Obstetric and Gynecologic Emergencies: A Review of Indications and Interventional Techniques

Shellie C. Josephs, M.D.¹

ABSTRACT

There are many interventional techniques that can be used to aid the obstetrician or gynecologist in caring for their patients in the acute setting. Embolization can be life saving in the case of postpartum hemorrhage. Bleeding related to cervical cancer or the threat of bleeding from cervical ectopic pregnancy is amenable to embolization as is hemorrhage related to uterine arteriovenous malformations. Postpartum women are also at a uniquely high risk for deep vein thrombosis and pulmonary emboli and may benefit from consultation and treatment by an interventional radiologist. The goal of this article is to discuss the valuable role that the interventional radiologist plays in the treatment of these obstetric and gynecologic conditions.

KEYWORDS: Postpartum hemorrhage, embolization, pelvic hemorrhage, uterine arteriovenous malformations, venous thromboembolic disease

Objectives: Upon completion of this article, the reader should be able to explain the indications for embolization for obstetrical and gynecologic hemorrhage as well as identify the techniques used for embolization.

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Interventional radiologists are very familiar with the normal pelvic arterial anatomy based on previous experience with embolization for pelvic trauma in addition to the increasing experience with uterine fibroid embolization (UFE). The proliferation of UFE has opened new doors allowing us to develop relationships with obstetricians and gynecologists that we may not have enjoyed prior to UFE. New opportunities to help this patient population have expanded the role of the interventionalist in the treatment of postpartum hemor-

rhage, cervical ectopic pregnancies, bleeding related to cervical cancer, and uterine arteriovenous malformations. Nonhemorrhagic emergencies in the antepartum and postpartum patient also include the diagnosis and treatment of deep vein thrombosis (DVT) and pulmonary embolus, including inferior vena cava filter placement when appropriate. These topics will be reviewed in this chapter including the basic pathophysiology of the events as well as indications for treatment and techniques for treatment.

¹Department of Radiology, Vascular and Interventional Radiology, University of Texas Southwestern Medical Center, Dallas, Texas.

Address for correspondence and reprint requests: Shellie C. Josephs, M.D., Department of Radiology, Vascular and Interventional Radiology, University of Texas Southwestern Medical Center, 5323 Harry Hines Blvd., Dallas, TX 75390-8834 (e-mail: Shellie.Josephs@UTSouthwestern.edu).

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PREGNANCY-RELATED MORTALITY STATISTICS

It is estimated that in the year 2005, there were 536,000 maternal deaths worldwide, primarily in developing nations.¹ In developed countries such as the United States, that rate is significantly lower at 9 to 17 deaths per 100,000 deliveries compared with 400 deaths per 100,000 deliveries worldwide. The greatest majority of the deaths in nondeveloped countries were related to postpartum hemorrhage (PPH). PPH is a leading contributor to morbidity rather than mortality in the United States whereas pulmonary embolus is the leading cause of mortality.²

POSTPARTUM HEMORRHAGE

There are innumerable physiologic changes that are associated with pregnancy. The maternal plasma serum concentration increases by 42% with a concomitant increase in red blood cell volume by 24%.³ This helps prepare the mother for the expected blood loss associated with a normal delivery. Expected blood loss with a spontaneous vaginal delivery is ~500 cc and with routine cesarean section, 1000 cc. PPH is defined as a blood loss of greater than 500 cc or any amount that, if not replaced, could cause shock or death in the mother. Up to 4% of vaginal deliveries and 6% of cesarean deliveries are associated with excessive blood loss and require transfusion.⁴ The most common cause of PPH is uterine atony. This occurs when the normal myometrium fails to contract after delivery of the placenta. The initial treatment involves the administration of intravenous (IV) oxytocin and uterine massage. Lower genital tract lacerations and retained placenta are other causes of early PPH and are treated appropriately with suture ligation of the site of bleeding and delivery of placental fragments. Other serious but less common causes of PPH include uterine rupture or inversion, both of which usually require urgent hysterectomy. Hereditary coagulopathies and abnormal placental implantation sites are associated with a high risk of bleeding and involvement of the interventional radiologist can be particularly

