

# *Postpartum Hemorrhage Management and Role of Interventional Radiology*

## *Clinical Review*

Maged Naser<sup>1</sup>, Mohamed M. Naser<sup>2</sup>, and Lamia H. Shehata<sup>3</sup>

<sup>1</sup> Mazahmiya Hospital, Ministry of Health, Kingdom of Saudi Arabia, Department of ob./gyn,

<sup>2</sup> King Fahd Hospital, Ministry of Health, Kingdom of Saudi Arabia, Department of Surgery,

<sup>3</sup> Care National hospital, Department of Radiology.



**Abstract** – Postpartum hemorrhage is the main source of maternal morbidity and mortality around the world, and rate in the United States, in spite of the fact that lower than in some resource limited countries, stays high. Women of color are at risk of develop a life-threatening postpartum hemorrhage. Risk assessment tools are available but since they need specificity and sensitivity, all pregnant women are considered at risk. Early identification and intervention in a hemorrhage require an interdisciplinary team to care and can save the lives of thousands of women every year. Over the past two decades, the role of pelvic blood vessel embolization has developed from a novel treatment option to assuming a critical part in the management of obstetric hemorrhage. Interventional radiology offers a minimal invasive, fertility- preserving option in conventional surgical treatment.

### **Keywords**

- Postpartum hemorrhage is the leading cause of maternal mortality morbidity especially in low-income countries.
- Women of color are at higher risk for postpartum hemorrhage than white women, because risk assessment tools only identify 85% of women with postpartum hemorrhage, consider all pregnant women at risk.
- Role of Interventional radiology in treatment of postpartum hemorrhage as preventive and/or combined with medical or surgical treatment.

## **I. INTRODUCTION**

### **1. General features**

Postpartum hemorrhage is defined as a blood loss of 1,000 mL or more or symptoms and signs of hypovolemia within the first 24 hours after delivery and as long as 12 weeks post pregnancy, paying little attention to strategy for delivery (vaginal or cesarean).[1] Early or essential post pregnancy hemorrhage, the most well-known sort, happens inside the primary 24 hours of delivery; secondary post pregnancy hemorrhage happens after the initial 24 hours. In the United States, maternal mortality has dramatically increased in the course of recent years, and post pregnancy bleeding represents 11% of these pregnancy-related deaths.[2] Other reasons for maternal dying incorporate infection and complications because of cardiovascular events. Racial disparities persist, as people of color in the United States have in excess of a three-fold hazard of passing on because of pregnancy entanglements compared with white women. [2,3] Postpartum hemorrhage is the main source of maternal mortality around the world, causing practically

25% of all pregnancy-related deaths. Women living in low-income countries are especially at risk of dying of a post pregnancy hemorrhage.[4]

### 1.1 Causes

The causes for post postpartum hemorrhage can be ordered by the 4 Ts memory helper: tone, trauma, tissue, and thrombin (Table 1). Uterine atony is a common cause for post postpartum hemorrhage, causing up to 80% of all cases.[1] Uterine atony is brought about by dysfunctional hypo contractility of the myometrium during the puerperium. Uterine atony can develop in women with multi fetal gestations, fibroid, polyhydramnios, and embryos who are large for gestational age (fetal macrosomia, characterized as a weight of 8 lb., 13 oz [4,000 g] or greater).[5] pharmacologic causes for uterine atony incorporate magnesium sulfate (utilized for neuroprotection in patients with a preeclampsia with severe features and in patients with eclampsia) and nifedipine (utilized for hypertension in a pregnancy). Chorioamnionitis, placental abruption, and a placenta that inserts into the lower uterine section can cause uterine atony and resulting post pregnancy hemorrhage. [1,6]

