Uterine Fibroid Embolization: Nonsurgical Treatment for Symptomatic Fibroids

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BACKGROUND: Earlier studies demonstrated the efficacy of uterine fibroid embolization (UFE). We seek to demonstrate the success of the procedure in a community hospital setting, and we attempt to identify patients likely not to benefit from embolization, if possible, before the procedure.

STUDY DESIGN: The study followed all women treated with UFE for menorrhagia or postmenopausal bleeding at a community hospital between 1997 and 1999. Relief of symptoms, ultrasound changes, and complications were documented. Six months after the procedure, analysis was performed on ultrasound and interview data from patients who underwent UFE. A smaller number of patients has been followed for 12 months and were available for the analysis. We examined characteristics of patients and procedures performed in an attempt to identify likely failures of treatment. We calculated complication and failure rates based on the entire group of patients.

RESULTS: From 183 patients who applied for UFE, 16 were excluded because of pathologic conditions found during preembolization evaluation; 167 women had an embolization, 163 were successfully embolized bilaterally, and 4 were embolized unilaterally because of technical failure. Eighty-eight percent of the patients (147 of 167 patients) reported an improvement or stabilization of symptoms 6 months after UFE. Forty-six patients followed for 12 months experienced myoma shrinkage of 37% (a significant shrinkage over 6 months, $p < 0.001$), and total uterine volume decreased 52%. Analysis of shrinkage data revealed no demographic or procedure variable associated with shrinkage. Six patients underwent hysterectomy (3.5%) after embolization, one as a result of postprocedure infection. Pain in the first 24 hours postprocedure affected almost all patients. Five percent of the patients passed submucous myomata after UFE; all these patients at risk were identified at preembolization hysteroscopy. Four patients experienced premature menopause after embolization early in the study. There were three criteria for failure, of which a patient had to meet only one: hysterectomy, $< 10\%$ shrinkage of myoma 6 months after UFE, or worsening symptoms after UFE. No variables of age or size of the uterus could be shown to predict failure. Patients who had undergone earlier pelvic surgery were more likely to fail UFE ($p = 0.012$).

CONCLUSIONS: Uterine fibroid embolization, an alternative treatment for myomas, offering low morbidity, can be performed in a community hospital setting. Eighty-eight percent of patients reported improvement or stabilization of symptoms. Total uterine volume decreased an average of 49% at 6 months after embolization. Shrinkage was unaffected by the size of the uterus, myoma, or patient characteristic before UFE. Longterm followup study reveals a significant continuing shrinkage of total uterine volume and myomata at 12 months. There has been no regrowth of fibroids. Earlier surgery was a factor predicting failure of UFE in our series. The risks to future fertility were small. (J Am Coll Surg 2001;192:95–105. © 2001 by the American College of Surgeons)

Uterine artery embolization (UFE) has been used to treat acute pelvic hemorrhage[1] associated with pelvic malignancy, postoperative bleeding,[2] and postpartum hemorrhage.[3-6]

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In the late 1980s, Ravina and coworkers[7] used embolization as a temporizing measure before myomectomy or hysterectomy. Many patients were spared surgery after uterine artery embolization when their myomata shrank.[8] UFE emerged as an alternative to surgery.[9-14] We evaluate UFE as therapy for uterine myomata conducted at a community hospital in Los Angeles. Some of these patients have been included in other published reports.[15] We attempt to identify patients not likely to benefit from UFE, either on demographic features, characteristics of the patient's uterus, or variables in the procedure of UFE.

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METHODS

All patients with menorrhagia or postmenopausal bleeding secondary to uterine myomata were accepted for this clinical prospective study. The study was conducted from April 1997 to August 1999. All patients underwent pelvic ultrasonography to measure the diameter of the largest myoma, and the total uterine volume (TUV) before UFE. Patients were offered traditional surgical techniques, or GnRH agonist therapy, as treatment for their myomata. Written informed consent was obtained before all embolizations. Consultation with the hospital human subjects committee was obtained before undertaking the study. Patients desiring future fertility were counseled about potential risks of UFE, including hysterectomy, radiation exposure, and premature menopause. Patients were excluded by contraindications to angiography and embolization, such as coagulopathy, pelvic inflammatory disease, diabetes mellitus, or vasculitis. Patients were screened by hysteroscopy, endometrial biopsy, and laparoscopy with a needle biopsy of the largest myoma. Findings at the time of preembolization evaluation could exclude patients.

Symptom evaluation was performed before embolization. Patients were asked to rate their bleeding symptoms using the following criteria: mild, menses lasting 3 to 4 days; moderate, passage of clots in 1 day, with menses lasting 4 to 6 days; severe, passage of clots 2 more days, menses lasting longer than 6 days, anemia requiring constant iron ingestion.