helpful in patients with these conditions because they are often known prior to delivery. If the initial maneuvers fail to stop the PPH, other techniques such as uterine packing, suture techniques, uterine or hypogastric artery ligation can be considered. Hypogastric artery ligation is technically challenging and by some reports is successful less than 50% of the time.⁵ Urgent transarterial embolization if available, or hysterectomy can also be performed as a final resort. The goal of treatment for all causes of PPH is cessation of bleeding in a timely fashion, before the onset of consumptive coagulopathy and end organ damage.

ABNORMAL PLACENTATION

Bleeding during labor or in the second half of pregnancy is frequently associated with abnormal implantation sites of the placenta (Fig. 1). *Placenta previa* refers to implantation of the placenta in the lower uterine segment. The risk of placenta previa is increased based on previous uterine surgery, including previous cesarean delivery, smoking, increased age, multiparity, and multiple pregnancies.⁶ Most cases of placenta previa can be managed conservatively with planned cesarean delivery after 36 to 37 weeks gestation, before cervical effacement. *Placenta accreta* refers to a placenta that is abnormally adherent to the uterus. The term frequently is used as a global term referring to abnormal placental ingrowth; however, the more specific terms include *placenta increta*, when the placenta invades the myometrium, and *placenta percreta*, in which there is invasion through to the serosa and sometimes the bladder. Placenta accreta, as a general term, can lead to massive blood loss at the time of delivery with the estimated average loss of 3,000 to 5,000 cc reported.⁷ The most important risk factor in the development of placenta accreta is previous cesarean delivery. Frequently, it is also associated with a placenta previa. One study reported the risk of placenta accreta in an unscarred uterus was 0.26% compared with 10% in a woman with four or more previous cesarean sections.⁸ Prior uterine artery embolization may also be a risk factor for developing placenta accreta. El-Miligy et al⁹

Figure 1 Depiction of abnormal placentation with (A) complete placenta previa, (B) placenta accreta, (C) placenta increta, and (D) placenta percreta.

recently reported a single case of placenta accreta and uterine atony causing postpartum bleeding in a young woman who had previously undergone uterine artery embolization (UAE) for fibroids. In the Ontario Multi-center Trial on uterine artery embolization for fibroids, there were 3 reported cases of abnormal placentation with 2 nulliparous women having placenta previa, one with a small area of accreta. The third patient had a diffuse placenta accreta, which required urgent cesarean hysterectomy.¹⁰ Therefore, it is recommended to consider patients who have undergone previous UAE for fibroids as potentially at risk for placental abnormalities; careful evaluation of the placenta by ultrasound (US) or magnetic resonance imaging (MRI) is recommended (Fig. 2).

EMBOLIZATION

Brown and Heaston et al first described the use of embolization in the treatment of PPH in 1979.^{11,12} Since that time, our tools and techniques have evolved considerably; nevertheless, the basic procedure has remained the same with Gelfoam (Pfizer, Inc., New York, NY) still leading as the most important embolization agent. Vedantham et al,¹³ published their review of the literature in 1997 and found 67 reported cases of trans-arterial embolization for PPH with an overall success rate of 97%. The patient volume in these published series was very small, with the largest consisting of only 15 patients. More recently, the number of procedures reported from individual centers has increased. In 2006, Vegas et al¹⁴ reported an additional 8 studies, including their own cohort, with an average number of patients of 20. The success of the procedure was reported to range from 83% reported by Hansch et al¹⁵ to 100%. Table 1 contains additional studies published in the English language since the year 2000.^{16–28} The success rate, as

