ranging from 40 to 1,300 μm. This agent has been shown to be safe and effective in single-arm trials.[39,40] A prospective, randomized control trial comparing Polyzene F–coated microspheres to TAGM for UAE is currently underway (ClinicalTrials.gov Identifier: NCT02884960).

Regardless of the particle choice, the goal of embolization is to occlude the vessels supplying the fibroid leaving the UA patent yet with slow flow, typically near stasis.[6] The angiographic endpoint of near stasis is the sluggish flow in the main UA with a persistent column of contrast through five heartbeats.

Aberrant Vascular Supply

Utero-ovarian anastomoses (UOA) have been considered the cause of treatment failure after UAE and also contributing to the few cases of permanent amenorrhea and ovarian dysfunction following UAE. Razavi et al[41] described three types of OA to UA anastomoses. In type I anastomosis, the OA supplies the fibroid through anastomoses with the intramural UA. In type II, the OA supplies the fibroid directly. In type III, the OA supply appears to be from the UA. The importance of recognizing these patterns is the contribution of the OA to the fibroid arterial supply and the potential effect of UAE on the OA supply. However, it should be noted that nonvisualization of such UOA does not exclude small underlying connections. Therefore, recognition of the particular type of UOA is important in identifying the potential for nontarget ovarian embolization and instances of possible clinical failure following UAE.

Despite the concern, there is little definitive evidence that any particular type of UOA is linked to ovarian failure. For example, in one series, Lanciego et al[42] performed UAE in the setting of varying types of UOA. The authors concluded that the recurrence rates, clinical failure, and amenorrhea after UAE did not seem to be influenced by UOA. Other factors such as patient's age may be more important to ovarian function. There is even evidence that direct embolization of the OAs in cases where fibroids are supplied by those vessels may not impact ovarian function clinically. Hu et al[43] reviewed the impact of OA embolization in addition to UAE on subsequent ovarian function. The authors concluded that compared with standard UAE, the addition of OA embolization did not precipitate the onset of menopause or increase menopausal symptom severity. These data contradict the commonly held belief that OA embolization is associated with ovarian failure.

The recurrence rate after UAE is approximately 20 to 28%.[43] Collateral supply from the OA to the fibroid can explain some of these cases of recurrence. Therefore, it is imperative to perform an aortogram or have a good-quality preprocedural MRI/MRA to evaluate for OA supply to the fibroid. In cases of dominant OA supply, the OA can be catheterized and embolized with particulate agents in a similar fashion to UAE.

Addition aberrant arterial supply to the fibroid may arise from the inferior mesenteric artery, the round ligament artery, and the internal pudendal artery.[44,45] In patients with an absent or diminutive UA, or in cases of prior pelvic surgery or fundal fibroids, close attention to other sources of arterial supply must be given to enhance the clinical success of UAE.

Periprocedural Pain Management

Superior Hypogastric Nerve Block

One of the main challenges of UAE is the management of postprocedural pain. While 70% of women have no pain during the actual procedure, greater than 90% of women

report pain after UAE.[46] The likely culprit for the pain in the immediate postprocedural setting is the ischemia caused by the embolization process. This immediate postprocedural pain is different from the postembolization pain which includes pain, fever, and fatigue for up to 72 hours, and is caused by the inflammatory reaction to the embolization.

Superior hypogastric nerve block (SHNB) is a technique which aims to reduce the ischemic pain following UAE. In this technique, the entry site on the anterior abdomen is selected, typically 2 to 5 cm below the umbilicus.[46] The skin is prepped and draped and following local anesthesia, a 21-gauge needle is advanced under fluoroscopic guidance with a clamp to the anterior portion of the fifth lumbar vertebral body. For optimal guidance, a cranio-caudal tilt of 5 to 15 degrees can be used. A catheter can be placed in the left common iliac artery from the right transfemoral approach to delineate the bifurcation of the abdominal aorta so the 21-gauge needle does not inadvertently penetrate through the aortic bifurcation. Once the bony prominence is reached and confirmed on lateral view, a small amount of dilute contrast (2–5 mL) is injected, which will opacify a crescent-shaped area anterior to the vertebral body. If an unfavorable distribution is seen, the needle should be repositioned. Following proper positioning, 10 m of 0.75% ropivacaine (Naropin, AstraZeneca) is injected and the needle is withdrawn. Binkert et al[46] demonstrated that SHNB is a safe and minimally time-consuming way to reduce post-UAE pain and opiate use, especially within the first 4 hours.