Patients described their pain symptoms using the following criteria: mild, ingestion of over-the-counter medication two or less times each menses; moderate, over-the-counter medication for more than 2 days, prescription analgesia for less than four doses per menses, or both; severe, requiring prescription analgesia for relief, more than four doses per menses.

Pressure was similarly categorized: mild, sense of urinary or bowel fullness only "occasionally" recognized; moderate, intermittent pain, but more than once per month, not requiring medication; severe, constant and required adjusting work or social schedule in order to urinate frequently, or use of laxatives or diet change to control constipation. Patients were interviewed 5 months after UFE. Improvement of symptoms was defined as going from severe or moderate symptoms to a lower category. Stabilization of symptoms was defined as remaining moderate or mild.

Ultrasonography was performed 6 weeks and 6 months after UFE. We measured follicle-stimulating hormone (FSH), complete blood counts, and clotting studies before and 6 months after UFE in all patients. A smaller group of patients was eligible for study 12 months after UFE and was evaluated using the same methods.

Results of ultrasonographic changes and interviews were compared with preembolization findings. Association between measures was given as a Pearson correlation coefficient.[16] Subgroups of patients are defined throughout the article (eg, successes versus failures, 300-versus 500-micrometer vial usage, etc). To determine significant differences between continuous measures within the subgroups, a Student's *t*-test was used. Prediction of fibroid shrinkage from various independent variables was analyzed using linear regression procedure. Stepwise multiple logistic regression analysis was used to assess the effect of several independent factors with the success or failure of the procedure.[17] A p value less than or equal to 0.05 was considered significant.

Definition of failure group

We created a failure group based on three categories: patients who underwent a hysterectomy, patients with less than 10% myoma shrinkage 6 months after UFE, and patients with worsening symptoms after UFE. A patient was considered a failure if she met only one criterion. Overlapping failure categories were counted as one. The failure group was then compared with those patients who succeeded after UFE. For purposes of this article, patients were considered a success if they did not meet the failure criteria. Statistical analysis was performed on all demographic characteristics of patients, size of the uterus, and fibroid pre-UFE, as well as procedure variables, using similar tests as described above.

Technique of uterine fibroid embolization

All patients received 60 mg of ketorolac and prophylactic intravenous antibiotics before UFE. During UFE, patients were managed by conscious sedation (fentanyl and midazolam). Imaging was recorded using digital subtraction technology. The most common technique used is described below.

The right groin was prepared and a right femoral arterial puncture was performed. A 5-F catheter and a guide wire were inserted and positioned at the level of the aortic bifurcation. The left common iliac artery was entered and then the left internal iliac was selectively catheterized. The catheter was positioned in the anterior

division of the internal iliac artery. Using digital subtraction road mapping, the left uterine artery was identified and often subselectively catheterized with a coaxially placed Tracker 325 microcatheter.

Under direct visualization, polyvinyl alcohol (PVA) particles were injected into the left uterine artery until stasis was obtained (Figs. 1 and 2). Subselective catheterization of the right uterine artery and free-flow UFE were performed on the right side. Right uterine artery catheterization was performed using a similar technique. The particle load for each procedure was calculated by dividing the TUV by the number of vials used.

After removal of the catheter and wire, hemostasis was achieved by direct compression for 15 minutes. To prevent bleeding, patients were confined to bed rest for 6 hours after UFE.

RESULTS

During the study period, 183 patients sought UFE. Sixteen patients were excluded because of conditions uncovered during the screening period (Table 1). A total of 167 women were embolized. Within our study, all the women treated with UFE ranged in age from 29 to 63 years, with an average age of 43 years for the entire group. Characteristics of the population are listed in Table 2.

No procedure was abandoned because of a complication. All but four patients (2%) were successfully embolized bilaterally. Of the four patients, three had one uterine artery that could not be cannulated, and one had an anomalous blood supply replacing one uterine artery.

Initially the particle size of PVA was 500 micrometer for UFE, and 108 procedures were performed with this size. Subsequently, we switched to a 300-micrometer particle PVA to obtain greater shrinkage. Sixty patients were embolized with the smaller size. Each vial of PVA contains approximately 1 cm^3 dry volume of particles. The number of vials of particles used was calculated for each patient. The number of vials of 300- and 500-micrometer particles used were not statistically different ($p = 0.22$) (Table 3).