defined by cessation of bleeding remains high, averaging ~88% among the listed studies. There is some decrease in success in cases of abnormal placentation with a range from 20 to 100%. It is unclear what causes this broad range; however, it may be related to the timing and vigor of the attempts to remove the placenta as well as the patient's condition at the time of referral for angiography, as cases of abnormal placentation can be associated with massive bleeding and subsequent development of coagulopathy. There is a trend toward increased utilization at centers that have recognized the usefulness of embolization. In France, a Clinical Practice Recommendation was proposed in 2004 with the aim of reducing mortality for PPH.²⁹ The recommendation stresses early recognition of abnormal bleeding with sequential treatment steps for hemorrhage. Arterial embolization or surgery is recommended if more conservative treatments have not worked with the rapid referral for intervention stressed. Mathe et al²⁵ published data comparing embolization procedures performed before and after the release of the clinical guidelines. There was a 4-fold increase in referrals for embolization with a decrease in time from the onset of hemorrhage until referral. The severity of hemodynamic instability and need for transfusion was decreased with early angiography and intervention with no change in the overall success rate.

EMERGENT PROCEDURES

Emergent embolization should be performed in the angiography suite if at all possible, with ongoing active resuscitation. The procedure is performed most commonly from a single puncture site, usually at the right common femoral artery. A pigtail catheter placed in the aorta at the level of the renal arteries allows imaging of extravasation if present. This should be followed by angiography at the level of the anterior division of the internal iliac artery, followed by more selective angiography of the uterine artery if no other site of extravasation is identified. Visualization of extravasation however, is not necessary for performing the embolization as this is more often not seen. Boulleret et al²⁰ visualized extravasation in only 42% of cases with only hypervascularity present in cases of uterine atony. Embolotherapy should be performed on an empiric basis if there are clinical signs of ongoing hemorrhage, usually from a catheter positioned at the level of the anterior division of the hypogastric arteries. If extravasation is seen, embolization can be directed more selectively, most commonly of the uterine arteries. Bilateral embolization is always recommended. Some authors advocate the use of both Gelfoam and coils if extravasation is identified, however, Gelfoam usually suffices. There are reports of embolization procedures performed safely with particulate agents, such as polyvinyl alcohol (PVA)²¹; however, the more distal site of embolization is usually not

Figure 2 Color Doppler ultrasound with placenta previa and placenta accreta with color flow extending to the bladder wall (arrow).

Table 1 Embolization Series Published since 2000

Reference	N	Etiology	Success (%)	Complications
Descargues et al, 2001 ¹⁶	7	Abnl placentation 7 Prophylactic (1)	71	None
Cheng et al, 2003 ¹⁷	21	PPH 15 - atony (5) - abnl placentation (6) - GU laceration (2) - other (2) Prophylactic 6 - accreta (1) - increta (3) - percreta (2)	80 100	1 Death DIC/MOF 1 Re-embo successful 1 GU infection
Chung et al, 2003 ¹⁸	33	Atony 13 Abnl placentation 8 - previa (4) - accreta (4) GU laceration 1 Other 11	94	3 Re-embo successful 8 Transient paresthesias/ pain lower extremities 1 Vaginal fistula
Ornan et al, 2003 ¹⁹	28	Atony 5 Abnl placentation 10 - previa (3) - accreta (7) GU lacerations 6 Coagulopathy 4 Other 8	97	1 Internal iliac perforation
Boulleret et al, 2004 ²⁰	36	Atony 28 GU laceration 4 Other 4	100	13.9% 1 Groin pseudoaneurysm, 1 DVT 2 Lower limb paresthesias 1 Puncture site hematoma
Hong et al, 2004 ²¹	10	Primary PPH 2 Retained placenta 2 Abnl placentation 5 Secondary PPH 1	80	None 2 patients not embolized, one required hysterectomy for bleeding
Ojala et al, 2005 ²²	22	Emergent 15 - atony (7) - Abnl placentation (4) Prophylactic 7 - previa (4) - accreta (3)	80 71	13.6% 1 Popliteal artery thrombosis 1 Vaginal necrosis 1 Paresthesia of right leg
Yong et al, 2006 ²³	29	Atony 18 Abnl placentation 10 - prophylactic (1) Coagulopathy 2 GU laceration 2	90	1 Cardiac arrest 1 Transient leg claudication 6 Minor fever 1 Cardiac arrest 1 Transient leg claudication 6 Minor fever
Shim et al, 2006 ²⁴	45	Uterine atony 24 Abnl placentation 5 GU laceration 5 Retained placenta 5 Other 6	88 20 100 100 100	5 Leg/buttocks numbness 1 Vessel dissection

