Transcatheter Arterial Embolotherapy: A Therapeutic Alternative in Obstetrics and Gynecologic Emergencies

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ABSTRACT

Transcatheter arterial embolization has become a major treatment modality in a variety of clinical applications, including management of bleeding related to a broad spectrum of obstetric and gynecologic disorders. Embolotherapy has a well-documented role in the management of pelvic and genital tract hemorrhage in the postpartum and postoperative/postcesarean setting. It is also an integral part in the treatment armamentarium of abdominal and cervical ectopic pregnancy, arteriovenous malformation, and gynecologic neoplasms, including more recently, uterine leiomyomata. Based on experiences accumulated over the past decades, embolotherapy has been proven to be highly effective with success rate in the 90 to 100% range in the appropriate clinical settings. It provides visualization of the bleeding site and enables targeted, minimally invasive therapy to achieve hemostasis, which allows preservation of the uterus and hence fertility. In hospitals where experienced personnel and technology is available, transcatheter arterial embolization should be considered in the emergent management of obstetric and gynecologic hemorrhage, particularly when local and conservative measures fail to attain hemostasis.

KEYWORDS: Arterial embolization, obstetric gynecologic hemorrhage

Objectives: Upon completion of this article, the reader should understand the indications and technique for transcatheter arterial embolization in the management of obstetric and gynecologic hemorrhage.

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Pelvic hemorrhage is one of the most common complaints of women who present to the emergency department. A spectrum of obstetric and gynecologic disorders such as ectopic pregnancy, placental abruption, uterine rupture, obstetric trauma, and pelvic malignancies can often present with pelvic bleeding in emergent or urgent settings. Many of these entities have tradi-

tionally been managed by open surgical or laparoscopic interventions including hypogastric artery ligation or hysterectomy after conservative treatments failed.¹⁻³ Over the last few decades, with improvements in devices and techniques, percutaneous imaging-guided treatments have emerged as potential therapeutic alternatives in a variety of clinical situations. This article will focus on

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Interventional Radiology On-Call; Guest Editor, Thuong G. Van Ha, M.D.

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DOI 10.1055/s-2006-948761. ISSN 0739-9529.

Figure 1 A 33-year-old gravida 5, para 5 female with postpartum intra-abdominal hemorrhage following complicated vaginal delivery. (A) Selective right uterine arteriogram shows an enlarged uterine artery and pseudoaneurysm. (B) Subselective arteriogram using a microcatheter shows a lobulated pseudoaneurysm. (C) Post-coil embolization shows obliteration of the pseudoaneurysm. (Case courtesy of George J. So, M.D.)

the utilization of transcatheter arterial embolization in controlling pelvic and genital tract bleeding.

Application of angiographic diagnosis and transcatheter arterial embolization of hemorrhage was initially reported in the 1960s and early 1970s in the setting of acute gastrointestinal hemorrhage.^{4,5} The first reported use of transcatheter arterial embolization in obstetrics and gynecology was for the

control of intractable pelvic hemorrhage in patients with gynecologic malignancies in the mid 1970s.^{6,7} Subsequently, in 1979, Brown et al performed embolization of the left internal pudendal artery using gelatin sponge (gelfoam) powder and pledgets to successfully stop postpartum hemorrhage, after local and surgical methods, including transabdominal hysterectomy, had failed.⁸

Currently, there are several indications for transcatheter arterial embolization in obstetric and gynecologic hemorrhages, which are reviewed below.