We calculated the particle load by the number of PVA vials used per liter of uterus embolized (range 0.4–17.1 vials/L). Particle load was not associated with either the TUV ($r = 0.038$, $p = 0.638$) or diameter of largest myoma ($r = 0.025$, $p < 0.672$). But a wide variation in the vascularity of myomas was noted (Fig. 3).

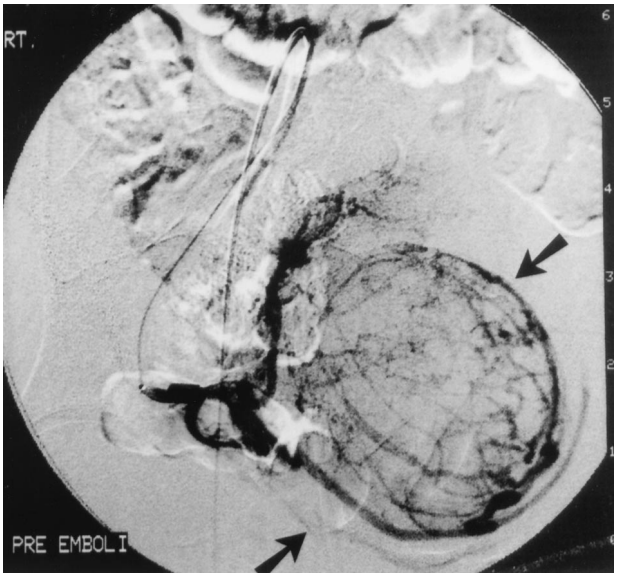

Figure 1. Contrast injection through left uterine artery. (Arrows outline the blood vessel supply of the myoma.)

Ultrasonographic changes

Before UFE, all patients underwent pelvic ultrasonography, most with the same observer and equipment. A correlation was found between the diameter of the largest fibroid and TUV; the larger the initial TUV, the larger the initial fibroid size ($r = 0.622$, $p < 0.001$).

The size of the uterus before UFE, measured by TUV and diameter of the largest myoma, was compared with shrinkage at 6 weeks, 6 months, and 12 months after the procedure.

Figure 2. View of the same artery after uterine fibroid embolization. No distal flow is noted. (Arrow points to catheter tip.)

Table 1. Patients Excluded Because of Preembolization Screening

Condition	n	How discovered
Sarcoma	3	Laparoscopy
Adenocarcinoma, endometrium	1	Hysteroscopy
Active salpingitis	5	Laparoscopy
Tubo-ovarian abscess	2	Laparoscopy
Solid ovarian tumor	1	Laparoscopy
Atypical hyperplasia	4	Hysteroscopy

Analysis of 6-month changes

We analyzed the changes in the group of 98 patients followed with ultrasonography at 6 months. We evaluated the shrinkage of myoma, comparing it with demographic variables of the patients, characteristics of the uterus and myoma pre-UFE, and variables of the procedure. No association was noted between shrinkage and any of these factors. Twelve patients presented to us with a history of depo-leuprolide use within 6 months before UFE. Use of this drug did not impact shrinkage negatively or positively. Comparing ultrasonographic data before use of leuprolide and 6 months post-UFE, no additional shrinkage was obtained (Tables 4, 5).

Longterm followup

Forty-six patients (27%) have been followed for more than 12 months. The rest have been lost to followup. There was progressive TUV shrinkage (52%) in relation to shrinkage at 6 months (49%). In this group of 46 patients with both 6- and 12-month followup ultrasonography, myoma shrinkage was significantly greater at 12 months (37%) when compared with 6 months (31%) ($p < 0.001$). No new growth of myomata after 12 months was seen on ultrasound.

Relief of symptoms

Of 167 patients embolized, 150 (89%) were contacted at 5 months postembolization by telephone. A total of 123 (82%) reported an improvement of menorrhagia 6 months post-UFE. But spotting for the first month after UFE was a common complaint (53%). Eighty-nine percent of the patients (133 of 150) who responded had additional complaints of pain and pressure before UFE. Seventeen percent (25 of 150) of the patients who responded reported relief of symptoms beginning almost immediately after UFE. Eighty-eight percent reported an improvement or stabilization of menorrhagia at the 5-month postembolization questionnaire. In addition, 87% of the patients (131 of 150) who responded to the questionnaire would recommend UFE to others. By the failure criteria of worsening symptoms after UFE, seven patients were included in the failure group.