Table 1 (Continued)

Reference	N	Etiology	Success (%)	Complications
Mathe et al, 2007 ²⁵	48	Atony 34 Retained placenta 6 Placenta accreta 4 Other 4	96	1 Hematoma of pubic symphysis
LaFolie et al, 2007 ²⁶	6	Abnl placentation 6	100	14.3% Uterine and bladder necrosis at 1 mo
Eriksson et al, 2007 ²⁷	20	Atony 13 Abnl placentation 3 Other 6	100	None 7 Repeat embo with coils
Soncini et al, 2007 ²⁸	16	Atony 9	100	6%
		Abnl placentation 3 - Prophylactic (2)	100	Pain, fever
		Other 4	93	
		Atony 156 (56%) Abnl placentation 70 (25%) Prophylactic 17 (6%)	100	

Abnl, abnormal; DIC, disseminated intravascular coagulopathy; DVT, deep vein thrombosis; GU, genitourinary; MOF, multiorgan failure; PPH, postpartum hemorrhage; embo, embolization.

necessary and is theorized to increase the risk of complications by reducing the availability of collateral flow to the uterus. There has been one report of complete uterine necrosis requiring hysterectomy following embolization for PPH with PVA particles with a diameter of 150 to 250 and 300 to 600 microns.³⁰ Evaluation of the inferior epigastric artery is also important, especially in patients who have undergone cesarean delivery or hysterectomy as there are reports of injury to that artery causing hemorrhage.^{18,27}

PROPHYLACTIC EMBOLIZATION

Women at highest anticipated risk for PPH include those with known placental abnormalities, especially accreta, as documented by antenatal US examination. In the anticipation of a bleeding event at delivery, it is recommended that the obstetrician involve the interventional radiologist early in the patient's care. It is not uncommon for the delivery area of many hospitals to be remote from the interventional radiology (IR) suite. Careful planning of the delivery is important to facilitate the efficiency of care. If there is not an x-ray compatible table or C-arm available in the delivery area, the procedure should be planned for the angiography suite or the operating room. Many individuals will be involved with this planning in addition to the interventional radiologist and obstetrician, including an anesthesiologist and a neonatologist. If the anticipated delivery date is early in gestation, the neonatal team must have the room to care for a premature infant with easy transport to the neonatal intensive care unit. The best way to facilitate this is to have a plan before delivery to ensure that all individuals and teams in-

involved know the location of delivery and what equipment to have available.

Most cases of accreta are observed as outpatients with plans for scheduled cesarean delivery before the onset of labor. It is not uncommon however, for a woman with known accreta to present to labor and delivery with unanticipated bleeding or the onset of labor. The IR team should have supplies together and marked clearly for such emergent cases with all of the interventional team, including the technologist, knowledgeable as to where the delivery will take place (Table 2). Two interventional radiologists are also

Table 2 Supplies for Prophylactic Embolization

Supplies for Prophylactic Embolization (All supplies should be duplicated for bilateral access)

Access needles
Starter wires
Hydrophilic wires
7 French sheaths
Selective catheters (2 different shapes, usually Cobra and Sps)
Balloon occlusion catheters (5.5 Fr Boston Scientific balloon occlusion catheter*)
0.024 Lumen microcatheters
0.018 Wires
Gelfoam†
Instrument and syringe pack
Tray setup and manifold set
Contrast
Ultrasound unit and sterile probe cover
Coil sizes ranging from 3–10 mm diameter

*Boston Scientific, Inc., Natick, MA.