Table 1

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>Medical or surgical history</p> <ul style="list-style-type: none"> <li>• Previous postpartum hemorrhage</li> <li>• Leiomyomas</li> <li>• Previous caesarean delivery or other uterine instrumentation</li> </ul>                                                                                                                                                                                                                                                                        |
| <p>Fetal issues</p> <ul style="list-style-type: none"> <li>• Multifetal gestation</li> <li>• Polyhydramnios</li> <li>• Large for gestational age fetus</li> <li>• Fetal macrosomia (birth weight greater than 8 lb., or 4000 gm)</li> </ul>                                                                                                                                                                                                                                                |
| <p>Maternal issues</p> <ul style="list-style-type: none"> <li>• Hypertensive disorders of pregnancy</li> <li>• Anemia</li> <li>• Inherited coagulopathy as Von Willebrand disease</li> <li>• Acquired coagulopathy as HELLP syndrome</li> <li>• Trial of labor after caesarean section</li> <li>• Induction and augmentation of labor</li> <li>• Arrest of second stage of labor</li> <li>• Prolonged third stage of labor</li> <li>• Instrumentation during delivery (forceps)</li> </ul> |

Placental issues

- Placental abruption.
- Placenta previa.
- Retained placenta.
- Chorioamnionitis.
- Acute uterine inversion.
- Subinvolution of uterus.

Trauma from instrumentation to assist with delivery likewise can cause post postpartum hemorrhage.[7] Patients who experience prolonged labor, especially when uterine stimulation like IV oxytocin and vaginal prostaglandins are utilized, can develop post postpartum hemorrhage.[8] Uterine rupture can occur in patients going through a trial of labor after cesarean delivery, and the risk is increased if the patient has had a low-vertical or high-vertical uterine incision with past cesarean deliveries.[8]

Placental anomalies can put a patient at increased risk for post postpartum hemorrhage.[7] These factors include retained placental as well as the ranges of a placenta previa and placenta accreta.[8] In placenta previa range, the placenta is attached to the uterine wall either incompletely or totally covering the internal cervical os. Placenta accreta range is a condition where the placenta strangely invades the uterine wall; this condition is divided into three classifications: accreta, increta, and percreta, depending upon the profundity of intrusion into the myometrium. Placenta percreta, the most intrusive sort, is described by the placenta developing through the uterine wall and potentially invading nearby organs.[9]

Coagulopathies might be another cause for post postpartum hemorrhage and can be either inherited or acquired.[10] Von Willebrand disease is one of the more common acquired coagulopathies that can cause post postpartum hemorrhage.[11] Acquired coagulopathies incorporate HELLP disorder (hemolysis, raised liver enzymes, and low platelets) and disseminated intravascular coagulopathy (DIC).[12] Placental abruption, amniotic fluid embolism, sepsis, fetal death, and HELLP syndrome can cause DIC.[13]

In a patient who gives an intense issue of coagulation and postpartum hemorrhage, the two most common causes are placental abruption and amniotic fluid embolism.[13] Patients with placental abruption will have pelvic pain. Vaginal bleeding may not usually be present in case, bleeding is intrauterine, and if the patient is being checked with a tocodynamometer, uterine tachysystole (rapid contractions) will be obvious. Patients with an amniotic liquid embolism develop respiratory and hemodynamic compromise and DIC. Morbidity and mortality from an amniotic fluid embolism still high.[14]

Other common primary causes include vaginal, and cervical lacerations and uterine inversion.[8] Uterine inversion is a medical emergency and requires prompt attention by trained healthcare provider. Uterine inversion occurs when the fundus of the uterus is pulled down into the uterine cavity making the uterus be turned inside-out.[15] The reversal may just be obvious in the vaginal canal or it can distend through the introitus. A typical secondary reason is subinvolution of the uterus or placental site.[1] Subinvolution happens when the uterus doesn't get back to its ordinary estimate and can be brought about by retained placental fragments or endometritis.

## 1.2 Risk factors

Risk factors for post postpartum hemorrhage incorporate being a woman of color, a previous history post postpartum hemorrhage, hematocrit under 30%, retained placenta, arrest of progress during the second stage of labor, a delayed stage of labor (characterized as over 30 minutes for the placenta to separate from the uterus), fetal macrosomia, hypertensive problems, induction and augmentation of labor.[3,8] A general classification of risk factors might be organized by the following characterizations: medical or surgical history, fetal issues, maternal issues, and placental/uterine issues (Table 1). Be that as it may, numerous women develop postpartum hemorrhage without known risk factors.