Table 2. Patient Characteristics

Characteristics	n
n	167
Average age (y)	43
Menopausal	2
Gravidity	1.2
Parity	0.7
Symptoms	
Menorrhagia	166
Postmenopausal	2
Bleeding, pain, pressure	161
Earlier depo-leuprolide therapy	12
Earlier surgeries	
Myomectomy	16
Caesarean section	7
Ovarian cystectomy	3
Hysteroscopy	8
Laparoscopy	17

Table 3. Procedure Variables

Variable	Average	Range
Vials of polyvinyl alcohol used	3.2	0.5–17
300-micrometer vials (60 patients)	2.9	1.25–17
500-micrometer vials (108 patients)	3.3	0.5–15
Particle load (vials/L)	3.1	0.4–17.1

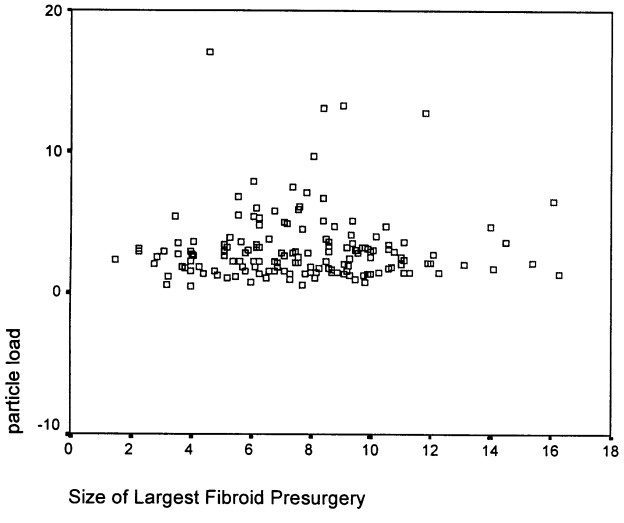

Figure 3. Correlation of particle load to the size of the largest fibroid.

Table 4. Ultrasonographic Changes (Without Lupron)

Time of ultrasonography	n	TUV (mL)	Range (mL)	% Reduction	p Value compared with lupron	Myoma (cm)	Range (cm)	% Reduction	p Value compared with lupron
Before UFE	155	1,389	117–8,804			7.8	1.5–16.3		
6 wk after UFE	125	864	102–4,640	36	0.28	6.1	1.1–14.2	23	0.42
6 mo after UFE	98	619	75–3,474	49	0.49	5.4	1.8–13.7	31	0.54
12 mo after UFE	46	608	103–3,716	52	0.44	5.0	1.4–11.0	37	0.9

TUV, total uterine volume; UFE, uterine fibroid embolization.

Morbidity

Pain

Pain was not noted by any patient during the procedure, but began almost immediately after the second uterine artery had been embolized. Almost all patients complained of postprocedure pain.

Of the total group, 119 patients (71%) were observed overnight for pain control. Seven patients were readmitted for pain control within the first week post-UFE. Most patients were able to return to work 1 week after UFE. Several patients described intermittent pains resembling severe dysmenorrhea, which required treatment with nonsteroidal antiinflammatory drugs, and could last as long as a month after UFE.

Radiation exposure

We calculated the radiation exposure to the ovaries in a random group of 50 consecutive patients. During UFE, patients received radiation exposure with both fluoroscopy and digital subtraction imaging. The average radiation exposure to the ovaries was approximately 0.9 to 1.1 rads per minute using our angiographic imaging system (GE Medical Systems Advantx Digital Processor). Average radiation exposure was 14 minutes (6.4–45.8 minutes), giving the patients an average exposure of 14 rads (5.9–51.7 rads).

Fever

As shown in Table 6, 12 (7%) patients reported a temperature rise after UFE. Eight called the physician as instructed. Three patients were readmitted to the hospital for evaluation of temperature source. Complete blood counts from all patients showed leukocytosis, often with a marked left shift of the differential blood count. Blood cultures were negative in all but one patient. Urine cultures were negative in all patients. After initial experience, we managed most patients complaining of post-UFE fever as outpatients, and did not use prophylactic antibiotics during fever workups. CT images of the pelvis were obtained in patients complaining of post-UFE fever. A common finding was the presence of air bubbles within the embolized myomas. As seen in Figure 4, these bubbles were artifacts from the UFE, and not related to the presence of gas-forming organisms. The presence of fever was not related either to the number of vials used for UFE ($r = 0.016$, $p = 0.855$), the particle size used ($r = 0.154$, $p = 0.064$), or the pre-UFE volume of the uterus ($r = 0.089$, $p = 0.29$). One patient did experience sepsis after UFE and will be described under the section on hysterectomy.

Two patients (1%) complained of nausea and vomiting and pain or fever during readmission to the hospital after UFE. This symptom was transient. Gastrointestinal workup was negative in all patients. But three patients were evaluated by laparoscope for persistent abdominal pain at least 6 months after UFE. All three of these patients suffered from filmy pelvic adhesions around pedunculated subserous myomas. These patients had neither additional disease nor adhesions before UFE.

