INVITED ARTICLE

Interventional Radiology in Obstetric Emergencies

Suyash Kulkarni[1], Nitin S Shetty[2], Anurag Gupta[3], Saketh Rao[4], Harshit Bansal[5]

Abstract

Postpartum hemorrhage (PPH) is one of the common causes of morbidity as well as mortality among pregnant women. Obstetric hemorrhage embolization (OHE)/uterine artery embolization (UAE) is the preferred treatment for PPH which has failed medical therapy. In cases of placental accreta spectrum (PAS), balloon catheter can be prophylactically placed in internal iliac arteries (IIAs) bilaterally before delivery to enable postpartum control of bleeding. An inferior vena cava (IVC) filter can be placed under fluoroscopy for a pregnant woman with deep vein thrombosis (DVT) for whom anticoagulation is contraindicated or needs to be stopped at the time of labor. Injection of chemical into the gestational sac can be performed under ultrasonography (USG) guidance to treat ectopic pregnancy. Percutaneous or transvaginal drainage of a collection can be done by ultrasound or computed tomography (CT) guidance for puerperal sepsis. Percutaneous nephrostomy (PCN) is performed for obstructive ureterolithiasis in case of urosepsis or significant stone burden. Sonography should be used for the guidance of interventional radiology (IR) procedures whenever possible. Fluoroscopy must be used only if necessary, giving special attention to radiation-sparing maneuvers.

Keywords: Interventional radiologist, Interventional radiology, Obstetric emergencies, Obstetric hemorrhage embolization, Postpartum hemorrhage, Prophylactic balloon catheter insertion, Uterine artery embolization.

Indian Journal of Critical Care Medicine (2021): 10.5005/jp-journals-10071-24090

Introduction

There can be complications of pregnancy during the gestational period or postpartum affecting the mother, fetus, or both.[1] Interventional radiologists treat postpartum hemorrhage (PPH), abnormal placental implantation, ectopic pregnancy, thromboembolic disease, puerperal sepsis, and obstructive uropathy. Interventional radiology (IR) offers nonsurgical therapeutic options, which not only reduce morbidity and mortality, but also improve the potential to preserve fertility. The prospect of interventions involving radiation causes anxiety and unease among patients and clinicians because of the increased awareness of the risk to the fetus from radiation exposure. Hence, fluoroscopy procedures must be performed with due diligence and minimize radiation exposure to a pregnant woman. The principle of ALARA, (As Low As Reasonably Achievable) should always be practised to keep radiation exposure to minimum. This article describes the IR procedures used to treat various emergencies during pregnancy and peripartum period and techniques to reduce the dose of radiation to fetus.

The IR procedures that are performed during obstetric emergencies include the following.

- Obstetric hemorrhage embolization (OHE)/uterine artery embolization (UAE)
- Prophylactic balloon occlusion
- Inferior vena cava filter placement
- Direct chemical injection into ectopic sac
- Abscess drainage
- Percutaneous nephrostomy (PCN).

Uterine Artery Embolization/Obstetric Hemorrhage Embolization

The OHE is an endovascular therapeutic procedure that blocks visceral arteries supplying the bleeding gravid uterus. While uterine arteries are the most common vessels to be embolized to control bleeding, other visceral arteries which may be targeted involves ovarian, vaginal, and internal pudendal.[1–3]

OHE or UAE is performed to treat PPH. PPH can be divided into a primary hemorrhage (>500 mL bleeding from the genital tract within the first 24 hours after birth) and secondary hemorrhage (after the first 24 hours till 6 weeks after the birth).[1] Uterine atony and trauma/laceration of the genital tract are the common causes of primary PPH. Other less frequent causes include congenital or acquired coagulation disorders, ruptured pseudoaneurysm, placental accreta spectrum (PAS), uterine rupture, inversion of uterus, fibroids, retention of placental fragments, coagulopathies, and uterine vascular malformation.[4]

PPH is initially managed by fluid resuscitation, removal of retained placental tissue, coagulopathy correction, uterotonic drugs, and tamponade by balloon, which may stop bleeding in up

[1]Department of Radiology, Tata Memorial Hospital, Mumbai, Maharashtra, India

[2]Department of Interventional Radiology, Tata Memorial Hospital, Homi Bhabha National Institute, Mumbai, Maharashtra, India