†Pfizer, Inc., New York, NY.

helpful as simultaneous performance of the procedure from each side reduces procedure time and radiation exposure. Ultrasound may be helpful to guide arterial puncture in the case of the gravid uterus and reduces the need for fluoroscopy of the groin puncture site. The routine use of occlusion balloons in the anterior division of the internal iliac artery is recommended as this allows more timely control of bleeding. Once the infant is delivered by cesarean delivery, the occlusion balloons should be inflated. The placenta can then be inspected and removed if possible. If this does not occur easily, then embolization should be performed through the occlusion balloon with Gelfoam cut into 1 to 2 mm pledgets. Prophylactic placement of bilateral balloon occlusion catheters in high-risk patients allows the freedom of a small amount of time to inspect and evaluate the uterus. Often, surgical suturing techniques or direct injection of pharmacologic agents into the uterus are enough to prevent bleeding without the use of embolization. Once the surgeon believes they have obtained hemostasis, the balloons should be deflated and then the uterus observed for signs of bleeding. If bleeding does occur, the balloons should be reinflated and embolization performed. The use of prophylactic balloon occlusion catheters is not universally accepted as there have been 2 comparison reports published that have shown no benefit of this technique.^{31,32} Hansch et al¹⁵ reported an estimated fetal dose when placing bilateral balloon occlusion catheters of 10 to 16 rad, assuming 5 to 8 minutes of fluoroscopy time with no exposures taken. Other investigators have measured the fetal dose during prophylactic balloon occlusion catheter placement at 3.2 to 6.1 rad.^{31,32} The absolute risk of fetal exposure, including the risk for developing childhood cancers is considered negligible at doses less than 5 rad and small at less than 10 rad.³³

CERVICAL ECTOPIC PREGNANCIES

Cervical ectopic pregnancies are very rare, accounting for less than 1% of all ectopic pregnancies. Although mortality related to cervical pregnancies is now rare, significant morbidity is not uncommon due to the risk of hemorrhage with subsequent loss of fertility related to hysterectomy. The rate of cervical pregnancies may be increasing due to the rising use of in vitro fertilization with an increase as well in the rate of concomitant intrauterine implantation sites.³⁴ With the frequent use of early US, the diagnosis can be made before the patient presents with massive bleeding, thereby increasing the therapeutic options to preserve fertility. Options include systemic chemotherapy with methotrexate, dilatation, and curettage—usually in conjunction with another procedure to reduce blood supply such as uterine artery ligation or embolization, or direct injection of either methotrexate or potassium chloride into the gesta-

tional sac. Direct injection has become the treatment of choice in asymptomatic patients, especially when there is a concomitant intrauterine pregnancy. This is based on the speed and safety of the more localized direct injection procedure as well as patient comfort, as this can typically be performed on an outpatient basis. Frates et al³⁵ have published the largest series to date on conservative management of cervical pregnancies with 12 cases, 4 of which were treated successfully with embolization followed by dilatation and evacuation. The embolization procedure was performed in a standard fashion with selective embolization of the uterine artery branches, including the transverse cervical branch with Gelfoam. Angiography and embolization are more frequently utilized in cases of acute hemorrhage.

FERTILITY AFTER EMBOLIZATION

Transarterial embolization is considered the alternative treatment for PPH, with urgent hysterectomy considered the standard treatment. Hysterectomy guarantees no future fertility, whereas embolization offers the chance of future fertility. Eriksson et al²⁷ published their data on the effect of embolization on future fertility and menses, including a literature review. They identified 4 studies that included a total of 104 patients that had previously undergone embolization for PPH. Follow-up information was available in 74 women reporting regular menses in 73. There were 19 fullterm infants delivered and 3 miscarriages reported. Salomon et al³⁶ reported a higher rate of severe PPH in subsequent deliveries in women who had undergone embolization. Chung et al¹⁸ report the only case of amenorrhea following embolization of a unilateral uterine artery and bilateral ovarian arteries using Gelfoam. They attributed this to hypothalamic hypogonadism. The patient eventually became pregnant again after ovulation induction. Ornan et al¹⁹ reported that the most frequent long-term side effect was transient buttocks numbness and urinary frequency. Overall, embolization for PPH appears to have little effect on resumption of menses and future fertility.