In a prospective, randomized controlled double-blinded trial comparing SHNB to placebo, Yoon et al[47] demonstrated that SHNB resulted in reduced opioid analgesia and antiemetic use in the immediate post-UAE period. However, no significant difference was noted in reduction of hospital admission rate or duration of hospital stay following UAE.

Pre–Uterine Artery Embolization Steroid Administration

Following UAE, a substantial inflammatory process manifests resulting in the postembolization syndrome consisting of pain, low-grade fevers, nausea, vomiting, and malaise. In a prospective, randomized control trial, Kim et al[48] demonstrated that the administration of a single-dose intravenous dexamethasone prior to UAE was effective in reducing inflammation and pain during the first 24 hours following the procedure. In this trial, the patients in the steroid arm received 10 mg of intravenous dexamethasone 1 hour prior to the UAE. The authors demonstrated that while the opiate use was not different between the control and the dexamethasone groups, the pain scores and the incidence of nausea and vomiting were lower in the group of patients who had received dexamethasone. In addition, compared with the placebo group, the patients who received dexamethasone had significantly lower elevations of inflammatory makers such as C-reactive protein, interleukin-6, and cortisol during the first 24 hours following the UAE. While additional studies may be needed to evaluate the utility of dexamethasone prior to UAE, its administration may be beneficial in reducing inflammation in the immediate postprocedural setting.

Post–Uterine Artery Embolization Lidocaine Administration

Lidocaine is an intermediate-acting local anesthetic agent which has been used intra-arterially during chemoembolization. With respect to UAE, intra-arterial administration prior to embolization has been shown to cause moderate to severe vasospasm which may result in clinical failure of UAE.[49] However, in a prospective, randomized control trial, Noel-Lamy et al[50] demonstrated that 10 mL of 1% lidocaine (100 mg) administered into the UA *after* embolization over a period of 15 seconds resulted in improved postprocedural pain and opiate use. The authors also reaffirmed that intra-arterial lidocaine administration prior to embolization resulted in more cases of incomplete necrosis, likely due to vasospasm. Postembolization intra-arterial administration of lidocaine appears to be a useful tool for reducing postprocedural pain and should be considered in every case of UAE.

Clinical Outcomes

Clinical Success and Complications

The expected outcomes following a UAE include 50 to 60% fibroid size reduction, 40 to 50% uterine size reduction, 88 to 92% reduction of bulk symptoms, greater than 90% elimination of abnormal uterine bleeding, and 80 to 90% patient satisfaction.[7] At 3-year follow-up, the overall reintervention rate among patients who underwent UAE was 14.4%.[7] This is in keeping with multiple prior studies which have concluded that UAE has a similar patient satisfaction rate compared with the other surgical alternatives and is associated with shorter length of hospital stay. However, patients undergoing UAE have higher minor complications and higher likelihood of surgical reintervention within 2 to 5 years.[51]

Compared with MR-guided focused ultrasound, UAE has been shown to have worse postprocedural pain but significantly lower reintervention rate.[52,53]

Complications following UAE include permanent amenorrhea (0–3% for women younger than 45 years, 20–40% for women older than 45 years), prolonged vaginal discharge (2–17%), fibroid expulsion (see section below), septicemia (1–3%), pulmonary embolus (<1%), and nontarget embolization (<1%).[7] Less common complications include infection, delayed contrast material reactions, urinary tract infection or retention, and nerve or vessel injury at the access site. Less than 1% of patients require hysterectomy because of UAE complications. Three fatalities have been reported following UAE, including pulmonary embolism, sepsis from pyometrium, and death from ovarian cancer.[2]