Table 5. Ultrasonographic Changes (with Lupron)

Time of ultrasonography	n	TUV (mL)	Range (mL)	% Reduction	Myoma (cm)	Range (cm)	% Reduction
Before	12	1,404	393–3,002		7.5	3.3–10.6	
6 wk after UFE	9	1,077	229–1,652	21	6.7	2.4–10.0	18
6 mo after UFE	6	818	175–1,296	42	6.0	3.1–8.0	27
12 mo after UFE	2	503	307–623	56	5.9	5.9	34

TUV, total uterine volume; UFE, uterine fibroid embolization.

Table 6. Post-Uterine Fibroid Embolization Complications

Complication	n	%
Fever	12	7.0
Nausea/vomiting	2	1.0
Passage of submucous myoma	8	5.0
Premature menopause	4	2.4
Hysterectomy	6	3.5

Passage of submucous myomas

Eight patients (5%) passed necrotic submucous myomas after UFE (Fig. 5). The symptoms surrounding passage of the tissue included discharge (often purulent or clear in nature), crampy pelvic pain, return of menorrhagia after a period of normal menses, and, less frequently, urinary retention. Timing of the passage of myomas varied from 2 weeks to 12 months after UFE. Of the 8 patients who passed necrotic tissue, 7 (88%) were among the 29 patients noted to have pedunculated submucous myomas at pre-UFE hysteroscopy. One patient who passed a necrotic myoma was noted to have a sessile submucous myoma at pre-UFE hysteroscopy. Five patients passed necrotic tissue without notifying the physician. Three patients required a vaginal myomectomy to complete the process of passage. The purulent discharge never grew an organism on culture. After removal of the necrotic myoma, discharge persisted as long as one month. Of note, 99 patients with submucous myomas seen at hysteroscopy before UFE apparently absorbed their myomas without symptoms, including 22 patients with a pre-UFE pedunculated submucous myoma noted.

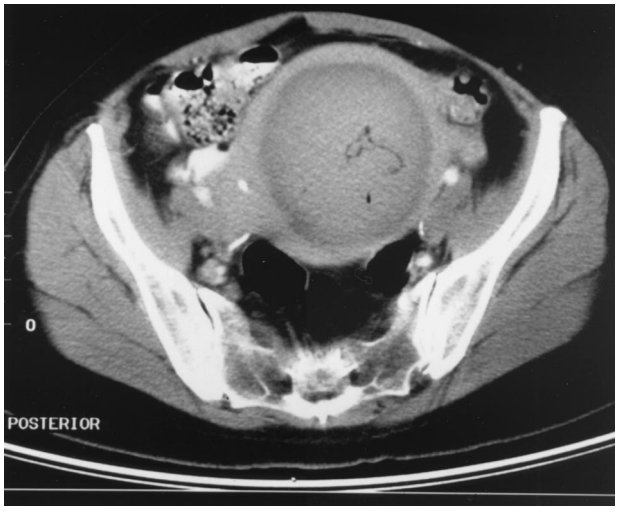

Figure 4. MRI taken one day after uterine fibroid embolization. Artifactual air bubbles are noted inside of myoma.

Premature menopause

Several patients reported up to 4 months of transient oligomenorrhea after UFE. Four patients (2.4%) with premenopausal levels of FSH before UFE developed menopausal levels at their 6-month checkup. All were more than 45 years old. One patient with elevated FSH post-UFE continues to experience menses and has no menopausal symptoms. After noting the four patients, we changed the technique of free-flow embolization. We did not continue injecting until stasis was obtained. Rather, when resistance was noted to the injection of PVA, the radiologist waited several minutes. A repeat contrast injection generally revealed devascularization. Since adopting this technique, no further FSH change has been noted.

Hysterectomy

Six patients (3.5%) underwent hysterectomy after UFE. The pathologic findings, in addition to fibroids for these patients, are listed in Table 7 (patients may have more than one finding).

One patient underwent hysterectomy as a result of post-UFE infection, and the other patients underwent hysterectomy after 6 months post-UFE. Four patients in the hysterectomy group had earlier surgery. Four had associated pelvic pathology noted at pre-UFE laparoscopy. Two patients underwent hysterectomy for reasons not directly related to their myomata. One of the patients, who had a unilateral embolization because of a previously ligated hypogastric artery, did not respond to embolization. There was no statistically significant difference in the pre-TUV of patients who underwent hysterectomy versus the entire sample ($p = 0.688$). Average myoma shrinkage in the hysterectomy group was 31%, and the average shrinkage in TUV was 37%. Two patients who underwent hysterectomy indicated they would recommend UFE to others. All six hysterectomy patients were placed in the failure group.