## 2. Clinical assessment

Despite the fact that risk assessment; tools can help with distinguishing women who might encounter a post postpartum hemorrhage, they may just recognize up to 85% of women with post postpartum hemorrhage. Thusly, all pregnant women ought to be considered at risk for post postpartum hemorrhage.[1]

The evaluation should focus on the patient's hemodynamic status; intervene immediately if the patient has signs of hemodynamic compromise. At the point when a post postpartum hemorrhage is suspected, emergency intervention with a rapid response team to guarantee coordinated care and to prevent cardiovascular collapse is essential. Also, ascertain if the placenta has been delivered. In the event that the placenta has been delivered, examine it for missing fragments. In the event that the placenta is still intact, utilize controlled cord tracing to deliver it. Physical assessment of the patient might uncover a bulky uterus. The fundus might be palpable above the level of the umbilicus.

Visual assessment of blood loss and the weighing of blood-soaked products have historically been utilized when really focusing on women during labor and delivery. Notwithstanding, visual estimation is related with a critical underestimation of genuine blood loss and ought to possibly be utilized when other objective measures are not available.[16] Calibrated drapes hangings have been developed to help unbiasedly evaluate blood loss and are promptly accessible at most US hospitals. The American College of Obstetricians and Gynecologists as of late published recommendations on utilizing tools to precisely evaluate blood loss and underscoring the importance of objective measurements to assist with decreasing morbidity and mortality.[16]

Heart rate and BP are the two most regularly utilized essential signs to assist with diagnosing a hemorrhage, however they need specificity.[17] what's more, women who are encountering a hemorrhage may not develop tachycardia or hypotension until significant blood loss (more noteworthy than 1,000 mL) has occurred. Signs of a hemorrhage include pulse greater than 110 beats/minute, BP of 85/45 mm Hg or less, SpO2 under 95%, delayed capillaries refill, decreased urine output, and pallor. Frequently these progressions won't be obvious until the patient develops shock.[17] The proportion of the pulse over the systolic BP is known as the shock index and might be useful in evaluating patients with critical bleeding events. A shock index more noteworthy than 1 requires immediate management. [6,17] Other signs and symptoms related with hypovolemia incorporate lightheadedness, palpitations, confusion, syncope, fatigue, air hunger, and diaphoresis.

### 2.1 Diagnosis

The diagnosis of post postpartum hemorrhage depends on the patient's physical assessment and the clinician's clinical acumen, on the grounds that a significant number of the objective measures independently need specificity and sensitivity. A baseline complete cell count, coagulation studies (including fibrinogen), and blood type and antibody screen, if not definitely known, ought to be requested. Hemoglobin and hematocrit levels are generally valuable in the underlying finding except if a past hemoglobin or hematocrit is known for comparison. Request a metabolic panel to assess for electrolyte abnormalities and renal compromise; likewise request D-dimer, fibrinogen, liver enzymes, and serum lactate levels.

Table 2

| Test                | clinical correlation                                                                                                                                      |
|---------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|
| Blood urea nitrogen | <ul style="list-style-type: none"> <li>• elevated in renal failure</li> <li>• elevated after resuscitation</li> <li>• Could indicate hemolysis</li> </ul> |
| D-dimer             | <ul style="list-style-type: none"> <li>• Elevated in hemorrhage</li> </ul>                                                                                |
| Fibrinogen          | <ul style="list-style-type: none"> <li>• Low or normal in coagulopathy</li> <li>• Very low in amniotic embolism and placental abruption</li> </ul>        |
| Hemoglobin and      | <ul style="list-style-type: none"> <li>• may not be low in acute hemorrhage</li> </ul>                                                                    |