Fibroid Expulsion

The reported incidence of fibroid expulsion following UAE ranges from 1.7 to 50%[54] with the presentation of pain, fever, or recurrent bleeding or discharge.[2] Expulsion may occur weeks to years following UAE, with a peak incidence at

3 months following the procedure.[54] Fibroids most likely at risk for expulsion include submucosal fibroids which are intracavitary, fibroids that are just beneath the endometrium, and transmural fibroids that extend from the endometrium to the serosa. Patients may report passing pieces of the fibroids or expel the entire tumor. If the necrotic components are not expelled from the uterine cavity, the patient is at risk for ascending infection resulting in life-threatening sepsis.[55] Treatment depends on the clinical status of the patient and can range from antibiotics, hysteroscopic extraction, or hysterectomy. Nulliparous women are potentially at greater risk to require hysterectomy compared with parous women.[54] The reported incidence of hysterectomy is appropriately 15% among patients expelling fibroids.[7]

Fertility and Pregnancy following Uterine Artery Embolization

Little is truly known about the effects of UAE on fertility and future pregnancies. Only one prospective, randomized controlled trial has compared reproductive outcomes following UAE to myomectomy.[56] Based on a randomized group of 121 women who were followed up for 2 years, the authors demonstrated that myomectomy resulted in better reproductive outcomes compared with UAE. However, the trial suffered from several limitations. In addition to its strict inclusion criteria which were not representative of a general population, the patients in the UAE group were recommended to undergo a second intervention (myomectomy) if their fibroids measured greater than 5 cm or in cases of regrowth of new fibroids to that size. The technical failure rate of UAE was 11% which is unusually high. As such, 33% of the UAE patients underwent a myomectomy and a 6-month interval was allowed for recovery before pregnancy was attempted. Therefore, in the 2-year follow-up period, the UAE patients had fewer opportunities to become pregnant compared with the patients in the myomectomy group.

In a recent prospective, noncomparative trial, Torre et al[57] demonstrated that women without infertility factors who underwent UAE had a substantial rate of subsequent fertility. The authors demonstrated that the annual fertility rate after UAE (33.3% for the whole study population, 62.5% for women intending to conceive) compared favorably with the 40 to 61% fertility outcomes after myomectomy.

Given the lack of robust data, the counseling of women considering fertility following UAE should be individualized. When the fibroid is amenable to myomectomy and the patient desires future pregnancy, then surgery should be the first recommended procedure. If the patient's anatomy is not suitable for surgery, then UAE should be offered as therapy. Lastly, following proper discussion of risks, benefits, and alternatives, a woman who wants to avoid surgery should still be offered UAE, even if she desires future fertility.[6]

Conclusion

The safety and efficacy of UAE for symptomatic uterine fibroids has been well-established. More recently, advances in techniques with the addition of novel forms of periprocedural patient care have resulted in improved postprocedural pain control. While reproductive outcomes following UAE are not clearly known, all patients with symptomatic uterine fibroids considering hysterectomy and myomectomy should be counseled about UAE by an interventional radiologist.

