

tracings, thus emphasizing the importance of continuous electronic fetal monitoring in today's practice of modern obstetrics.

REFERENCES

1. Collins J, Collins C, Collins C. Umbilical cord accidents. Slidell (LA): The Pregnancy Institute; 2004.
2. Pauli R. The umbilical cord and stillbirth. *WiSSP*. Winter 1993-94;1(2).
3. Naidu M, Nama V, Karoshi M, Kakumani V, Worth R. Umbilical cord rupture: a case report and review of literature. *Int J Fertil Womens Med* 2007;52:107-10.
4. Pinette M, Wax J, Wilson E. The risk of underwater birth. *Am J Obstet Gynecol* 2004;190:1211-5.
5. Krakowiak P, Smith EN, de Bruyn G, Lydon-Rochelle MT. Risk factors and outcomes associated with a short umbilical cord. *Obstet Gynecol* 2004;103:119-27.
6. Spivack M. Anatomic peculiarities of human umbilical cord and their clinical significance. *Am J Obstet Gynecol* 1946;52:387-401.
7. Bowles H, McKee R. Ruptures of the umbilical cord with a case of intrapartum rupture of all three vessels. *Calif Med* 1949;70:422-3.
8. Mohide P, Keirse M, Chalmers I, Enkin M. Methods of biophysical assessment in effective care in pregnancy and childbirth. Vol 1. Oxford (UK): Oxford University Press; 1989.

Successful Bilateral Uterine Artery Embolization During an Ongoing Pregnancy

Andrei Rebarber, MD, Nathan S. Fox, MD, Donna A. Eckstein, BA, Robert A. Lookstein, MD, and Daniel H. Saltzman, MD

BACKGROUND: Uterine arteriovenous malformations are rare, potentially life-threatening, vascular anomalies.

CASE: We report a case of a large arteriovenous malformation diagnosed during pregnancy that was successfully treated with bilateral uterine artery embolization at 20 weeks of gestation during an ongoing pregnancy. The procedure was uncomplicated, did not result in any fetal heart-rate changes, and, at 35 weeks of gestation, a liveborn male neonate was delivered through repeat cesarean without complications. Both the patient and her son are doing well more than 2 years after the procedure.

CONCLUSION: Uterine artery embolization during an ongoing pregnancy did not result in acute complications to the fetus or mother.

(*Obstet Gynecol* 2009;113:554-6)

Uterine arteriovenous malformations are rare, potentially life-threatening, vascular anomalies that often present with vaginal bleeding in the nonpreg-

nant state.¹ They rarely have been described in pregnancy, possibly owing to impairment of the normal implantation process resulting in early pregnancy failure. Because the hormonal changes concomitant with pregnancy may cause proliferation, this diagnosis is potentially ominous during pregnancy. We report a case of uterine arteriovenous malformation treated with uterine artery embolization at 20 weeks of gestation during an ongoing pregnancy with a successful pregnancy outcome.

CASE

A 34-year-old multigravida transferred to our practice at 20 weeks of gestation with vaginal bleeding and a previously identified arteriovenous malformation occupying the lower uterine segment. This pregnancy was conceived with in vitro fertilization embryo transfer owing to male-factor infertility. The patient's obstetric history was significant for two prior cesarean deliveries, the second of which was associated with asymptomatic separation of the uterine scar noted at the time of that delivery, which was repaired.

Transabdominal and transvaginal ultrasound examinations were performed and revealed an age-appropriate singleton fetus with no anatomical abnormalities. The cervix was closed and measured 2.7 cm in length. An anterior placenta was visualized without signs of previa. However, a large subchorionic hematoma was seen.

The lower uterine segment appeared attenuated. Color flow Doppler ultrasonography revealed an 8.1-cm vascular mass in the midline of the lower uterine segment with a low-velocity flow in a "swirling" pattern consistent with a large varix. (Fig. 1) These findings were suggestive of arteriovenous malformation.

The patient was counseled regarding voluntary termination of pregnancy followed by definitive treatment such as embolization, surgical removal via hysterotomy, or hysterectomy compared with an experimental procedure in which bilateral uterine artery embolization would be performed while continuing the pregnancy. The patient opted for the latter owing to her desire to

From the Department of Obstetrics, Gynecology, and Reproductive Science and the Department of Interventional Radiology, Mount Sinai Medical Center, and Carnegie Hill Imaging for Women, New York, New York.