[3,4]Department of Interventional Radiology, Tata Memorial Hospital, Mumbai, Maharashtra, India

[5]Department of Radio-diagnosis, University College of Medical Sciences, New Delhi, India

Corresponding Author: Nitin S Shetty, Department of Interventional Radiology, Tata Memorial Hospital, Homi Bhabha National Institute, Mumbai, Maharashtra, India, Phone: +91 9757092013, e-mail: drnsshetty@gmail.com

How to cite this article: Kulkarni S, Shetty NS, Gupta A, Rao S, Bansal H. Interventional Radiology in Obstetric Emergencies. Indian J Crit Care Med 2021;25(Suppl 3):S273–S278.

Source of support: Nil

Conflict of interest: None

to 85% of the patients.[1,4] With the advent of obstetric interventions, OHE/UAE is performed to arrest the blood loss. OHE/UAE is the treatment of choice in uncontrolled PPH and should be performed when initial medical therapy fails and before any surgical therapy.[1,4]

Preprocedure Imaging

Imaging before catheter angiography can be done in cases where the patient is hemodynamically stable and the bleeding is slower or intermittent.

- Sonography may show fluid in the abdomen and retained placental products or clots.
- Doppler study would not contribute significantly in acute bleeding except in case of uterine vascular malformation.
- Computed tomography (CT) angiography helps to detect active extravasation or pseudoaneurysms.
- Magnetic resonance imaging (MRI) and magnetic resonance angiography (MRA) give information similar to CT and are useful in diagnosing abnormal placentation during gestation.

Patient Preparation

Routine hematological and other laboratory parameters such as renal function and coagulation must be assessed and, if needed, optimized. It is recommended that procedure should be done under conscious sedation and analgesia. OHE should be performed after 30 minutes of administering uterotonic drugs since they can induce spasm of the uterine arteries and cause difficulty in angiographic assessment.

Anatomical Blood Supply Relevant for OHE/UAE and Angiographic Procedure

The internal iliac artery (IIA) splits into anterior and posterior divisions. The anterior division gives rise to key visceral arteries to need to be targeted for OHE—uterine, vaginal, and internal pudendal arteries. There are communications between anterior and posterior divisions of IIA, as well as between the branches of the internal iliac, external iliac, and mesenteric arteries.[1] These anastomoses provide vascularity to the bleeding uterus through collateral supply which can at times be responsible for failure of OHE/UAE. In addition, these collateral communications would be responsible for nontarget embolization resulting in complications.

OHE/UAE procedure is usually performed using the femoral artery as an access route. In a profusely bleeding patient, few interventional radiologists prefer bilateral femoral access for simultaneous embolization of bilateral uterine arteries to save time and minimize radiation exposure in a profusely bleeding patient.

Selective cannulation of the uterine artery using dedicated catheters and microcatheters is performed, and embolic material is injected under minimum fluoroscopic exposure. Suppose the patient is hemodynamically unstable or cannulation of the uterine artery is difficult, the anterior division of the IIA is embolized to arrest bleeding as soon as possible.

