Pregnancy After Uterine Artery Embolization for Leiomyomata: The Ontario Multicenter Trial

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OBJECTIVE: To report on pregnancies and deliveries occurring in a large cohort of women who underwent uterine artery embolization instead of surgery for symptomatic leiomyomata.

METHODS: A total of 555 women underwent uterine embolization in a multicenter clinical trial. The primary embolic agent was 355–500 μm polyvinyl alcohol particles with treatment end-point as bilateral stasis in the uterine arteries. Women desiring pregnancy were informed of the uncertain effect of embolization on fertility and pregnancy. Average age at embolization was 43 years (range 18–59 years). Thirty-one percent were younger than age 40 years. Women were followed up prospectively by telephone, and obstetric records of the women who conceived were reviewed.

RESULTS: Twenty-one women of average age 34 years (range 27–42 years) conceived, (3 of these twice), and 13 women were nulliparous. Twenty-three of the 24 pregnancies were conceived spontaneously (1 woman had in vitro fertilization). There were 4 spontaneous abortions (16.7%, 95% confidence interval 5.4–41.9%) and 2 elective pregnancy terminations. Fourteen of the 18 live births were full term and 4 were preterm. There were 9 vaginal deliveries and 9 cesarean deliveries, 4 of which were elective. Abnormal placentation occurred in 3 cases, all nulliparas (12.5% 95% confidence interval 3.1–36.3%). Two cases developed placenta previa (1 had a clinical partial accreta) and the third developed a placenta membranacea with accreta resulting in cesarean hysterectomy. Three postpartum hemorrhages all secondary to placental abnormalities occurred. Four newborns were small for gestational age (≤ 5th percentile); 2 of these pregnancies were complicated by gestational hypertension.

CONCLUSION: Women are able to achieve pregnancies after uterine artery embolization, and most resulted in term deliveries and appropriately grown newborns. Close monitoring of placental status, however, is recommended. (Obstet Gynecol 2005;105:67–76. © 2005 by The American College of Obstetricians and Gynecologists.)

LEVEL OF EVIDENCE: II-3

Uterine artery embolization has now been shown in several large cohort studies to be an effective treatment for symptomatic uterine leiomyomata.[1–7] The therapeutic effect of uterine embolization is thought to result from unrecoverable postembolic ischemic change within the leiomyomata leading to leiomyoma necrosis and volume reduction with subsequent improvement in menorrhagia, bulk (pressure) symptoms, and dysmenorrhea. Many patients with large symptomatic leiomyomata opting for uterine embolization also desire to maintain their fertility.

The efficacy of uterine embolization in the management of pelvic hemorrhage, both obstetric and gynecologic has been well documented[8–10.] Successful pregnancy outcomes have been reported after embolization for obstetric hemorrhage,[11,12] gestational trophoblastic tumors,[13] arteriovenous anomalies of the uterus,[14,15] and cervical ectopic pregnancy.[16–18]

There is little published on the effect of uterine embolization for symptomatic leiomyomata on fertility and pregnancy. In addition to this study there have been only 4 case reports[19–22] and 5 clinical studies,[23–28] involving a total of 58 pregnancies in women undergoing uterine embolization for symptomatic leiomyomata. Uterine embolization continues to be offered primarily as a treatment alternative to hysterectomy to women with symptomatic leiomyomata. The use of embolization for fertility preservation, however, is rapidly becoming an issue, as more women of child-bearing age elect for transcatheter management of their symptomatic leiomyomata. To date, most centers have advocated a cautious approach in dealing with these patients and have generally advised against uterine embolization until more is known.

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Funded in part by the Boston Scientific Corporation.

0029-7844/05/$30.00
doi:10.1097/01.AOG.0000149156.07061.1f

This study evaluated the pregnancies occurring in a large cohort of women undergoing uterine embolization as an alternative to hysterectomy for symptomatic leiomyomata in a prospective multicenter clinical study (the Ontario Uterine Fibroid Embolization Trial).[7] The objectives of that study were to evaluate the safety, effectiveness, and durability of embolization. The desire for fertility was not an exclusion criterion for the study, and pregnancies were identified during our ongoing prospective follow-up interviews. These patients formed the basis of this study.