Failure analysis

As shown in Table 8, of the 167 patients, 21 (13%) were considered failures: 6 who underwent hysterectomy, 6 with shrinkage of $< 10\%$, and 13 patients with worsening symptoms after UFE (several patients overlapped categories, leaving the above-mentioned failure group). We then compared the failure group with the success group. For the purposes of this analysis, patients not in the failure group were considered successes.

We analyzed patient demographic characteristics such

Figure 5. Abscess seen on MRI in patient who ultimately underwent a hysterectomy for infection after uterine fibroid embolization.

as age, parity, menopausal status, earlier surgery, findings at the time of laparoscopy, and characteristics of the patient's uterus. The occurrence of earlier surgery is related to failure ($p = 0.01$). Next we compared the failure with the UFE procedures, size of particles used ($p = 0.785$), and particle load ($p = 0.057$). No procedure variable could be associated with failure. Last, we compared complications after UFE with the success and failure groups and could not associate any postprocedure event with failure.

DISCUSSION

Relief of symptoms

Ninety-two percent of patients reported stabilization or improvement in menorrhagia 6 months after UFE. This is similar to the 88% reported by Ravina and colleagues.[8] Of the patients suffering from pain and pressure, 69.7% reported pain relief. In the group with continuing pain, two had severe adhesions noted at pre-UFE laparoscopy, two had severe endometriosis, and seven had earlier surgery.

Shrinkage in TUV and individual myomata was comparable to the results of Ravina and colleagues and others[8,18-20] (Fig. 6). Our patients experienced similar shrinkage compared with Ravina and colleagues' patients and others. One group measured pre- and post-TUV as calculated by CT.[18] This gives a more accurate assessment of size than ultrasonography, but is more costly, and exposes the patients to radiation. The CT-measured group was only followed at 3 months post-UFE, but their measurements are within the range of ultrasonographically-measured groups.

Of interest, three patients could not be embolized because of uterine artery anomalies on one side. These patients show shrinkage similar to bilateral UFE—TUV decrease of 49% and myoma decrease of 48%—and relief of symptoms. Unilateral UFE in general has not been shown to be successful when unilateral catherization was a result of spasm or inability to cannulate an artery.[5] Perhaps patients with unilateral uterine anomalies will respond similarly to patients with bilateral embolization. Our one patient with a previously ligated hypogastric artery who underwent unilateral embolization was a failure. Sixteen patients had undergone myomectomy before UFE. Other studies suggest that approximately 30% of patients will experience new myoma growth after myomectomy. At least 10% will require further surgery.[21,22] Although it is still too

Table 7. Hysterectomy after Uterine Fibroid Embolization

Findings	n
n	6
Adhesions	2
Endometriosis	3
Adenomyosis	4
Unknown	1

Patients may have more than one finding.

Table 8. Failure Analysis

Variable	Success	Failure	p Value
Age (y)	43.18	42.57	0.49
Menopausal status	6.7%	16.7%	0.334
Parity	0.7	0.23	0.14
Earlier surgery	5%	20%	0.01*
Associated pathology noted at time of laparoscopy	40.54%	21.42%	0.53
Adenomyosis	16.78%	7.14%	0.12
TUV pre-UFE	1,373 mL	1,600 mL	0.55
TUV 6 months post-UFE	629 mL	698 mL	0.72
>5 PVA vials used	3.07	4.17	0.49
Size of largest fibroid pre-UFE	7.77 cm	8.08 cm	0.70
Particle load	3.02	4.37	0.06
500-micrometer vials used	35%	38%	0.79
Pelvic pain	34%	36%	0.89

*Statistically significant.
PVA, polyvinyl alcohol; TUV, total uterine volume; UFE, uterine fibroid embolization.

early to speak with authority about recurrence after UFE, we would have expected some patients to experience recurrence of fibroids in the time period of this study. Of special significance, two patients who delivered a term pregnancy after UFE underwent ultrasonography at 4 months postpartum. Their results show persistent decrease of largest myoma and a decrease of TUV postpartum.

Pain

Patients experienced pain after UFE, often being severe and requiring narcotic analgesia. It appears to be the same type of ischemic pain reported for patients undergoing embolization in other parts of the body.[23,24] A total of 119 (71%) patients were discharged within 24 hours of UFE. Patients who had undergone earlier myomectomy noted a significant decrease in pain compared with laparotomy, and a rapid return to work or home life. We advise patients to plan for a week off work after UFE.