Choice of Embolic Materials for OHE/UAE

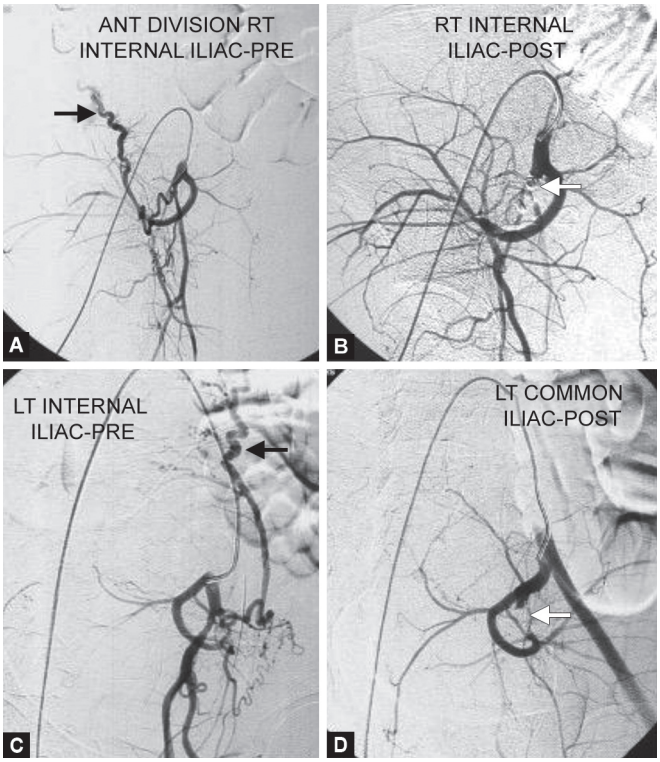
The embolic materials can be either temporary or permanent. The temporary embolic agent most commonly used is particles of absorbable gelatine sponge which contain water-insoluble gelatine that allows recanalization of vessels in few weeks. The permanent embolic agents are coils, microspheres, plugs, and liquid polymers. In most cases of PPH, active extravasation of contrast is not seen, especially when bleeding is due to uterine atony. In case of uncontrolled PPH, if there is no identifiable bleeding site, prophylactic embolization of both the uterine arteries and the anterior division of IIA is performed (Fig. 1). When active extravasation is identified, the distal branch of the uterine artery is the common culprit, followed by the vaginal artery. If the source of bleeding is identified, such as a pseudoaneurysm or active extravasation, then superselective catheterization of the bleeding artery and embolization with coils or liquid embolic agent is performed (Fig. 2). The mechanism of action of liquid embolic agents such as n-butyl-cyanoacrylate (NBCA) glue or ethylene vinyl alcohol (EVOH) copolymer suspended in dimethyl sulfoxide (Onyx) is independent of the body's coagulation cascade and is used predominantly for embolization of uterine arteriovenous malformations (AVMs) (Fig. 3).

Medication and Periprocedural Care

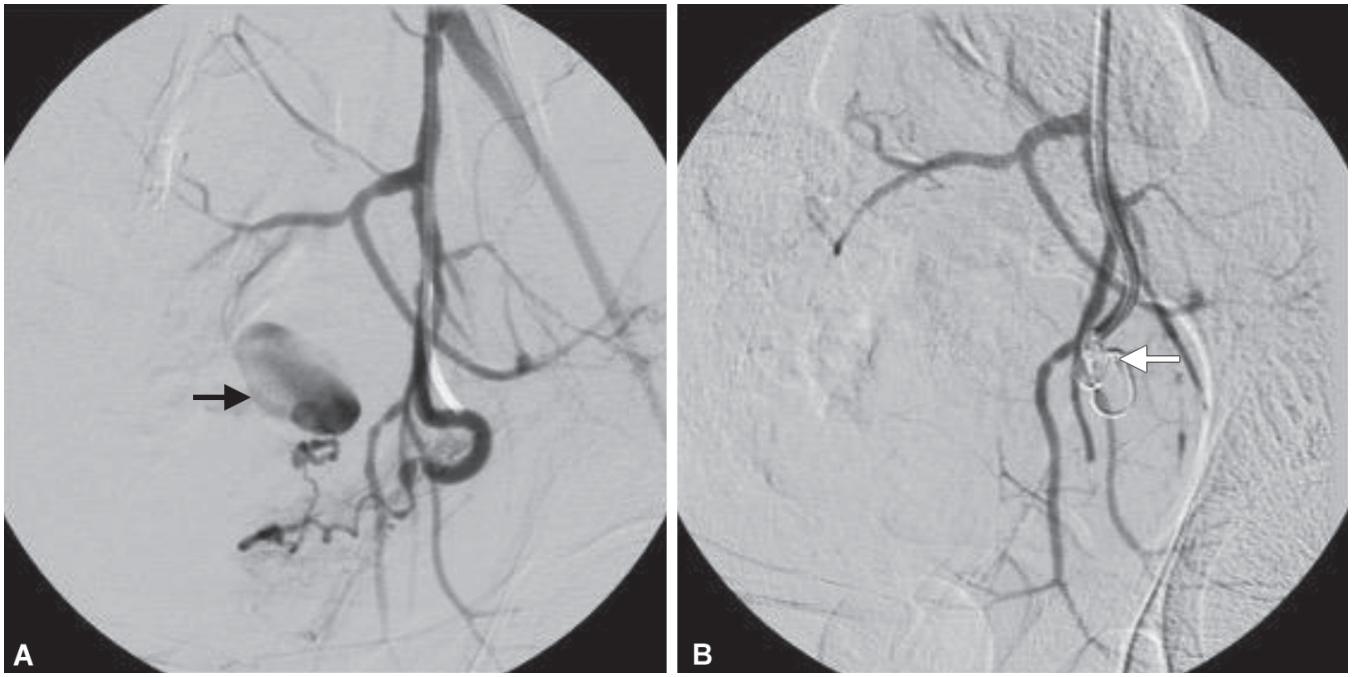
For good clinical outcome and success of OHE/UAE, patients should receive adequate hemodynamic support, including administration of fluid, uterotonic drugs, antifibrinolytics like tranexamic acid, blood and blood products, fibrinogen, platelets, and other appropriate clotting factors.[1,5]