References

1 Stewart EA. Clinical practice. Uterine fibroids. N Engl J Med 2015; 372(17):1646–1655
2 Silberzweig JE, Powell DK, Matsumoto AH, Spies JB. Management of uterine fibroids: a focus on uterine-sparing interventional techniques. Radiology 2016;280(03):675–692
3 Stewart EA, Shuster LT, Rocca WA. Reassessing hysterectomy. Minn Med 2012;95(03):36–39
4 Ravina JH, Herbreteau D, Ciraru-Vigneron N, et al. Arterial embolisation to treat uterine myomata. Lancet 1995;346(8976):671–672
5 Spies JB. Current evidence on uterine embolization for fibroids. Semin Intervent Radiol 2013;30(04):340–346
6 Spies JB. Current role of uterine artery embolization in the management of uterine fibroids. Clin Obstet Gynecol 2016;59 (01):93–102
7 Dariushnia SR, Nikolic B, Stokes LS, Spies JB; Society of Interventional Radiology Standards of Practice Committee. Quality improvement guidelines for uterine artery embolization for symptomatic leiomyomata. J Vasc Interv Radiol 2014;25(11): 1737–1747
8 Rajan DK, Margau R, Kroll RR, et al. Clinical utility of ultrasound versus magnetic resonance imaging for deciding to proceed with uterine artery embolization for presumed symptomatic fibroids. Clin Radiol 2011;66(01):57–62
9 Siddiqui N, Nikolaidis P, Hammond N, Miller FH. Uterine artery embolization: pre- and post-procedural evaluation using magnetic resonance imaging. Abdom Imaging 2013;38(05):1161–1177
10 Zhou J, He L, Liu P, et al. Outcomes in adenomyosis treated with uterine artery embolization are associated with lesion vascularity: a long-term follow-up study of 252 cases. PLoS One 2016;11 (11):e0165610
11 Popovic M, Puchner S, Berzaczy D, Lammer J, Bucek RA. Uterine artery embolization for the treatment of adenomyosis: a review. J Vasc Interv Radiol 2011;22(07):901–909, quiz 909
12 Bae SH, Kim MD, Kim GM, et al. Uterine artery embolization for adenomyosis: percentage of necrosis predicts midterm clinical recurrence. J Vasc Interv Radiol 2015;26(09):1290–6.e2
13 Turok DK, Gawron LM, Lawson S. New developments in long-acting reversible contraception: the promise of intrauterine devices and implants to improve family planning services. Fertil Steril 2016;106(06):1273–1281
14 Smeets AJ, Nijenhuis RJ, Boekkooi PF, Vervest HA, van Rooij WJ, Lohle PN. Is an intrauterine device a contraindication for uterine artery embolization? A study of 20 patients. J Vasc Interv Radiol 2010;21(02):272–274
15 Wu TI, Yen TC, Lai CH. Clinical presentation and diagnosis of uterine sarcoma, including imaging. Best Pract Res Clin Obstet Gynaecol 2011;25(06):681–689
16 Barral M, Placé V, Dautry R, et al. Magnetic resonance imaging features of uterine sarcoma and mimickers. Abdom Radiol (NY) 2017;42(06):1762–1772
17 Chrisman HB, Minocha J, Ryu RK, Vogelzang RL, Nikolaidis P, Omary RA. Uterine artery embolization: a treatment option for symptomatic fibroids in postmenopausal women. J Vasc Interv Radiol 2007;18(03):451–454
18 Lee SJ, Kim MD, Kim GM, Won JY, Park SI, Lee DY. Uterine artery embolization for symptomatic fibroids in postmenopausal women. Clin Imaging 2016;40(01):106–109