MATERIALS AND METHODS

Patients underwent uterine artery embolization in a prospective multicenter single-arm clinical treatment trial encompassing the practices of 11 interventional radiologists in 8 Ontario hospitals. Between November 1998 and November 2000, 555 women underwent uterine embolization for symptomatic leiomyomata and were enrolled in the study. Institutional Review Board approval for the study was obtained at all sites, and informed consent was obtained from patients before treatment. The average age of women in our study was 43 years (range 18–59 years). Thirty-one percent were aged less than 40 years, and 50% were nulliparous. The desire for fertility retention was not an exclusion criterion, and women were informed about the lack of information about the safety of undertaking pregnancy after uterine embolization. More complete details of the characteristics of the Ontario cohort have been reported elsewhere.[29]

Uterine artery embolization was performed with polyvinyl alcohol particles sized 355–500 μm as the primary embolic agent, with an embolization endpoint of complete stasis in the uterine arteries. Bilateral embolization was performed in 97% of the cases. Complete technical details on the procedure have been reported elsewhere.[30]

Patients were followed up with telephone interviews and ultrasonography at 2 weeks, 3 months, 6 months, and planned annually for 5 years. At the end of the study period, the 1-year and 2-year follow-up interview rates for the entire cohort were 91% and 84%. At telephone follow-up interviews, patients were asked whether they had been trying to achieve pregnancy and whether they had been successful. Women reporting pregnancies were sent additional consent forms for release of their obstetric records from physician offices and hospitals.

Because the study was not originally designed to evaluate fertility or pregnancy outcomes, we did not obtain detailed reproductive histories, investigate infertility factors, or measure gonadotropin levels. Maternal age, parity, prior myomectomy, and duration (months) from embolization to conception were noted, along with antepartum complications. Pregnancy details included management setting (teaching or community hospital), attending physician (obstetrician, family doctor), planned and actual mode of delivery, and indications for cesarean delivery. Peripartum complications were noted.

Neonatal outcome measurements included gestational age (preterm $<$ 37 weeks), sex, birth weight, Apgar scores, and birth weight percentiles for gestational age. Low birth weight (LBW) was defined as less than 2,500 g, and very low birth weight (VLBW) was defined as less than 1,500 g.[31] Percentiles for birth weights were determined by linear interpolation using birth weight gestational age charts for male and female singletons based on the Canadian population.[32] Small for gestational age (SGA) was conservatively defined as those birth weights at or below the 5th birth weight percentile for gestational age. Exact confidence intervals (CI) for proportions based on number of women achieving pregnancy were calculated using StatXact software (Cytel Software, Cambridge, MA).

RESULTS

During our follow-up period after embolization, 24 pregnancies occurred in 21 women (Table 1). Three patients became pregnant twice. Average age at embolization of this group was 34 years (range 31–42 years). Eleven patients were white, 7 were African American, and 3 were Asian. Thirteen were nulliparous and 6 were nulligravida. Twelve patients had prior spontaneous abortions, and 2 had histories of recurrent miscarriages (4 and 9 spontaneous abortions, respectively).

Three patients (all nulliparous) had prior myomectomies and 1 of these (gravida 2, para 0) had 2 prior myomectomies. At embolization, all patients had dominant transmural leiomyomata, and all except for 1 measured 5 cm or greater in diameter (range 3–12 cm) (Table 2). The average number of leiomyomata per uterus was 3. The average uterine volume was 426 mL (standard deviation 320). Postembolization leiomyoma volume reduction averaged 46% (standard deviation 22%). No patients underwent magnetic resonance imaging before pregnancy to evaluate the integrity of the uterine wall. After embolization, menstruation resumed at the first cycle in all but 2 patients, whose menstruation resumed at the second cycle.

Twenty-three pregnancies were spontaneous and 1 (in a patient who had had 2 previous myomectomies) was achieved by in vitro fertilization. The pregnancies resulted in 18 live births, 4 spontaneous abortions (16.7%, 95% CI 5.4– 41.9%) and 2 elective terminations (1 for Trisomy 18 and 1 for an unplanned pregnancy). Of the

Table 1. Characteristics of Women Achieving Pregnancy After Leiomyoma Embolization