Postprocedural Follow-up Care

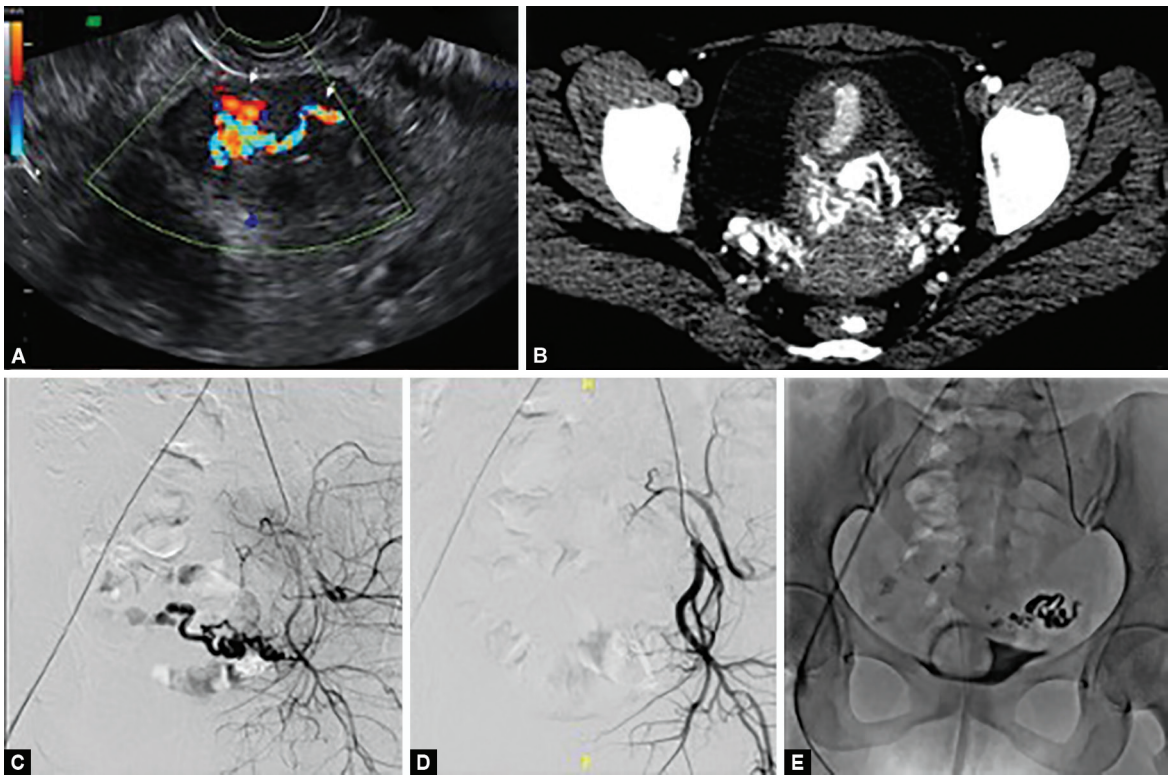
Patients may experience postembolization syndrome for a few days characterized by abdominal pain, nausea, low-grade fever, and increased white blood cell (WBC) counts. It is managed



Figs 1A to D: A 21-year-old postpartum lady presented with primary PPH due to atonic uterus. Because of difficult uterine artery cannulation, bilateral anterior division of the internal iliac artery was embolized using coils (white arrows in B and D); (A and C) Angiogram of right and left iliac artery respectively shows dilated and tortuous uterine arteries (black arrows); (B and D) Postcoiling angiogram of iliac artery shows adequate embolization resulting in stabilization of patient's hemodynamics *Courtesy:* Dr Bhavesh A Popat, KEM Hospital