|                 |                                                                                |
|-----------------|--------------------------------------------------------------------------------|
| hematocrit      |                                                                                |
| Liver enzymes   | <ul style="list-style-type: none"> <li>• elevated in HELLP syndrome</li> </ul> |
| Lactate         | <ul style="list-style-type: none"> <li>• elevated in septic shock</li> </ul>   |
| Serum calcium   | <ul style="list-style-type: none"> <li>• may be low in hemorrhage</li> </ul>   |
| Serum magnesium | <ul style="list-style-type: none"> <li>• may be low in hemorrhage</li> </ul>   |
| Serum potassium | <ul style="list-style-type: none"> <li>• may be low in hemorrhage</li> </ul>   |

Table2

### Laboratory testing in postpartum hemorrhage

Recognizing the reasonable justification of hemorrhage is basic; completely assess and palpate the patient's perineum, vaginal vault, and uterine cavity. Ultrasonography is an effective, and quick tool that can be utilized to assess the pelvis for a retained placenta, hematomas, or peritoneal blood.

## 2.2 Treatment

Early diagnosis and intervention are essential in diminishing mortality from post postpartum hemorrhage and a coordinated team effort should be utilized. At the same time, clinicians should deal with the patient's hypovolemia and shock and recognize the reason for the hemorrhage. If the patient has a massive hemorrhage, inform the rapid response team and utilize life support measures.

Two fundamental starting medications for post postpartum hemorrhage are oxytocin and uterine massage. Bimanual pressure of the uterus likewise can be performed. Guarantee that the patient has an indwelling urinary catheter to screen urinary yield since an anuria is related with massive hemorrhage. Implement resuscitation measures including elevating the patient's legs, administering oxygen, and mixing 0.9% sodium chloride solution or Ringer lactate by means of a 14-gauge catheter.

Early administration of the antifibrinolytic tranexamic acid has been displayed to lessen maternal mortality from post postpartum hemorrhage. [1,18] When hemorrhage occurs, tranexamic acid ought to be allowed within 3 hours of delivery. Rapid transfusion of 2 to 4 units of packed red blood cells is recommended.[1] Type-specific is preferred, however type O Rh-negative blood might be utilized. Screen for a coagulopathy; 4 units of fresh frozen plasma are at first used to help correct a coagulation defect. In case the patient's fibrinogen levels are essentially diminished, administer cryoprecipitate. When significant thrombocytopenia persists, administer platelet concentrates. The standard proportion of packed red blood cells to fresh frozen plasma to platelets is 1:1:1.

Further management is embraced relying upon the reason for the hemorrhage.[19] Uterine atony, the most well-known reason for post postpartum hemorrhage, is overseen as portrayed above, with the addition of ergonovine, carboprost, and misoprostol (Table 3).[1] Carboprost is contraindicated in patients with a history marked by asthma, and hypertension is a contraindication for methylergonovine.[1] Other mediations for uterine atony incorporate intrauterine tamponade with a uterine inflatable or bandage, B-Lynch stitching of the uterus, blood vessel ligation, and uterine artery embolization.[19] Definitive careful management with hysterectomy might be essential.

Table3

| Drug            | Use and dosage                                                                                                               | Notes                                                                                                                                                                                                |
|-----------------|------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| oxytocin        | <ul style="list-style-type: none"> <li>• Prevention and treatment 10 - 40 units IV or 10 units Intra myometrially</li> </ul> | <ul style="list-style-type: none"> <li>• Used in third stage of labor to Help prevent postpartum hemorrhage and used first line in treatment. Can be administered Iv or intramyometrially</li> </ul> |
| Tranexamic acid | <ul style="list-style-type: none"> <li>• Treatment 1g IV</li> </ul>                                                          | <ul style="list-style-type: none"> <li>• Must be used early in treatment protocol</li> </ul>                                                                                                         |