Pregnancy Number	Age at Embolization	Race	Parity	Health Status	Prior Myomectomy	Delivery Status
P1	27	W	Gravida 4, para 0	VG	. . .	LB
P2	28	AA	Gravida 2, para 0	VG	. . .	LB
P3	2nd	. . .	. . .	. . .	. . .	LB
P4	30	A	Gravida 2, para 1	NVG	. . .	LB
P5	30	W	Gravida 0, para 0	VG	. . .	LB
P6	33	W	Gravida 0, para 0	VG	1	SA
P7	33	AA	Gravida 1, para 1	G	. . .	LB
P8	33	W	Gravida 1, para 0	NVG	. . .	LB
P9	34	W	Gravida 2, para 0	E	. . .	LB
P10	34	AA	Gravida 0, para 0	VG	. . .	LB
P11	35	AA	Gravida 2, para 0	VG	. . .	LB
P12	35	W	Gravida 2, para 0	E	2	LB*
P13	2nd	. . .	. . .	. . .	. . .	SA
P14	35	AA	Gravida 4, para 3	NVG	. . .	LB
P15	2nd	. . .	. . .	. . .	. . .	LB
P16	36	W	Gravida 1, para 0	NVG	. . .	LB
P17	36	W	Gravida 3, para 2	VG	. . .	LB
P18	36	A	Gravida 0, para 0	VG	. . .	SA
P19	36	AA	Gravida 1, para 1	E	. . .	TA
P20	36	W	Gravida 4, para 2	VG	. . .	LB
P21	37	W	Gravida 2, para 1	G	. . .	LB
P22	37	AA	Gravida 9, para 0	G	. . .	LB
P23	38	A	Gravida 0, para 0	G	. . .	SA
P24	42	W	Gravida 0, para 0	VG	1	TA

W, White; AA, African American; A, Asian; NVG, not very good; G, good; VG, very good; E, excellent; LB, live birth; SA, spontaneous abortion; TA, therapeutic abortion.

* Pregnancy in vitro fertilization–assisted.

18 births, 14 were term and 4 were preterm (1 woman had 2 preterm deliveries). The average time from embolization to conception was 15 months (range 2–42 months). Ten occurred within the first year, 7 within the second year, 5 within the third, and 2 within the fourth year after embolization. The spontaneous abortions occurring in 4 patients 7, 12, 30, and 35 months after embolization, did not seem to be related to the duration to conception after embolization. The ages and (parity) of these patients were 34 (gravida 0, para 0), 37 (gravida 0, para 0), 38 (gravida 2, para 0), and 39 (gravida 0, para 0) years.

Twenty-one pregnancies were managed by obstetricians and 3 by family doctors. Care was more likely to be provided in a community hospital (n = 16) than a teaching hospital (n = 8). Pregnancies were uneventful except for 2 patients who required admission early in the third trimester for antepartum hemorrhage secondary to placenta previa. There were no complications related to leiomyoma growth or ischemic degeneration or breakdown. One patient in our study had a pregnancy before embolization complicated by red (ischemic) degeneration that resulted in the patient being hospitalized for several months to manage pain. Her pregnancy after embolization, like the others in our study group, was uneventful. Four patients in the group developed gestational hypertension, and 2 were delivered preterm.

The average age at delivery was 36 years (range 29–42 years). A trial of labor planned for 14 of the pregnancies resulted in 9 vaginal deliveries (7 spontaneous and 2 induced) and 5 cesarean deliveries (Fig. 1). The 2 labor inductions were for a postdate pregnancy and gestational hypertension. The indications for the 5 cesarean deliveries after a trial of labor were nonreassuring fetal heart rate tracing (n = 3), failure to progress (n = 1), and failed induction of labor (n = 1). The indications for the 4 elective cesarean deliveries involved prior myomectomy (n = 1), repeat cesarean delivery (n = 1), and antepartum hemorrhage (n = 2), both secondary to placenta previa.