19 Katsumori T, Nakajima K, Mihara T. Is a large fibroid a high-risk factor for uterine artery embolization? AJR Am J Roentgenol 2003;181(05):1309–1314
20 Bérczi V, Valcseva É, Kozics D, et al. Safety and effectiveness of UFE in fibroids larger than 10 cm. Cardiovasc Intervent Radiol 2015;38 (05):1152–1156
21 Smeets AJ, Nijenhuis RJ, van Rooij WJ, et al. Uterine artery embolization in patients with a large fibroid burden: long-term clinical and MR follow-up. Cardiovasc Intervent Radiol 2010;33 (05):943–948
22 Singh SS, Belland L. Contemporary management of uterine fibroids: focus on emerging medical treatments. Curr Med Res Opin 2015;31(01):1–12
23 Volkers NA, Hehenkamp WJ, Birnie E, et al. Uterine artery embolization in the treatment of symptomatic uterine fibroid tumors (EMMY trial): periprocedural results and complications. J Vasc Interv Radiol 2006;17(03):471–480
24 Hutchins FL, Worthington-Kirsch R, Berkowitz RP. GnRH analogs and uterine artery embolization. J Am Assoc Gynecol Laparosc 1999;6(03):367–368
25 Kim MD, Lee M, Lee MS, et al. Uterine artery embolization of large fibroids: comparative study of procedure with and without pretreatment gonadotropin-releasing hormone agonists. AJR Am J Roentgenol 2012;199(02):441–446
26 Gonsalves C. Uterine artery embolization for treatment of symptomatic fibroids. Semin Intervent Radiol 2008;25(04): 369–377
27 Katsumori T, Akazawa K, Mihara T. Uterine artery embolization for pedunculated subserosal fibroids. AJR Am J Roentgenol 2005; 184(02):399–402
28 Margau R, Simons ME, Rajan DK, et al. Outcomes after uterine artery embolization for pedunculated subserosal leiomyomas. J Vasc Interv Radiol 2008;19(05):657–661
29 Smeets AJ, Nijenhuis RJ, Boekkooi PF, et al. Safety and effectiveness of uterine artery embolization in patients with pedunculated fibroids. J Vasc Interv Radiol 2009;20(09):1172–1175
30 Lacayo EA, Richman DL, Acord MR, et al. Leiomyoma infarction after uterine artery embolization: influence of embolic agent and leiomyoma size and location on outcome. J Vasc Interv Radiol 2017;28(07):1003–1010
31 Stall L, Lee J, McCullough M, Nsrouli-Maktabi H, Spies JB. Effectiveness of elective unilateral uterine artery embolization: a case-control study. J Vasc Interv Radiol 2011;22(05):716–722
32 Costantino M, Lee J, McCullough M, Nsouli-Maktabi H, Spies JB. Bilateral versus unilateral femoral access for uterine artery embolization: results of a randomized comparative trial. J Vasc Interv Radiol 2010;21(06):829–835, quiz 835
33 Resnick NJ, Kim E, Patel RS, Lookstein RA, Nowakowski FS, Fischman AM. Uterine artery embolization using a transradial approach: initial experience and technique. J Vasc Interv Radiol 2014;25(03):443–447
34 Fischman AM, Swinburne NC, Patel RS. A technical guide describing the use of transradial access technique for endovascular interventions. Tech Vasc Interv Radiol 2015;18(02): 58–65
35 Das R, Champaneria R, Daniels JP, Belli AM. Comparison of embolic agents used in uterine artery embolisation: a systematic review and meta-analysis. Cardiovasc Intervent Radiol 2014;37(05): 1179–1190
36 Kroencke TJ, Scheurig C, Lampmann LE, et al. Acrylamido polyvinyl alcohol microspheres for uterine artery embolization: 12-month clinical and MR imaging results. J Vasc Interv Radiol 2008; 19(01):47–57
37 Chrisman HB, Dhand S, Rajeswaran S, et al. Prospective evaluation of the embolic agent bead block in the treatment of uterine leiomyomas with uterine artery embolization: a phase II study. J Vasc Interv Radiol 2010;21(04):484–489
38 Worthington-Kirsch RL, Siskin GP, Hegener P, Chesnick R. Comparison of the efficacy of the embolic agents acrylamido polyvinyl alcohol microspheres and tris-acryl gelatin microspheres for uterine artery embolization for leiomyomas: a prospective randomized controlled trial. Cardiovasc Intervent Radiol 2011;34 (03):493–501
39 Stampfl U, Radeleff B, Sommer C, et al. Midterm results of uterine artery embolization using narrow-size calibrated embozene microspheres. Cardiovasc Intervent Radiol 2011;34(02):295–305