Corresponding author: Nathan S. Fox, MD, Carnegie Hill Imaging for Women, 70 East 90th Street, New York, NY 10128; e-mail: nfox@mfmnyc.com.

Financial Disclosure

The authors did not report any potential conflicts of interest.

© 2009 by The American College of Obstetricians and Gynecologists. Published by Lippincott Williams & Wilkins.

ISSN: 0029-7844/09



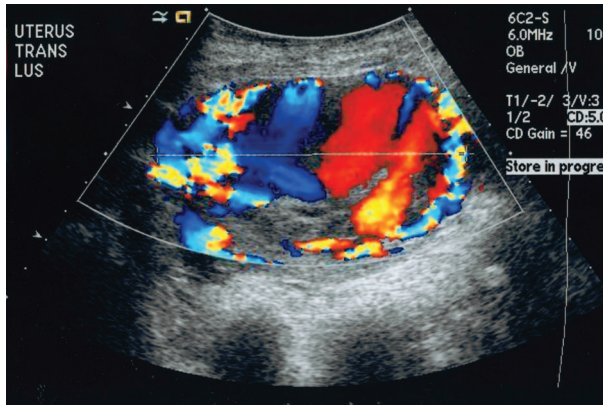


Fig. 1. Color flow Doppler ultrasonogram of the lower uterine segment demonstrating a vascular mass consistent with arteriovenous malformation.

Rebarber. *Uterine Artery Embolization During Pregnancy.* *Obstet Gynecol* 2009.

continue the pregnancy and preserve her fertility and because of religious observance.

The patient received intravenous sedation. The single-wall Seldinger technique was used to gain retrograde access to the right common femoral artery. An 035 Bentson wire (COOK Medical, Inc., Bloomington, IN) was advanced into the abdominal aorta at the level of L2 and then advanced to the level of the left common femoral artery. A Roberts catheter (COOK Medical, Inc.) was used to select the left internal iliac artery and then retracted to select the left uterine artery. Then, a Prowler 14 catheter (Cordis, Warren, NJ) along with an Agility 10 wire (Cordis) were used to select the arteriovenous malformation seen within the pelvis. Vasospasm was treated with the administration of 100 micrograms of nitroglycerin in four separate aliquots. The Prowler catheter was advanced into the arteriovenous malformation, and hand-injection angiogram was performed to confirm proper location (Fig. 2). Glue embolization with 1 cc of glue and 1 cc of Ethiodol was performed in the uterine artery and in several vessel branches. After the procedure, marked reduction of flow through the vascular malformation was demonstrated both by arteriogram and power Doppler ultrasonogram (Fig. 3). The patient tolerated the procedure well. Fetal heart tones were within the normal range throughout the procedure.

The antepartum course was complicated by intermittent episodes of vaginal bleeding and late-onset intrauterine growth restriction. At 35 weeks of gestation, the patient underwent a repeat lower uterine segment transverse cesarean delivery owing to spontaneous onset of labor. The neonate was a liveborn male weighing 1,820 grams (fourth percentile²) with Apgar scores of 9 at 1 minute and 9 at 5 minutes. A lower uterine segment necrotic mass that was avascular and approximately 3 cm by 5 cm was left in situ. The placenta was 220 g (less than the 10th percentile for gestational age). Pathologic examination of the placenta showed widespread old retromembranous hematomas

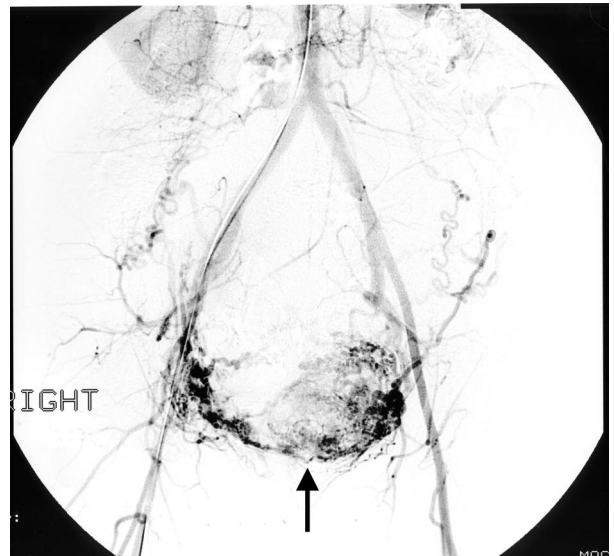


Fig. 2. Preembolization angiogram demonstrating a vascular mass (arrow) in the maternal pelvis.