Overall 3 pregnancies (12.5%, 95% CI 3.1–36.3%), all nulliparas, were complicated by abnormal placentation. Two patients aged 35 and 36 years had complete placenta previa. Neither had undergone prior myomectomy. Both were admitted and delivered early in the third trimester because of antepartum hemorrhage. Clinically, 1 of these patients (pregnancy 9) had a small area of placenta accreta in the vicinity of the cervix. The placenta was left in situ on this area. The other patient (pregnancy 8) underwent an inverted T incision due to

Table 2. Uterine Leiomyoma Disease in Women Achieving Pregnancy After Embolization

Pregnancy Number*	Number of Leiomyomata (Involvement)	Leiomyoma Length† (cm)	Leiomyoma Location	Uterine Volume (mL)	Leiomyoma Volume Reduction (% at 3 mo)
P1	1 (moderate)	8.1	IM	451	24
P2	3 (extensive)	6.8	IM, SS	294	49
P4	1 (extensive)	8.0	IM	367	60
P5	2 (moderate)	2.7	IM	143	60
P6	> 5 (extensive)	5.2	SS	389	55
P7	> 5 (extensive)	7.0	IM, SS	1045	16
P8	> 5 (extensive)	8.5	SS	982	22
P9	3 (extensive)	9.9	IM	314	91
P10	3 (extensive)	4.8	IM	387	44
P11	> 5 (extensive)	7.8	IM	791	59
P12	2 (extensive)	8.9	IM, SS	267	89
P14	1 (minimal)	5.3	IM, SS	96	37
P16	1 (moderate)	4.7	IM	188	29
P17	1 (extensive)	10.8	IM	106	62
P18	1 (extensive)	6.7	IM	282	9
P19	3 (extensive)	7.0	IM	448	34
P20	1 (extensive)	10.2	IM, SS	440	38
P21	3 (moderate)	10.4	IM	130	62
P22	4 (moderate)	7.6	IM, SS	163	45
P23	> 5 (entire)	12.1	SS	1227	21
P24	4 (extensive)	6.4	IM	443	52

IM, intramural; SS, subserosal.
Minimal extent of leiomyoma uterine involvement was < 10%, moderate was 10–50%, extensive was > 50%, and entire was 100 %.
* Pregnancies 3, 13, and 15 were second pregnancies.
† Leiomyoma measurements are for the dominant or largest leiomyoma present.

lower segment leiomyomata with a breech delivery. Both deliveries resulted in postpartum hemorrhage, although neither delivery necessitated transfusion.

The third case (pregnancy 10) involved an African-American, 34-year-old women who conceived 3 years after embolization and had an uneventful pregnancy. A

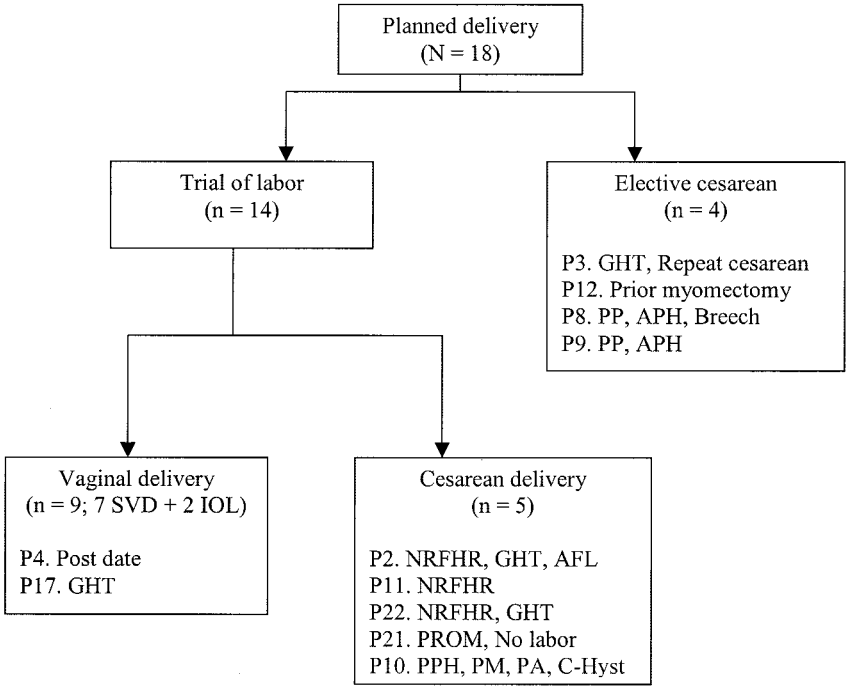

Fig. 1. Delivery management and complications after leiomyoma embolization. AFL, amniotic fluid level; APH, antepartum hemorrhage; C-Hyst, cesarean hysterectomy; GHT, gestational hypertension; IOL, trial of labor with induction; NRFHR, nonreassuring fetal heart rate tracing; PA, placenta accreta; PM, placenta membranacea; PP, placenta previa; PPH, postpartum hemorrhage; P, pregnancy number; PROM, premature rupture of membranes; SVD, spontaneous vaginal delivery.