Figs 2A and B: A 23-year-old lady presented with massive PV bleed 24 hours after post LSCS. (A) Angiogram of the left internal iliac artery revealed a large pseudoaneurysm (black arrow) arising from the branch of the uterine artery. Since the patient was hemodynamically unstable and arteries were in spasm due to noradrenaline infusion, coil embolization (white arrow) of the left uterine artery was done; (B) Angiogram of left internal iliac artery post embolization does not reveal pseudoaneurysm. *Courtesy:* Dr Bhavesh A Popat, KEM Hospital



Figs 3A to E: A 33-year-old woman treated for gestational trophoblastic disease 10 years back presented with a history of recurrent abortions and diagnosed to have uterine AVM. (A and B) Ultrasound and axial CT scan image shows dilated and tortuous vessels within the myometrium of the uterus suggestive of vascular malformation (white arrow); (C) Left internal iliac angiogram shows dilated and tortuous branches of uterine artery with early draining vein suggestive of uterine AVM (black arrow). Superselective cannulation of the feeding artery and embolization of AVM was done using 33% glue (NBCA); (D) Postembolization angiogram shows complete disappearance of AVM; (E) Radiograph shows cast of glue (white arrow) within the vascular malformation

conservatively with hydration, analgesics, and anti-inflammatory medications.

Rebleed after embolization for obstetric hemorrhage is seen in 5–10% of the patients, which may be due to arterial spasm, bleeding from collateral vessels, or invasive placenta. OHE/UAE is repeated with embolization of uterine arteries or anterior division of IIA if they are patent. If these arteries are occluded, other bleeding sources (collateral vessels) should also be evaluated. Communication from collateral vessels might occur from ovarian, rectal, mesenteric, lumbar arteries, or the artery of the round ligament.[1]

Complications

OHE/UAE is a safe procedure, and the morbidity associated with arterial embolization is significantly less after surgery. Complications related to angiography procedure in general include puncture site hematoma at the groin, arterial dissection, and reactions to contrast medium. Serious complications following OHE like ovarian failure, bladder, and rectal wall necrosis are rare and arise from zealous overembolization or disruption of collateral supply due to prior ligations. Necrosis of uterus following embolization is extremely rare. Buttock ischemia and gluteal claudication might appear due to nontarget embolization of branches of the posterior division branches IIA, which is usually minor and transient, but could be lifestyle-limiting.[1,4,6]

Clinical and Technical Success

OHE/UAE is a safe and effective procedure for PPH with a reported success of 91% (range: 79–100%). Repeat UAE, when bleeding persists or recurs after the first session, has a success rate of 67–80%.[1,2] Factors that predict failure of embolization are unilateral embolization, collateral/accessory arterial supply, previous surgical ligation, invasive placentation, disseminated intravascular coagulation (DIC), and severe arterial vasospasm on angiography.[1,7] The rate of success of embolization for the control of bleeding in uterine AVM is reported to be 93–96% and by PAS disorder is around 80%.[1,4,6,7]