POSTPARTUM HEMORRHAGE

Postpartum hemorrhage, as defined by the American College of Obstetrics and Gynecology, constitutes a 10% change between predelivery and postdelivery hematocrit, or a need for erythrocyte transfusion.⁹ Postpartum hemorrhage can occur as a result of uterine atony, genital tract lacerations, retained placental fragments, uterine rupture, abnormal placentation, and coagulopathies and is associated with severe blood loss and morbidity.¹⁰ Hemorrhage, in fact, is one of the leading causes of pregnancy-related death in the United States.¹¹ Initial conservative treatment options include uterine massage, oxytocin, methylergonovine, prostaglandin F_{2α} analogs, suturing of lacerations, curettage of retained fragments, and vaginal packing. These maneuvers are sufficient in most instances to control the hemorrhage. The next step historically includes various surgical options such as bilateral hypogastric artery ligation with or without adjunctive ovarian artery ligation, uterine artery ligation, and hysterectomy with variable success rates.¹⁰

Since the first case of transcatheter arterial embolization to control postpartum hemorrhage reported by Brown et al¹⁸ in 1979, there have been numerous reported cases of successful transcatheter arterial embolization in controlling postpartum bleeding with an aggregate success rate of ~97%.^{10,12} There are several clear advantages of embolotherapy over surgery for postpartum hemorrhage; these include: (1) easy identification of site of bleeding with subsequent targeted therapy (Fig. 1), (2) preservation of the uterus and hence fertility, (3) decreased risk of rebleeding from collateral circulation due to more distal occlusion in embolization, and (4) ability to visualize and occlude collaterals. In addition, embolotherapy allows repeat embolization, surgery, and other hemorrhage control measures. Finally, these procedures can be performed using conscious sedation and local anesthesia, thereby avoiding the risks associated with generalized anesthesia.^{12,13} Therefore, where there is continued hemorrhage despite more conservative measures and when equipments and interventional radiology personnel are readily available, transcatheter arterial embolization should precede surgical arterial ligation or hysterectomy in the acute setting, as embolization can be very difficult if not impossible after arterial ligation.¹²

POSTOPERATIVE/POSTCESAREAN HEMORRHAGE

Since the first report of successful hemostasis using transcatheter arterial embolization in a patient who had undergone gynecologic surgery by Oliver and

Lance¹⁴ in 1979, additional cases appeared in the literature demonstrating efficacy of this technique in postoperative hemorrhage.^{15,16} Rosenthal and Colapinto reported success of arterial embolization in treatment of seven of the nine postoperative vaginal bleeding episodes.¹⁵ One of the failures was attributed to previous bilateral hypogastric ligation that prohibited catheter access to the bleeding branch for embolization. In case of failed local measures including packing and ligation of bleeding sites, embolization is advocated early in the postoperative management while the patient's coagulation status and vital signs are relatively normal¹⁷ with surgery reserved for failure of angiographic procedures. In addition to unfavorable postsurgical tissue environment and distorted anatomy, as in the postpartum setting, prior arterial ligation may preclude subsequent embolization.¹²

HEMORRHAGE FROM ECTOPIC PREGNANCY

Given the advances in prenatal care and screening obstetric ultrasound, ectopic pregnancies are now frequently detected at an earlier stage where medical therapy with methotrexate or surgery can be safely performed, particularly for tubal and ovarian pregnancies. However, surgery for abdominal and cervical pregnancies can be associated with massive hemorrhage. Therefore, transcatheter arterial embolization performed in a prophylactic setting or on an emergent basis can be an important adjunctive management in this subset of patients.¹³ There are at least 13 cases of successful arterial embolization of abdominal ectopic pregnancy performed prophylactically or after surgical removal of the ectopic fetus.¹⁸⁻²⁷ In fact, one patient with a mid-trimester abdominal pregnancy was treated successfully without any surgical intervention by ultrasound-guided fetal intracardiac injection of potassium chloride, selective embolization of left internal iliac artery, followed by ultrasound-guided drainage of hematoma.²⁶ At least 15 cases of successful embolization for cervical ectopic pregnancy are also reported in the literature.^{24,28-34} One of the rarest kinds of ectopic pregnancy develops within a previous cesarean section scar. Yang et al³⁵ reported three cases of ectopic pregnancy within cesarean section scar where bilateral uterine artery embolization was successfully used to prevent intraoperative bleeding in two patients and to stop postoperative bleeding in the third patient.