Pron. Pregnancy After Uterine Artery Embolization. Obstet Gynecol 2005.

Table 3. Neonatal Outcomes After Leiomyoma Embolization

Pregnancy Number	Age at Delivery (y)	Gestational Age (wk)	Sex	Weight (g)	Birth Weight (Percentile*)	Apgar Scores (at 1, 5, 10 min)
Term births						
P1	31	40	F	3,770	71	9, 9
P4	34	40	F	3,070	19	9, 9
P5	33	40	M	3,230	21	5, 7
P7	36	39	F	3,285	46	8, 9
P10	38	41	M	3,800	86	6, 8,10
P11	37	39	M	2,830	6	3, 7, 9
P12	37	38	M	2,815	14	8, 9
P14	35	40	M	4,082	82	9, 9
P15	38	39	M	3,368	43	9, 9
P16	37	40	M	2,495	< 3	8, 9
P17	37	39	F	2,670	5	9, 9
P20	39	39	M	3,285	36	9, 9
P21	38	38	F	3,130	47	9, 9
P22	39	38	M	2,430	3	6, 8
Preterm births						
P2	29	36	M	2,485	13	7, 8
P3	31	34	F	2,420	62	8, 9
P8	35	31	M	1,055	4	4, 8, 10
P9	37	34	M	2,075	27	9, 9

* Percentiles for birth weight for gestational age were determined by linear interpolation from Canadian Growth Standard charts.[32]

cesarean delivery was performed for failed induction of labor at 41 weeks gestation. At surgery, dilated superficial vessels were identified running over the external surface of the entire uterus. The infant (3,800 g) was delivered through a lower segment incision. The placenta occupied the entire uterine cavity and extended into the lower segment. The patient began to bleed heavily as traction was placed on the cord. The placenta did not separate and a clinical diagnosis of placenta increta or accreta was made. A cesarean hysterectomy was carried out. The patient lost 5 L of blood and received 7 units of packed red cells. The pathology report confirmed placenta accreta. The placental cake measured 2 cm in thickness, in keeping with a placenta membranacea.

The neonatal outcomes are summarized in Table 3. Five infants had LBWs (3 of whom were preterm) and 1 (also preterm) had a VLBW of 1,055 g. Delivery of the VLBW infant preterm at 31 weeks was the result of antepartum hemorrhage secondary to a placenta previa. Of the 18 infants, 12 were appropriate weight for gestational age. Of the 4 infants SGA (≤ 5th percentile), 3 were delivered at term. Two were born to women with gestational hypertension. All of these women conceived within 12 months of embolization.

DISCUSSION

Uterine artery embolization has only recently become a treatment option for symptomatic leiomyomata. The literature on pregnancies after uterine embolization is limited to case reports or clinical studies investigating the safety and effectiveness for leiomyoma reduction and symptom relief.

Because our study was also not designed to evaluate fertility, the denominator of women attempting to achieve pregnancy was not optimally defined. Although 164 women reported a desire for future pregnancy before embolization, only 35 women reported that they were trying to conceive at the 1-year follow-up telephone interview. Although age and past reproductive histories of many of the patients in this cohort suggests a level of subfertility before their embolization, most conceived spontaneously. One patient in our study achieved a pregnancy with in vitro fertilization, and at least 1 other successful pregnancy has been reported after embolization with in vitro fertilization.[26] The efficacy of in vitro fertilization in women having undergone embolization is also an emerging consideration for both infertile women with leiomyomata and physicians providing these treatments

Potential effects of embolization on ovarian function are an important consideration if fertility preservation is desired. Few studies, however, have reported on gonadotropin levels. Of the 5 case studies[33–37] reviewing gonadotrophin levels after embolization, the largest involved 66 cases,[33] and follow-up was short term, to 6 months or 12 months.[37] Clearly, the evidence is far too limited to make conclusive statements on premature menopause or ovarian failure after embolization.