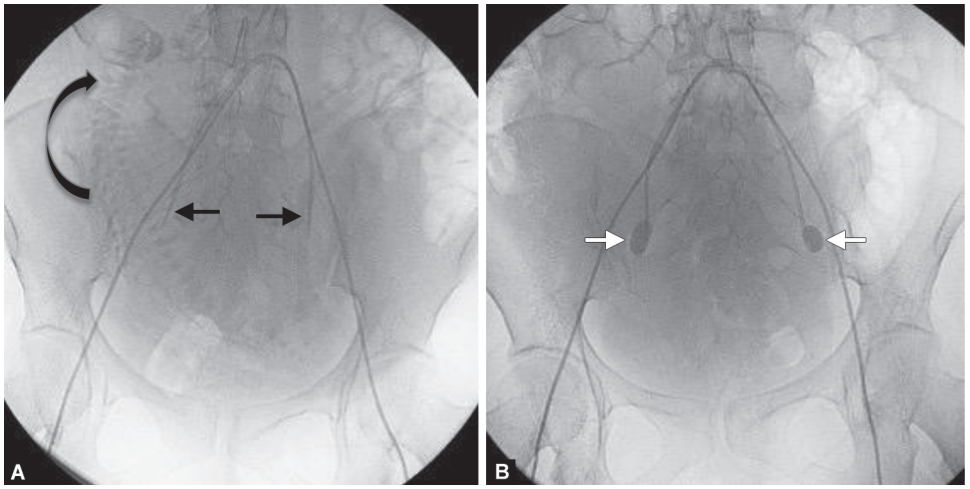
Prophylactic Balloon Occlusion

This refers to the placement of occlusion balloon catheters in IIAs or their anterior divisions bilaterally in patients for whom heavy bleeding is anticipated (particularly in cases of the morbidly adherent placenta) before cesarean section. With the patient in the angiography suite, arterial access is taken in bilateral femoral arteries, and occlusion balloon catheters are positioned into the anterior division of the IIAs with minimum radiation exposure to the mother and fetus. The balloons are tested for adequate inflation for vessel occlusion and secured to avoid displacement of catheter while transferring the patient to the obstetric theater. After successful delivery, the balloons are inflated in place to enable the obstetrician to perform hysterectomy or remove as much of the placenta feasible along with any myometrium and reconstruct the uterus. The patient is then shifted to the IR suite, and angiography is done with embolization if necessary (Fig. 4). Balloons are removed immediately or on the following day.

Studies that have investigated the potential of prophylactic balloon catheter occlusion of the anterior division of the IIAs in women with PAS disorder have reported clinical success rates of up to 86%. Complications include transient lower limb paresthesia, endometritis, and peritonitis.[8]

Inferior Vena Cava Filter Placement

As compared to nonpregnant women, the incidence of deep vein thrombosis (DVT) in pregnancy is 5–6 times more common, and pulmonary thromboembolic disease is the leading cause of maternal death. The risk factors include factor V Leiden mutation, prior DVT, obesity, prolonged bed rest, and surgical delivery. Generally, thrombolytics during pregnancy is not recommended except in cases of life-threatening conditions such as pulmonary embolism with hemodynamic instability, acute myocardial ischemia (MI), cerebral thrombosis, and threatened limb due to DVT and the treatment of choice is low molecular weight heparin. However, when anticoagulation needs to be withdrawn at the time of delivery or when anticoagulants are contraindicated; retrievable inferior



Figs 4A and B: A 28-year-old lady with a history of previous LSCS was diagnosed with placenta accreta spectrum during the antenatal check-up. Because of expected PPH, it was decided to prophylactically place balloon catheter in both the internal iliac artery prior to labor induction. (A) Fluoroscopic image shows the tip of balloon catheter (black arrows) in internal iliac arteries on both sides. The outline of the fetal spine can be seen faintly (curved arrow); (B) Post-delivery, the balloon catheter was inflated (white arrows) and shifted to the IR suite for uterine artery embolization to control PPH. *Courtesy:* Dr Bhavesh A Popat, KEM Hospital

vena cava (IVC) filter can be placed in the IVC. The placement of the filter is done preferably in the intrahepatic portion of IVC to avoid compression by the gravid uterus and also allow filtration in cases of thrombosis of gonadal vein.[9]

Direct Injection of Chemical into Ectopic Gestational Sac

The incidence of ectopic pregnancy among women in the general population is 2% and among those who undergo fertility treatments is 4.5%. The usual location of an ectopic gestational sac is the fallopian tube (>90% of cases), uterine cornu (2–4%), cervix (1%), ovary, scar of Cesarean section scar, and abdomen. The conventional treatment options for ectopic pregnancy include short-interval surveillance, medical therapy, and surgery. For a patient with nonviable tubal pregnancy, a low or downward-trending serum level of beta-human chorionic gonadotropin (β-hCG) expectant management is practiced.[1,10] Medical management by means systemic administration of methotrexate is considered in case of a viable gestational sac in the fallopian tube. If systemic methotrexate therapy fails or has heterotopic pregnancies with intrauterine implantation that pregnant woman wishes to retain, fertility-preserving conservative treatment options become essential. IR procedures form the core of conservative management in these cases and USG guided injection of chemical directly into ectopic implant is performed as a non-surgical alternative. Following administration of antibiotic prophylaxis, under all aseptic precautions, a 20G needle is inserted into the amniotic sac transvaginally, with transvaginal sonography (TVS) guidance. The amniotic fluid is aspirated first, and then, a chemical, either methotrexate (1 mg/kg) or hyperosmolar glucose (50% solution) or potassium chloride (1–3 mL in a 2 mEq/mL solution) is injected into the sac.[1,6] The advantages of direct injection of methotrexate into the amniotic sac include a higher local concentration of the chemical and a lower risk of systemic side effects. The main contraindications to this procedure are hemoperitoneum and hemodynamic instability which require immediate surgical exploration.