UTERINE ARTERIOVENOUS MALFORMATIONS

Uterine arteriovenous malformations (AVMs) may be either congenital or acquired, usually postinstrumentation such as dilatation and curettage, uterine surgery including cesarean delivery, diethylstilbestrol exposure, gestational trophoblastic disease, or direct trauma. Endometrial and cervical cancers have also been linked to the diagnosis of uterine AVMs. A careful evaluation of the patient history as well as assessment of the beta-human chorionic gonadotropin (b-HCG) levels are essential at differentiating these as often the imaging characteristics will be the same. Congenital AVMs are

more likely to have arterial supply that is not related to the uterine arteries and the extent of the lesion may extend outside of the confines of the uterus; however, these findings can be variable. A patient who presents with extensive vaginal bleeding with a normal b-HCG level, especially after any instrumentation, should be suspected to have an acquired AVM (Fig. 3). The diagnosis can be made on transvaginal color Doppler US, which should be performed prior to any further instrumentation as further curettage can make the bleeding worse. US typically shows nonspecific findings on gray scale imaging with dilated vascular channels within the myometrium with Doppler revealing high velocity, multidirectional flow in a mosaic pattern.³⁷ Patients who are hemodynamically stable can undergo conservative

management with observation; however, embolization may be required urgently in those with heavy bleeding. The procedure has been performed with Gelfoam; however, particulate agents and glue also have a role in the treatment of these lesions with up to a 93% clinical success rate reported.³⁸ Some acquired malformations are noted to regress spontaneously. Timmerman et al³⁹ noted that the cases they observed on US were subsequent to term pregnancies, late abortions (after the 18th week), and following molar pregnancies. They theorized that some of these malformations may represent failure of involution of the placental bed rather than true AVMs and that observation in clinically stable patients was sufficient until resolution was demonstrated on color Doppler (Fig. 4).

Figure 3 (A) Aortogram with uterine arteriovenous malformation. (B) Selective injection of the left internal iliac artery. (C) Following treatment with polyvinyl alcohol and onyx.

Figure 4 Contrast enhanced computed tomography scan showing presumed extravasation from uterus in patient 3 weeks postabortion, presenting to emergency department with severe vaginal hemorrhage. Bleeding resolved spontaneously. Arteriogram performed one day later revealed no extravasation or pseudoaneurysm.

PELVIC MALIGNANCIES

Hemorrhage related to pelvic malignancies can occur in patients with cervical or endometrial cancers or less commonly metastatic disease to the vagina. Gestational trophoblastic disease can also present with vaginal bleeding that may be profuse. There are scattered reports throughout the medical literature primarily as case reviews with very few large series on gynecologic malignancies. Mihmanli et al⁴⁰ reported a case series of 6 patients, 4 with cervical cancer with average duration of bleeding of 4.5 days. Arteriograms in these patients revealed a “blush” in the uterus with no overt extravasation, with embolization of bilateral uterine arteries performed with PVA particles. The procedure was 100% successful in the cessation of hemorrhage with

no significant complications. Pisco et al⁴¹ reported the largest series of patients with pelvic neoplasms, including bladder and prostate. Of their 108 patients, 76 of these were women with a total of 39 uterine and 16 ovarian malignancies. The overall success rate of the embolization was 77% (83 patients) with a reduction of the severity of bleeding in an additional 25 patients. They were unable to reduce the need for transfusion in an additional 11 patients, 6 of whom had only unilateral embolization due to anatomic reasons. In patients with advanced malignancies, prior radiation and older age may make the arterial anatomy more complex; however, bilateral embolization is still the goal due to the rich cross filling of the arteries of the pelvis. In addition, tumor invasion of larger arteries such as the external iliac arteries may occur and present with retroperitoneal hemorrhage. Treatment with embolization or stent-graft placement can be life saving in these cases of large vessel invasion (Fig. 5).