Initially it was not known whether an embolized uterus could sustain a pregnancy, and it was thought that

fetal losses could be high. Interpreting spontaneous abortion rates after embolization is difficult because of confounding factors such as advanced maternal age and the large leiomyoma burden present in most embolization study cohorts. Our study patients were older (an average of 42 years) and were generally more comparable in age to patients undergoing hysterectomy. Patients in our cohort also had multiple leiomyomata and long standing symptoms. Half were nulliparous, and many had prior spontaneous abortions.

Spontaneous abortions are known to increase with maternal age, ranging from 18% in the late 30s to 34% in the early 40s in the general population.[38] The 16.7% spontaneous abortion rate in our study, although based on a small sample, does not seem to be higher than the general population rates. Our rate was also similar to the 20% rate reported in the British embolization cohort,[28] but lower than the 35% and 29% reported in the French[24,25] and American[26] studies. Because embolic techniques with respect to angiographic endpoints were similar in these studies, patient differences and variability due to small samples are likely to account for these discrepancies. The high rate in the French study could be accounted for to some extent by the use of smaller embolic particles (150 –300 μm) and the advanced maternal age of the women (all older than 40 years of age). Based on these initial reports, although the numbers of pregnancies are small, uterine embolization does not seem to confer an obvious increased risk of pregnancy wastage.

Uterine embolization causes irreversible ischemia leading to leiomyoma degeneration, volume reduction, and symptom relief (particularly for menorrhagia). Because embolization cannot target exclusively the leiomyoma vascular supply, there is a concern for potential effects on the myometrium. Leiomyomata, however, are thought to be generally more susceptible to ischemia than the normal myometrium, which has an extensive collateral vascular system that is protective. Fortunately, endometrial and uterine infarction after uterine artery embolization is rare.[39,40] Our own experience is 2 cases (0.36%) of uterine infarction in the cohort of 555 women.[41]

Although the integrity and strength of the myometrium after uterine embolization is not known, results from histopathologic studies of failed embolization have concluded that the adjacent myometrium is generally spared.[40] It does seem possible, however, that a uterus having substantial areas that underwent ischemic or hyaline degeneration may be weak and could potentially rupture. Recently in one of our centers, but after our study enrollment was completed, a uterus ruptured during pregnancy after embolization. The woman, however, had 2 myomectomies as well as an embolization (personal communication, Wendy Whittle, March 24, 2004). Although pregnancies occurring after embolization are too few to make definitive comments on risk of uterine rupture, the use of multiple uterine interventions in women with leiomyomata hoping to achieve pregnancy does have increased risks.

Little is known about the optimal time to achieve pregnancy after embolization. Leiomyomata in most cases gradually shrink, and although most reductions are achieved within 6 months to a year,[26]the extent and timing of uterine healing associated with these changes are unknown. In our study patients intending to conceive after embolization were advised to wait several months, in keeping with the advice given women after myomectomy.[42]

The observation in our study of 3 cases of abnormal placentation was unexpected. Although ours is a small study, the number of cases of abnormal placentation seems unusually elevated. The incidence of placenta previa at delivery varies in published studies from 3 to 6 per 1,000 pregnancies.[43] Placenta accreta, occurring when there is a focal or diffuse absence of the decidua basalis resulting in a poorly formed decidua that leads to deeper trophoblast invasion is also a rare complication.[44] The incidence has been reported to range widely from 1 in 540 to 1 in 70,000.[45] An increasing incidence of placenta accreta (1 in 14,780 deliveries in 1960–1970 to 1 in 7,270 deliveries in 1970 –1980)[46] has been attributed to an increasing cesarean delivery rate.[45,46] The risk of accreta when placenta previa is present is approximately 5% without a previous uterine surgery and can be as high as 30% with a prior cesarean delivery.[47] Placenta membranacea, a variant wherein a thin placenta covers the entire uterine cavity and observed in 1 of our cases, is also a rare event (1 in 21,500 deliveries).[48] It is thought to result from a developmental abnormality affecting the trophoblastic shell of the early placenta, resulting in villi covering the entire amnion.[44]

The known risk factors for abnormal placentations include advanced maternal age (older than 35 years), multiparity, smoking, and prior cesarean delivery.[44,46–48] In a population-based record linkage study[49] involving birth records and hospital discharge records, leiomyomata were not found to be associated with placenta previa (odds ratio 1.76, 95% CI 0.76–4.05), but they were found to be significantly associated with abruptio placentae (odds ratio 3.87, 95% CI 1.63–9.17). The 3 women in our study with placental anomalies, although older (34, 35, and 36 years), were nulliparous, and none had prior myomectomy.