Ectopic Pregnancy in Other Sites than Fallopian Tube

The direct injection of chemical is an effective therapy for gestational sac in the cornu, cervix, or scar of previous Cesarean section. Since the sac in a cornual ectopic pregnancy may be larger than that in a tubal pregnancy, UAE may be performed just before cornual sac injection to reduce the vascularity and the risk of postinjection hemorrhage. In case of cervical pregnancy, since the tissue surrounding the sac would be vascular and fibrous resulting in severe intraoperative or postoperative hemorrhage, bilateral prophylactic uterine artery balloon occlusion before a direct sac injection would reduce the risk of bleeding.[11]

Abscess Drainage

Parenteral antibiotics are the mainstay of therapy for postpartum endometritis; however, if fever persists after 2–3 days of treatment with antibiotics, it may signify a different source of infection for puerperal sepsis. USG or CT is used to evaluate the source of infection and guide further intervention . In case of postoperative collections/abscess, drainage can be done by transvaginal or percutaneous transabdominal route with USG or CT guidance. USG is generally preferred because it captures in real time, is easily available, and involves no ionizing radiation. CT may be required for transabdominal/transgluteal drainage of collections that are not visible on USG.[1,7]

Percutaneous Nephrostomy

PCN is a procedure done to drain the urine externally by inserting a flexible tube into the dilated renal pelvis. The most common indication for PCN during pregnancy is obstructive ureterolithiasis, and more than 80% of these occur in the second and third trimesters.[1,7] Management is usually conservative, since the obstruction resolves with hydration, bed rest, and analgesia in 80% of the patients, which if fails require ureteroscopic removal. In case of urosepsis or significant burden of stone (sum of maximum diameters, >1 cm), PCN is performed. PCN is a temporary diversion procedure performed as a bridge for ureteral stenting, ureteroscopy, or spontaneous passage of stones and allows deferral of definitive therapy until postpartum.

PCN in a pregnant woman is performed under ultrasound guidance in an oblique prone position. When the sonographic visibility is poor, procedure is done using limited fluoroscopy, with appropriate techniques to minimize the radiation exposure to fetus. Though PCN can be performed with local anesthesia alone, intravenous sedation with opiates may be required for uncooperative or anxious pregnant women. There may be a risk of septic shock following PCN in the setting of urinary infection, and hematuria, but significant bleeding is rare.[7]

At times, there can be an iatrogenic injury to the bladder or ureter due to complication during Cesarean delivery, which may result in urinoma or vesicouterine fistula. In such cases, PCN is done to divert the urine away from the injury site and promote healing.[6,5]

Radiation Exposure to Fetus and Health Implications

The risk to a fetus from ionizing radiation during diagnostic imaging is drastically increased when the exposure exceeds 150 mGy.[1,9] Teratogenesis, however, is absent below a specific threshold of radiation level; above that threshold, the severity depends on the fetus's gestational age at the time of exposure. The risk for radiation-induced abnormality is negligible at doses of less than 50 mGy, in comparison with baseline risks for all developmental abnormalities.[1,12]

Techniques for Minimizing Radiation Dose to Pregnant Woman

Given the potential for teratogenesis, all efforts are taken to limit the radiation exposure to pregnant women to the minimum. USG should be used for the guidance of IR procedures whenever possible. Fluoroscopy must be used only if necessary, giving special attention to radiation-sparing maneuvers.[11] Monitoring and recording of radiation doses to pregnant women are important to enable future assessment of possible effects on the fetus. The radiation dose received by the pregnant mother during IR procedures should be included in the medical record of the patient.