INTRACTABLE HEMORRHAGE RELATED TO PELVIC MALIGNANCY

The earliest gynecologic application of transcatheter arterial embolization was in treatment of intractable pelvic hemorrhage related to pelvic malignancies.^{6,7}

Figure 2 A 54-year-old female with history of cervical cancer, status post-total abdominal hysterectomy and bilateral salpingo-oophorectomy, with known tumor recurrence, presenting with severe vaginal bleeding, which was unresponsive to vaginal packing. (A) Pelvic arteriogram shows tumor neovascularity supplied by branches of the hypogastric arteries bilaterally. (B) Selective injection of one of the feeding branches shows tumor neovascularity without evidence of contrast extravasation. Embolization was performed with gelfoam.

The data on transcatheter arterial embolization of pelvic malignancies are not as extensive as the data on embolization of postpartum hemorrhage. However, there are studies that show embolization to be beneficial in this setting. Pisco et al³⁶ performed transcatheter embolization of the internal iliac arteries in 108 patients with uncontrollable bleeding from pelvic neoplasms (uterus in 39, ovary in 16, urinary bladder in 50, and prostate in 3) with complete control of the hemorrhage in 69% of the patients and partial control in 21% of the patients. Yamashita et al³⁷ reported 100% temporary control of bleeding in 17 patients with malignant neoplasms. However, reembolization was required in three of the patients. These patients all underwent subsequent treatment for their neoplasm with radiation, surgery, or chemotherapy. In contrast to postpartum hemorrhage, intractable hemorrhage due to malignant neoplasms seldom showed specific bleeding sites (Fig. 2). Nevertheless, embolization was also usually effective in these circumstances.³⁷ In the study of Inaba et al,³⁸ one patient with recurrence of uterine cervical cancer developed infection after surgery with arterial hemorrhage manifested by vaginal hemorrhage, which was confirmed by extravasation of contrast at angiography; the patient received transcatheter arterial embolization of the external iliac artery. To prevent

distal migrating of the coil, the authors used a balloon to occlude the distal side. Bleeding was successfully controlled. Mihmanli and others³⁹ showed successful cessation of intractable vaginal hemorrhage by arterial embolization using polyvinyl alcohol particles in six patients with gynecologic malignancies. Based on these limited reports, it appears that arterial embolization plays a role in urgent control of significant bleed in the setting of pelvic neoplasm until more definitive therapy can be rendered.

ARTERIOVENOUS MALFORMATION

Massive uterine bleeding in young women can be infrequently caused by uterine arteriovenous malformation (AVM) (Fig. 3), which could be congenital or acquired. The acquired AVM may be the result of uterine curettage for miscarriages, gestational trophoblastic disease, hysterectomy, and the removal of an intrauterine device.⁴⁰ Pelvic AVM can cause severe bleeding and surgical ligation of feeder vessels have failed due to rapid recruitment of collateral vessels. Before the availability of transcatheter embolization, hysterectomy was performed. Between 1982 and 1999, 25 cases of AVMs were treated by embolization with success rate of 96% following one to two embolization procedures.⁴⁰ A more

Figure 3 A 46-year-old female presenting to the Emergency Department with severe vaginal bleeding. Pelvic (A) and selective left hypogastric (B) arteriogram show enlarged tangles of vascularity infiltrating the uterus with early venous opacification, consistent with an AVM, as seen on ultrasound (C).

recent retrospective study by Jacobowitz et al⁴¹ showed patients required a mean of 2.4 embolization procedures over an average of 23.3 months, and subsequent surgery was performed in 15%. The authors concluded that transcatheter embolization plays a significant role in the treatment of symptomatic pelvic vascular malformation. In a study of 15 patients with acquired AVM conducted by Ghai et al,⁴² bleeding was controlled in 14 of 15 (93%) of the patients and one patient underwent a hysterectomy. A total of 25 embolization procedures were performed in these patients with nine of them performed on emergent basis.