40 Smeets AJ, Nijenhuis RJ, van Rooij WJ, et al. Embolization of uterine leiomyomas with Polyzene F-coated hydrogel microspheres: initial experience. J Vasc Interv Radiol 2010;21(12):1830–1834
41 Razavi MK, Wolanske KA, Hwang GL, Sze DY, Kee ST, Dake MD. Angiographic classification of ovarian artery-to-uterine artery anastomoses: initial observations in uterine fibroid embolization. Radiology 2002;224(03):707–712
42 Lanciego C, Diaz-Plaza I, Ciampi JJ, et al. Utero-ovarian anastomoses and their influence on uterine fibroid embolization. J Vasc Interv Radiol 2012;23(05):595–601
43 Hu NN, Kaw D, McCullough MF, Nsouli-Maktabi H, Spies JB. Menopause and menopausal symptoms after ovarian artery embolization: a comparison with uterine artery embolization controls. J Vasc Interv Radiol 2011;22(05):710–715.e1
44 Chang S, Lee MS, Kim MD, et al. Inferior mesenteric artery collaterals to the uterus during uterine artery embolization: prevalence, risk factors, and clinical outcomes. J Vasc Interv Radiol 2013;24(09):1353–1360
45 Saraiya PV, Chang TC, Pelage JP, Spies JB. Uterine artery replacement by the round ligament artery: an anatomic variant discovered during uterine artery embolization for leiomyomata. J Vasc Interv Radiol 2002;13(9, Pt 1):939–941
46 Binkert CA, Hirzel FC, Gutzeit A, Zollikofer CL, Hess T. Superior hypogastric nerve block to reduce pain after uterine artery embolization: advanced technique and comparison to epidural anesthesia. Cardiovasc Intervent Radiol 2015;38(05):1157–1161
47 Yoon J, Toonsi F, Valenti D, Muchantef K, Cabrera T, Boucher L. Superior Hypogastric Nerve Block (SHGNB) as post uterine artery embolization (UAE) analgesia: a prospective, randomized, double-blinded study. Paper presented at: Annual Meeting of the Society of Interventional Radiology; March 8, 2017; Washington, DC
48 Kim SY, Koo BN, Shin CS, Ban M, Han K, Kim MD. The effects of single-dose dexamethasone on inflammatory response and pain after uterine artery embolisation for symptomatic fibroids or adenomyosis: a randomised controlled study. BJOG 2016;123 (04):580–587
49 Keyoung JA, Levy EB, Roth AR, Gomez-Jorge J, Chang TC, Spies JB. Intraarterial lidocaine for pain control after uterine artery embolization for leiomyomata. J Vasc Interv Radiol 2001;12(09): 1065–1069
50 Noel-Lamy M, Tan KT, Simons ME, Sniderman KW, Mironov O, Rajan DK. Intraarterial lidocaine for pain control in uterine artery embolization: a prospective, randomized study. J Vasc Interv Radiol 2017;28(01):16–22
51 Gupta JK, Sinha A, Lumsden MA, Hickey M. Uterine artery embolization for symptomatic uterine fibroids. Cochrane Database Syst Rev 2014;(12):CD005073
52 Barnard EP, AbdElmagied AM, Vaughan LE, et al. Periprocedural outcomes comparing fibroid embolization and focused ultrasound: a randomized controlled trial and comprehensive cohort analysis. Am J Obstet Gynecol 2017;216(05):500.e1–500.e11
53 Froeling V, Meckelburg K, Schreiter NF, et al. Outcome of uterine artery embolization versus MR-guided high-intensity focused ultrasound treatment for uterine fibroids: long-term results. Eur J Radiol 2013;82(12):2265–2269
54 Shlansky-Goldberg RD, Coryell L, Stavropoulos SW, et al. Outcomes following fibroid expulsion after uterine artery embolization. J Vasc Interv Radiol 2011;22(11):1586–1593

55 Radeleff B, Eiers M, Bellemann N, et al. Expulsion of dominant submucosal fibroids after uterine artery embolization. Eur J Radiol 2010;75(01):e57–e63
56 Mara M, Maskova J, Fucikova Z, Kuzel D, Belsan T, Sosna O. Midterm clinical and first reproductive results of a randomized controlled trial comparing uterine fibroid embolization and myomectomy. Cardiovasc Intervent Radiol 2008;31(01): 73–85
57 Torre A, Fauconnier A, Kahn V, Limot O, Bussierres L, Pelage JP. Fertility after uterine artery embolization for symptomatic multiple fibroids with no other infertility factors. Eur Radiol 2017;27 (07):2850–2859