Fever

Seven percent of our patients reported a post-UFE temperature elevation. All patients experienced this complication within the first 4 days after UFE. Like pain, fever is a component of postembolization syndrome.[1,14,15] The leukocytosis is often impressive, above 20,000, with a marked shift in the differential WBC count. Our one patient who did develop sepsis after UFE had an extremely large TUV before UFE (7,932 mL). We no longer attempt complete stasis of arterial flow in patients with very large (>2,500 mL TUV) uteri, and have not experienced another infection. Other centers have reported a higher number of patients suffering from post-

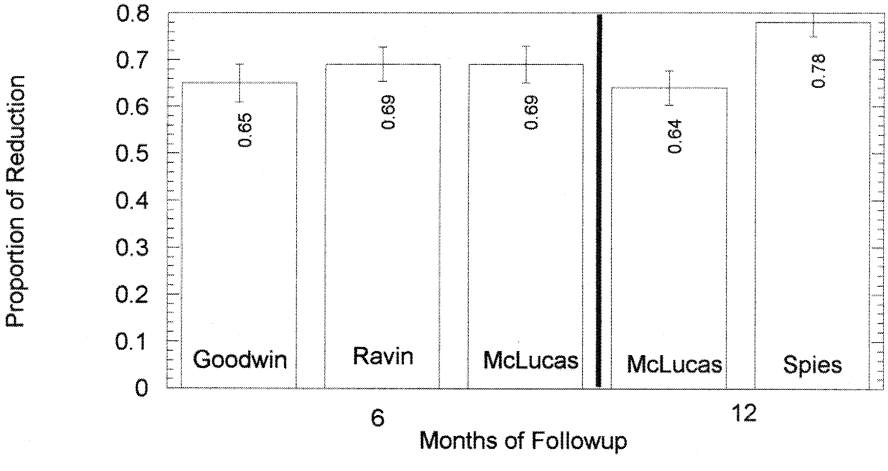

Figure 6. Reduction of the largest fibroid size from different centers.

UFE syndrome.[20] In our series pre-UFE laparoscopy screening was helpful in avoiding this complication. Seven patients were found to have active pelvic infections and treatment by UFE was delayed until resolution. Nonetheless, physicians performing UFE must aggressively pursue any temperature rise, especially one that develops after an elapsed time period. One mortality at another center, secondary to sepsis, has been reported following UFE.[25] Anaerobic organisms can cause the necrotic myoma to actually split the serosa in such cases (Fig. 7). Prompt surgery should prevent such mortalities.[26]

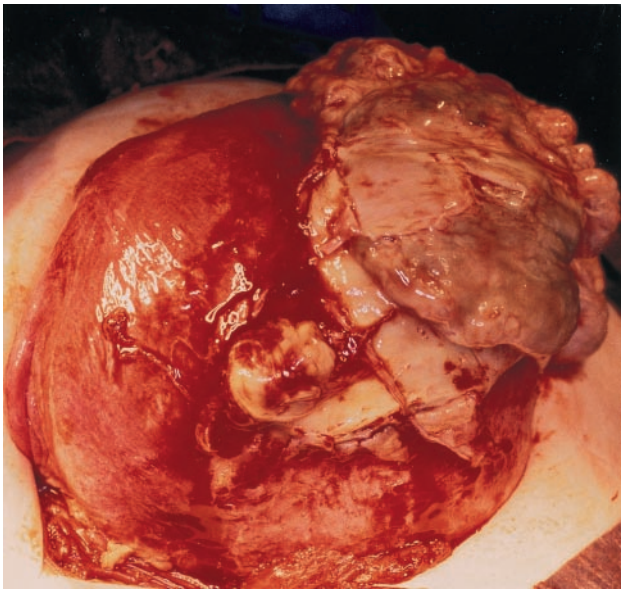

Figure 7. Necrotic myoma. Anaerobic organisms can cause the necrotic myoma to actually split the serosa.

Value of preoperative endoscopy

One advantage of UFE is its performance under sedation, avoiding general anesthesia or epidural required during laparotomy. Hysteroscopy can be performed in an office setting and is no more invasive than balloon ultrasonography. Hysteroscopy can predict the likelihood of myoma prolapse by detecting pedunculated submucous myomas before UFE. Of 29 patients with hysteroscopy-proved pedunculated submucous myomas, 7 (24%) passed their myomas vaginally after the procedures. Our patients with pedunculated submucous myomas are given special warning instructions after UFE; they are instructed to call at any time with the appearance of vaginal discharge, cramping, or return of bleeding after a period of normal menses (Fig. 8).