PREOPERATIVE HEMOSTASIS/ PROPHYLACTIC USES

Mitty and others evaluated the use of prophylactic transcatheter arterial catheterization and/or embolization in nine patients with known antepartum (precesar-

ean section) or preoperative risks for bleeding, such as placenta accreta, placenta previa, abdominal ectopic pregnancy, uterine leiomyomas, and twin fetal deaths, and concluded that there is a potential role of prophylactic arterial catheterization in patients at increased risk for obstetric hemorrhage.²² Transcatheter arterial embolization has also been used in the preoperative setting in women with an increased risk for severe bleeding during surgery for hypervascular masses, including ectopic pregnancy, which has been previously discussed, and uterine fibroids.⁴³

SYMPTOMATIC UTERINE FIBROID

Uterine leiomyomas can be a cause of severe menorrhagia. Since the discovery by Ravina and coworkers that fibroids shrunk secondary to uterine artery embolization done preoperatively to reduce the complications of surgery,⁴⁴ transcatheter arterial embolization is now an

accepted treatment for symptomatic uterine fibroid,^{45–47} though usually in an elective setting.

EMERGENCY EMBOLOTHERAPY IN OBSTETRICS AND GYNECOLOGY

Pertaining to emergent or urgent need for transcatheter arterial embolization in the obstetrics and gynecologic applications in the on-call setting, several considerations are at play: (1) the underlying etiology of the hemorrhage, (2) patient's clinical response to local conservative measures, and to a large extent (3) the severity and acuity of patient presentation and other clinical parameters. Active continuing hemorrhage despite local conservative treatments targeting the underlying etiology represents the primary indication for emergency embolotherapy in the postpartum and postoperative/postcesarean setting. These patients may be hemodynamically unstable and may have evidence of disseminated intravascular coagulation. Similarly, intractable pelvic hemorrhage secondary to gynecologic malignancies or arteriovenous malformation may require urgent angiographic intervention, particularly in those patients whose medical conditions preclude major surgery.

CONTRAINDICATIONS

The contraindications for pelvic transcatheter arterial embolization include those related to usage of iodinated contrast media such as known clinically significant allergy to contrast media, renal insufficiency, severe hypertension, uncorrectable bleeding diathesis, or coagulopathy.

TECHNIQUE

Transcatheter arterial embolization is most often done with the aid of conscious sedation. Prophylactic antibiotics such as cefazolin can be administered. Pelvic arteriogram is first obtained via the standard transfemoral approach. Selective catheterization of the hypogastric arteries is usually performed next to identify the source(s) of bleeding. For postpartum hemorrhage, gel-foam pledgets or slurry are most commonly used to induce temporary vascular occlusion because the material is effective for 2 to 4 weeks and allows for collateral development.¹³ Particles such as polyvinyl alcohol particles are not recommended in this setting because of increased risk of ischemic complications from more distal occlusions.⁴⁸ Even in cases where specific site of bleeding is not identified, embolization can still be effective.^{13,18}

In postoperative bleeding where a bleeding terminal artery can be identified, in addition to gelfoam, coil embolization is also efficacious in establishing hemostasis.¹⁵

In the setting of abdominal ectopic pregnancy, gelfoam pledgets are most frequently used to embolize the blood supply of the placenta preoperatively to reduce hemorrhage.^{22,23} Lobel and others used gelfoam pledgets and coils for preoperative embolization of cervical pregnancy.²⁸ It is noteworthy that surgical treatment or dilatation and curettage should immediately follow arterial embolization in the management of abdominal and cervical ectopic pregnancies, respectively, as formation of collateral vessels can occur within hours.¹³

More permanent embolic agents as polyvinyl alcohol particles have been used for embolization of hemorrhage associated with neoplasms. However, gelfoam is often utilized as well.