It is uncertain whether abnormal placentas observed in our pregnancies are directly related to embolization. It is possible that during embolization endometrial perfu-

sion could be compromised, leading to a focal or total absence of the decidua basalis. The fact that menstruation resumed after embolization in all of these women, however, suggests that the effects on the endometrium must have been more limited or focal. Denudation of endometrium after embolization has recently been described.[50] In that case report, an atrophic endometrial cavity was found after a hysteroscopic investigation for persistent amenorrhea 6 months postembolization. Biopsy results confirmed atrophic endometrium. The patients in our study were very aggressively embolized to no flow in the uterine arteries, and adverse effects on the endometrium are possible.

Abnormal placentas have also been reported in pregnancies after endometrial resection or ablation. In a recent review[51] of pregnancy occurring after these procedures, although half (49%; 22/45) were terminated at maternal request, 6 of the 17 pregnancies that progressed beyond 20 weeks had abnormally adherent placentas. Three of the placentas were very adherent, 2 were accretas (1 requiring a cesarean hysterectomy), and 1 was increta in which the uterus was preserved. The authors advised hysteroscopy after these procedures to demonstrate endometrial integrity before attempting pregnancy. Given the abnormal placentations occurring in our study, women contemplating pregnancy after uterine embolization might be advised to undergo diagnostic hysteroscopy to determine endometrial integrity.

Leiomyomata have been reported to be associated with higher complication rates during pregnancy, labor and delivery.[49,52–54] We did not have a protocol for managing pregnancies in our study and because women only had routine obstetric ultrasonography, we are unable to comment directly on the behavior of leiomyomata in the gravid uterus after embolization. Although there were no leiomyoma-related complications in our study such as red degeneration, the number of pregnancies is too small to conclude that embolization might be protective for this complication. Pregnancies were uneventful except for 2 cases of placenta previa that had to be admitted and delivered early in the third trimester because of antepartum hemorrhage. The majority of patients in our study group labored at term. Uterine leiomyomata can lead to abnormal fetal lie, and breech rates as high as 13% have been reported.[49] Only 1 infant presented as breech in our study, but the patient also had placenta previa (another risk factor for abnormal fetal lie).

Leiomyomata are also thought to be associated with a higher incidence of dystocia (poor contractility),[52,53] and there may be further concerns regarding the contractility of myometrium of the embolized uterus. However, the majority of vaginal deliveries in our study were spontaneous. Although many deliveries in our study were managed by a trial of labor resulting in spontaneous vaginal delivery, an equal number of deliveries involved either elective or cesarean deliveries during labor. The number of deliveries in our study is too small to allow us to make recommendations on delivery management. However it would seem prudent to follow these pregnancies with at least the same assumed risk as after transmural myomectomy or cesarean delivery until more is known about pregnancy after embolization.

Women with leiomyomata have been reported to be twice as likely as women without leiomyomata to deliver a term, LBW infant.[49] Neonatal outcomes in our study, however, were generally favorable. All infants were born live, and none of the fetuses required delivery in the mid trimester. Four infants, however, were SGA using a definition of 5th percentile or less for birth weight for gestational age, and 2 of these were below the 3rd percentile. The number of LBW babies is difficult to interpret, because 2 of the mothers also had gestational hypertension (another risk factor for LBW). The infant having a VLBW (1,055 g) SGA (4th percentile) was delivered at 31 weeks because of antepartum hemorrhage secondary to placenta previa.

Our report shows that women, many of them nulliparous with previous miscarriages are able to achieve successful pregnancies after uterine embolization. These outcomes do provide some hope to women who otherwise would have had a hysterectomy or are unsuitable for myomectomy. Larger prospective studies, however, are needed to learn more about fertility and outcomes of these pregnancies. In the interim, pregnancies occurring after embolization should be managed conservatively despite the uneventful pregnancies and successful trial of labors in our study until more is known about delivery outcomes. These patients would also benefit from an evaluation of their placental status during pregnancy to facilitate appropriate transfer of care if abnormalities are detected.

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Received June 9, 2004. Received in revised form September 23, 2004. Accepted September 29, 2004.

APPENDIX

The following physicians assisted in the clinical follow-up of the patients:

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