VENOUS THROMBOEMBOLIC DISEASE

It is estimated that the risk of DVT in pregnancy is 5 to 6 times higher than in the nonpregnant woman.⁴² Nearly 1 in 1,000 pregnant women develop DVT on a yearly basis with most of these occurrences during the antenatal period (65%).⁴³ In a meta-analysis performed by McColl et al,⁴³ the risk was highest in the third trimester accounting for 42% of all reported incidence; however, the risk actually begins in the first trimester with 24% of reported DVT occurring early. In the 6-week period after delivery that defines the postpartum period, women remain at high risk with ~35% of DVTs occurring during this phase of recovery. Risk factors for

Figure 5 Tumor invading external iliac artery with massive extravasation. (A) Arteriogram of left external iliac artery with extravasation noted. (B) After placement of Wallgraft endoprosthesis (Boston Scientific, Inc, Natick, MA) to exclude extravasation.

the development of DVT include thrombophilia, prior DVT, obesity, bed rest, and surgical delivery. Thrombophilia is noted in almost 50% of women who develop gestational venous thrombosis. It is interesting to note that 90% of gestational-related DVTs occur on the left side compared with 55% in the general population.⁴⁴ This is possibly related to compression on the left common iliac vein from the crossing iliac artery. Management with low-molecular-weight heparin is the treatment of choice; however, there are rare patients with contraindications to anticoagulation during pregnancy and withdrawal of anticoagulation may be indicated before delivery. Those patients may require an inferior vena cava filter, placed preferably in the intrahepatic portion of the inferior vena cava to avoid compression by the gravid uterus as well as to allow filtration in cases of gonadal vein thrombosis. The estimated radiation dose to the patient during the average caval filtration procedure is 166 mGy (16.6 rad) when using 2.8 minutes of fluoroscopy and 33 exposures.⁴⁵ This can however, be reduced even further by placement of the filter with the use of intravenous US for sizing the cava and for guiding placement.⁴⁶

Pulmonary thromboembolic disease is the leading cause of maternal death in the United States.⁴⁷ The use of thrombolytics during pregnancy has not been studied and is generally not recommended except in cases of life-threatening thrombosis such as PE with hemodynamic compromise, cerebral thromboses, acute myocardial ischemia (MI) and DVT with threatened limb viability. In 1995, Turrentine et al⁴⁸ reviewed the world literature and found 172 women with thrombotic disease who were treated with thrombolytics. The majority was for DVT (148) with fewer cases for PE (11). Overall, the mortality rate for the mother was 1.2% with a 5.8% rate of loss of pregnancy and hemorrhagic complications were reported in 8.1% of cases. Most cases were performed with streptokinase in this review and, although it is not indicated, most were not catheter-directed as this was not a common procedure during the period of the study (1961 to 1995). Because of this large review, scattered case reports have been published regarding treating women in the peripartum period. There is evidence that recombinant tissue plasminogen activator is the agent of choice for therapy due to the larger size of this molecule, being less likely to cross the placental barrier.⁴⁹ There is not significant data to reach conclusions regarding safety of the procedure; therefore, its use should be reserved for those women who are critically ill due to PE.

CONCLUSIONS

There are many ways in which the interventional radiologist can come to the aid of our colleagues in obstetrics and gynecology. Embolization has been shown to be an

effective procedure for controlling hemorrhage in the postpartum period as well as related to other gynecologic conditions such as tumor and arteriovenous malformations. The role of catheter-directed intervention in DVT and pulmonary embolic disease should be individualized as sufficient data regarding the safety of thrombolytics in the antenatal period is insufficient.

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