A variety of embolic materials have been reported in the setting of AVM, including bucrylate glue, polyvinyl alcohol particles, gelfoam, and coils.^{12,40}

COMPLICATIONS

Complications from pelvic vascular interventions can broadly be divided into three main categories: angiography-related complications, infections, and ischemic phenomena.¹²

Angiography-related complications include puncture site-related groin hematoma and vascular damage, catheter-induced distal embolization or dissection, and contrast media-associated reactions or nephrotoxicity.⁴⁹ Isolated angiography-related complications have been reported in the postpartum setting⁵⁰ and in the treatment of uterine fibroids.⁴⁶

As with any interventional procedures, there is a small risk of infectious complications. In a study by Rajan et al,⁵¹ of the 410 patients who received uterine arterial embolization procedures, only five patients developed intrauterine infectious complications requiring intravenous antibiotic therapy and/or surgery. Gilbert et al²⁹ reported that 9 of 10 patients had postprocedural fever, of which eight patients responded to antibiotics alone and one patient required drainage of hematoma-abscess. There are also a few case reports of pelvic and abdominal wall abscesses following uterine artery embolization.¹²

Ischemic phenomena are known complications related to pelvic arterial embolization. However, according to the study by Stancato-Pasik et al,²⁴ 92% (11 of 12) of the women who underwent selective gelatin sponge pledget (gelfoam) embolization of uterine vessels for obstetric hemorrhage resumed normal menses within 2 to 5 months. The one patient who was amenorrheic on follow-up was receiving medroxyprogesterone acetate for bleeding related to a uterine AVM. All three patients who desired pregnancy had full-term healthy newborns. There are other isolated reports of pregnancy in women status post-uterine artery embolization to control pelvic hemorrhage.^{19,30,52} More recent studies on women who

received uterine arterial embolization for treatment of leiomyomata also demonstrated a significant number of uneventful pregnancies and deliveries.⁵³⁻⁵⁶

A study of six patients who underwent super-selective bilateral uterine artery embolization for treatment of fibroid and subsequently had complete loss of ovarian arterial circulation demonstrated by ultrasound immediately postprocedure showed that four of the six women had reestablished perfusion on follow-up. Only one of the six patients, the only patient over 45 years of age, experienced onset of new menopausal symptoms.⁵⁷ Of note, these patients received embolization by polyvinyl alcohol particles or Embospheres (triacyl gelatin microspheres). There are also data to suggest that in women younger than 40 years of age, with regular menstrual cycles pretreatment, uterine artery embolizations for fibroids have no impact on ovarian reserve by sonographic or hormonal parameters.⁵⁸ A case of permanent amenorrhea associated with endometrial atrophy after uterine artery embolization, again, using polyvinyl alcohol particles, for fibroids was reported.⁵⁹ There is one case of uterine necrosis after arterial embolization for postpartum hemorrhage, requiring hysterectomy. The small size of polyvinyl alcohol particles (150 to 250 μm) used likely caused the ischemic event.⁴⁸ Shashoua et al⁶⁰ reported the first case of ischemic uterine rupture after uterine artery embolization for treatment of symptomatic uterine myomas requiring hysterectomy in the United States.

A case report citing full-thickness necrosis of buttock, which occurred after uterine artery embolization, eventually healed over 14 weeks after surgical debridement.⁶¹ Necrosis of the bladder has been observed secondary to pelvic artery embolization.⁶² Similarly, paresis of the lower extremities as a result of pelvic embolization for pelvic malignancies has also been reported.⁶³ Vesicovaginal fistula as an infrequent complication following transcatheter internal iliac arterial embolization therapy has been described in patients with gynecologic cancer status postradiotherapy.⁶⁴

Additionally, radiation exposure may impose potential risks to patients receiving embolotherapy¹⁵ and can be of theoretical consideration.

SUMMARY

In conclusion, the overall effectiveness of transcatheter arterial embolization is high in treatment of obstetric and gynecologic hemorrhage with a relatively low complication rate. The advantages of transcatheter arterial embolization include accurate identification and targeted hemostasis of the bleeding source in a minimally invasive fashion. In addition, embolization allows further procedure in case of recurrent bleed, and it does not preclude surgical treatment. In obstetric and gynecologic patients, one of the most important bene-

fits of transcatheter arterial embolization is potential preservation of fertility. In hospitals where experienced personnel and technology are available, transcatheter arterial embolization should be an integral part in the emergent management of obstetric and gynecologic hemorrhage.

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