Conclusion

There can be complications of pregnancy during the gestational period or postpartum affecting the mother, fetus, or both. IR plays a critical role in treating complications such as PPH, abnormal placental implantation, ectopic pregnancy, thromboembolic

disease, puerperal sepsis, and obstructive uropathy. Interventional radiologists offer radiologic image-guided therapy as an alternative to surgery, including UAE, prophylactic balloon placement, direct chemical injection, IVC filter placement, abscess drainage, and PCN, respectively, in these instances. OHE/UAE is the treatment of choice to control PPH when initial medical therapy fails and should be considered before any surgical treatment is instituted. These procedures are minimally invasive, reduce morbidity and mortality compared to surgery, and have the maximum potential for preserving the future fertility of the pregnant woman. Whenever fluoroscopy is used for image guidance while performing an IR procedure on a pregnant woman, care should be taken to keep the radiation exposure to the fetus as low as achievable.

Orcid

Suyash Kulkarni https://orcid.org/0000-0001-5972-6111
Nitin S Shetty https://orcid.org/0000-0002-6389-1678
Anurag Gupta https://orcid.org/0000-0003-1897-7752
Saketh Rao https://orcid.org/0000-0003-0234-9882
Harshit Bansal https://orcid.org/0000-0001-7384-0359

References

1. Rand T, Patel R, Magerle W, Uberoi R. CIRSE standards of practice on gynaecological and obstetric haemorrhage. CVIR Endovasc 2020;3(1):85. DOI: 10.1186/s42155-020-00174-7.
2. Iwata A, Murayama Y, Itakura A, Baba K, Seki H, Takeda S. Limitations of internal iliac artery ligation for the reduction of intraoperative hemorrhage during cesarean hysterectomy in cases of placenta previa accreta. J Obstet Gynaecol Res 2010;36(2):254–259. DOI: 10.1111/j.1447-0756.2009.01157.x.
3. Pelage JP, Soyer P, Repiquet D, Herbreteau D, Le Dref O, Houdart E, et al. Secondary postpartum hemorrhage: treatment with selective arterial embolization. Radiology 1999;212(2):385–389. DOI: 10.1148/radiology.212.2.r99jl05385.
4. Gonsalves M, Belli A. The role of interventional radiology in obstetric hemorrhage. Cardiovasc Intervent Radiol 2010;33(5):887–895. DOI: 10.1007/s00270-010-9864-4.
5. Lim AK, Agarwal R, Seckl MJ, Newlands ES, Barrett NK, Mitchell AW. Embolization of bleeding residual uterine vascular malformations in patients with treated gestational trophoblastic tumors. Radiology 2002;222(3):640–644. DOI: 10.1148/radiol.2223010035.
6. Soyer P, Dohan A, Dautry R, Guerrache Y, Ricbourg A, Gayat E, et al. Transcatheter arterial embolization for postpartum hemorrhage: indications, technique, results, and complications. Cardiovasc Intervent Radiol 2015;38(5):1068–1081. DOI: 10.1007/s00270-015-1054-y.
7. Lopera J, Suri R, Kroma GM, Garza-Berlanga A, Thomas J. Role of interventional procedures in obstetrics/gynecology. Radiol Clin 2013;51(6):1049–1066. DOI: 10.1016/j.rcl.2013.07.008.
8. Sentilhes L, Kayem G, Chandraharan E, Palacios-Jaraquemada J, Jauniaux E. FIGO consensus guidelines on placenta accreta spectrum disorders: conservative management. Int J Gynecol Obstet 2018;140(3):291–298. DOI: 10.1002/ijgo.12410.
9. Milford W, Chadha Y, Lust K. Use of a retrievable inferior vena cava filter in term pregnancy: case report and review of literature. Aust N Z J Obstet Gynaecol 2009;49(3):331–333. DOI: 10.1111/j.1479-828X.2009.01004.x.
10. Silver RM, Branch DW. Placenta accreta spectrum. New Engl J Med 2018;378(16):1529–1536. DOI: 10.1056/NEJMcp1709324.
11. Thabet A, Kalva SP, Liu B, Mueller PR, Lee SI. Interventional radiology in pregnancy complications: indications, technique, and methods for minimizing radiation exposure. Radiographics 2012;32(1):255–274. DOI: 10.1148/rg.321115064.
12. Josephs SC. Obstetric and gynecologic emergencies: a review of indications and interventional techniques. Semin Intervent Radiol 2008;25(4):337–346. DOI: 10.1055/s-0028-1102992.