Depending on the size of the submucous myoma and the situation of the patient, expectant management may be elected, or vaginal myomectomy chosen. Several other centers have reported similar expulsions of submucous myomata after UFE.[27,28] Hysteroscopy-aided biopsy detected six patients with endometrial hyperplasia. These patients would not be candidates for UFE as a stand-alone procedure. All have been followed with monthly progestagen therapy; endometrial biopsy is normal in all patients. One patient with endometrial adenocarcinoma was excluded from the study altogether.

Patients with adenomyosis appear to be at higher risk for failure from UFE, whether as an only disease process or associated with myomata.[29] So, in patients with physical examination and ultrasonographic changes suggestive of adenomyosis, further studies are done. MRI studies of the pelvis, and resectoscope biopsy of the myometrium using the technique suggested by McCausland,[30] were used to confirm the diagnosis. Patients with coexistent myomata and adenomyosis were given a lower success rate of 50%, based on the number of our hysterectomy patients after UFE with adenomyosis and the results of other centers.[18]

It would be beneficial to eliminate screening laparos-

Figure 8. Myoma protruding from vagina at time of vaginal myomectomy after uterine fibroid embolization.

copy, a procedure usually requiring general anesthesia. Failure of UFE was associated with earlier surgery and other pelvic disease. Embolization of the uterine arteries will not positively impact adnexal disease, and may indeed aggravate pelvic inflammatory disease, and put increased pressure on pelvic adhesions during myoma shrinkage. We are now forgoing laparoscopy in selected patients: women with uteri less than 16 cm in height, slow-growing myomata, without a history of other pelvic disease or surgery, and no adnexal findings on pre-UFE ultrasound and pelvic examination. Patients who were excluded from UFE by virtue of acute infection or malignancy found at laparoscopy would require a screening protocol of similar sensitivity, which would also remove them from the UFE. No screening test, including Doppler flow ultrasonography has been demonstrated to identify sarcoma.

Fertility

Patients considering future fertility need to be counseled concerning the small risk of premature menopause after UFE. In our series of 168 patients, four women older than 45 years developed menopausal levels of FSH within 6 months of UFE. After adopting the injection technique changes noted in the body of this article, this complication has not recurred. But the interventional radiologist must rule out an anastamosis to the ovarian artery from the uterine artery before injection of PVA. Radiation exposure to the ovaries was not significant in our series. The average radiation exposure of 14 rads during UFE should be compared with the 6-rad exposure of a barium enema, or 2-rad exposure of a hysterosalpingogram. The proficiency of the radiologist plays an important factor in the time consumed under fluoroscopy and subsequent radiation exposure. In addition, the patient desiring fertility should also be informed of the chance of hysterectomy as a complication of UFE. This information may be given in light of risk factors increasing hysterectomy, such as TUV $>$ 2,500 cc, and earlier surgery. Myomata are not considered impediments to fertility, but rather predisposing factors for pregnancy loss. Both of our patients who conceived did so without additional aided reproductive techniques after UFE. Both patients experienced uncomplicated pregnancies, confirming reports of successful pregnancy after UFE from other centers.[31] Because myomata shrink only an average of 40%, the persistence of myomata may play a role in the relatively high percentage of women with breech presentation and cephalopelvic disproportion during delivery. Fertility rate after UFE must be compared with patients who had undergone either myomectomy by laparotomy (40%),[21] hysteroscopy[32] (35%), or laparoscopy[33] (38%).

When comparing UFE with myomectomy as a procedure for fertility, we must consider the known impediments to fertility of myomectomy—adhesion formation, new growth of myomata, and the risk of hysterectomy. Uterine rupture may occur after myomectomy, whichever approach is chosen.[34] In addition, most women who have had a myomectomy must undergo cesarean section.

In conclusion, uterine fibroid embolization is a proven method for treatment of myomata, which can be satisfactorily performed in the community hospital setting. There have been no reports of recurrence, suggesting the permanence of this nonsurgical procedure. Our group demonstrated continuing shrinkage of the largest myoma at 12 months.

No demographic or fibroid characteristic pre-UFE could predict failure. Defining failures as patients who underwent hysterectomy, those having $<$10% TUV shrinkage, and those whose symptoms worsened, our group achieved a success rate of approximately 88%. It is possible that UFE will be shown to offer better overall results than myomectomy with known morbidity of hemorrhage, adhesion formation, and infection.[35-37] Although pain and postoperative fever are common complaints for patients post-UFE, these side effects are minor when compared with the morbidity of surgical procedures. In fact, earlier surgery was noted to be a risk of failure in our population. UFE should be offered to patients as a first therapy. Risks to the UFE patient appear to be less than hysterectomy.[38-40]

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