Rebarber. *Uterine Artery Embolization During Pregnancy.* *Obstet Gynecol* 2009.

present in the peripheral membranes, and there were focal hypoxic-ischemic villous changes. No macroinfarcts or microinfarcts were noted.

The postpartum course was uncomplicated. The patient and neonate went home on postoperative day 4. At 2 years of age, the child is doing well and has met all of his developmental milestones. The patient underwent saline-infusion ultrasonography at 4 months postpartum using



Fig. 3. Postembolization angiogram demonstrating disappearance of the vascular mass (arrow).

Rebarber. *Uterine Artery Embolization During Pregnancy.* *Obstet Gynecol* 2009.



two-dimensional, three-dimensional, and Doppler ultrasonography. The endometrial cavity appeared within normal limits without signs of an arteriovenous malformation.

COMMENT

A Medline search from 1960 to August 2008 using the search terms “uterine arteriovenous malformation” and “pregnancy” indicates that this is the first case report of uterine arteriovenous malformation treated during an ongoing pregnancy with uterine artery embolization. Prior reports focused on treatment after pregnancy; performing embolization during pregnancy was not listed as a management option.³

Although these anomalies may be congenital, they most often occur after uterine trauma such as curettage or cesarean delivery.¹ Development of abnormal vascular connections between arteries and veins may occur during the healing process. They are most often diagnosed in multiparous women of child-bearing age, suggesting a correlation between hormonal changes and pathogenesis.⁴ It is possible that fertility treatments may increase the risk owing to hormonal alterations. Before the advent of minimally invasive surgery, uterine arteriovenous malformations most often were treated with hysterectomy. Uterine artery embolization is now the treatment of choice.⁴

The literature on subsequent pregnancy after uterine artery embolization is sparse. Owing to the scarcity of uterine arteriovenous malformations, most information found on this subject pertains to patients who underwent the therapy to treat postpartum hemorrhage or leiomyomata. The largest series is of 50 patients from 1982 to 2002.⁵ It demonstrates that women who became pregnant after uterine artery embolization are at risk for malpresentation, preterm delivery, and postpartum hemorrhage. Other possible complications include fetal growth restriction, uterine atony, and uterine rupture. Pregnancy after uterine arteriovenous malformation embolization also has been associated with increased incidence of miscarriage and stillbirth.¹ Theoretically, hypovascularity after embolization may affect placentation and subse-

quent fetal growth.¹ In this case, the observed intrauterine growth restriction may have been related to this therapy.

Embolization of both uterine vessels during an ongoing pregnancy did not result in acute complications to the mother or the fetus. Because of the enhanced collateral blood flow present in the pregnant uterus, arrest of perfusion through these two main tributaries did not result in acute fetal compromise.

This case likely represents a select case suitable for this novel therapy because the arteriovenous malformation was diagnosed early in pregnancy, it was accessible for embolization, and alternate therapies were not acceptable to the patient.

Increasing rates of cesarean delivery and greater reliance on fertility treatments may make uterine arteriovenous malformations more common. Additionally, other potentially life-threatening conditions such as placenta accreta and percreta, if prenatally diagnosed, may be amenable to this method of treatment preoperatively, thereby reducing blood flow to the term uterus before delivery. Our case suggests that this may not have a detrimental effect on the fetus in utero. In selected cases, uterine artery embolization may be an option during gestation while preserving the pregnancy as well as future fertility.

REFERENCES

1. Grivell RM, Reid KM, Mellor A. Uterine arteriovenous malformations: a review of the current literature. *Obstet Gynecol Surv* 2005;60:761-7.
2. Oken E, Kleinman KP, Rich-Edwards J, Gillman MW. A nearly continuous measure of birth weight for gestational age using a United States national reference. *BMC Pediatr* 2003; 3:6.
3. Nasu K, Yamaguchi M, Yoshimatsu J, Miyakawa I. Pregnancy complicated by asymptomatic uterine arteriovenous malformation: a case report. *J Reprod Med* 2007;52:335-7.
4. Delotte J, Chevallier P, Benoit B, Castillon JM, Bongain A. Pregnancy after embolization therapy for uterine arteriovenous malformation. *Fertil Steril* 2006;85:228.
5. Goldberg J, Pereira L, Berghella V. Pregnancy after uterine artery embolization. *Obstet Gynecol* 2002;100:869-72.