|                  |                                                                                       |                                                                                                                                                                                  |
|------------------|---------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Methylergonovine | <ul style="list-style-type: none"> <li>• Treatment 0.2 mg</li> </ul>                  | <ul style="list-style-type: none"> <li>• Contraindicated in hypertensive disorders and cardiovascular diseases.</li> <li>• Can be given IV, IM and Intramyometrially.</li> </ul> |
| Carboprost       | <ul style="list-style-type: none"> <li>• Treatment 0.25 mg</li> </ul>                 | <ul style="list-style-type: none"> <li>• Can be given IM or intramyometrially</li> <li>• Contraindicated in patients with asthma.</li> </ul>                                     |
| Misoprostol      | <ul style="list-style-type: none"> <li>• Treatment</li> <li>• 600-1000 mcg</li> </ul> | <ul style="list-style-type: none"> <li>• Can be given orally, sublingually or rectally as suppository.</li> </ul>                                                                |

## II. ANTENATAL DIAGNOSIS AND PROCEDURAL PLANNING

PAS (placenta accrete spectrum) issues can be analyzed antenatally utilizing duplex ultrasound or MRI [20]. Early conclusion in high-risk patients is significant for organizing follow-up during pregnancy and empowers complex multidisciplinary anticipating delivery related to obstetrics, sedatives, birthing assistance, neonatology, hematology and interventional radiology groups [21]. Inclusion of the patient in the dynamic cycle is additionally a fundamental piece of the multidisciplinary individualized consideration plan [22]. A several centers have contended that maternal morbidity can be decreased in these high-risk pregnancies in case the executives is unified in profoundly specific maternity units.

### Interventional radiology techniques

As a general rule, the interventional radiology techniques can be considered either preventive or reactive. Preventive procedures incorporate the utilization of temporary occlusion balloons in the iliac arteries or distal aorta as an adjunct to surgical procedure determined to decrease intraoperative blood loss. These transitory hemostatic measures give the surgeon time to accomplish “a hemostasis” through curettage and stitching of the placental implantation site [23]. Conversely, active measures, for example, blood vessel embolization are performed if hemorrhage can't be controlled with a surgical procedure or other adjunctive techniques.

### Preventive procedures

#### 1.1 Temporary occlusion of iliac arteries utilizing balloon catheters

##### A. Technique

This procedure includes insertion of an inflatable balloon catheter into each of the iliac arteries through bilateral common femoral arterial access. It is performed utilizing low-dose fluoroscopic guidance under local anaesthesia prior cesarean segment. the balloon catheters are embedded into the anterior divisions of each inside iliac arteries however different other anatomical areas have been accounted for including the main trunk of the internal iliac arteries and the common iliac arteries [21] (Fig. 1a).

Brief test occlusion is performed to estimate the volume of contrast medium needed to expand each balloon. The balloons are then deflated. The catheters and the sheaths are flushed, stitched and dressed to decreased the risk of dislodgement during the patient's transfer. The patient is then moved to the obstetric theater. The interventional radiology team should go to the obstetric theatre to guarantee the balloons are effectively inflated and in the event of uncontrollable hemorrhage, be ready to continue with immediate embolization. After delivery and clamping of the umbilical cord, each balloon is inflated to the predetermined volume to reduce blood flow, while the surgical procedure is completed [21].

If the interventional group reports no critical intraoperative hemorrhage, the inflatable catheters are left inflated for 4-6 hours. The inflatable catheters are emptied however left in situ for the time being and the patient is checked intently for clinical proof of hemorrhage. In the event that the patient remaining parts steady, the sheaths and inflatable catheters are removed by the

interventional radiologist, the following morning. Multidisciplinary protocols ought to be set up to ensure staff on the recovery wards know about management of blood vessel sheaths and recognition of ischemic complications of the lower limb.

In the event that critical hemorrhage happens regardless of inflation of the occlusion balloons, the presence of intra-arterial catheters in the internal iliac arteries allows rapid progression to blood vessel embolization (Fig. 1b). Ideally, embolization is performed after move to the angiography suite to guarantee ideal imaging suite, however if the patient is considered unstable for transfer, embolization can be performed through the occlusion catheters in the obstetric theatre utilizing portable image intensifiers.

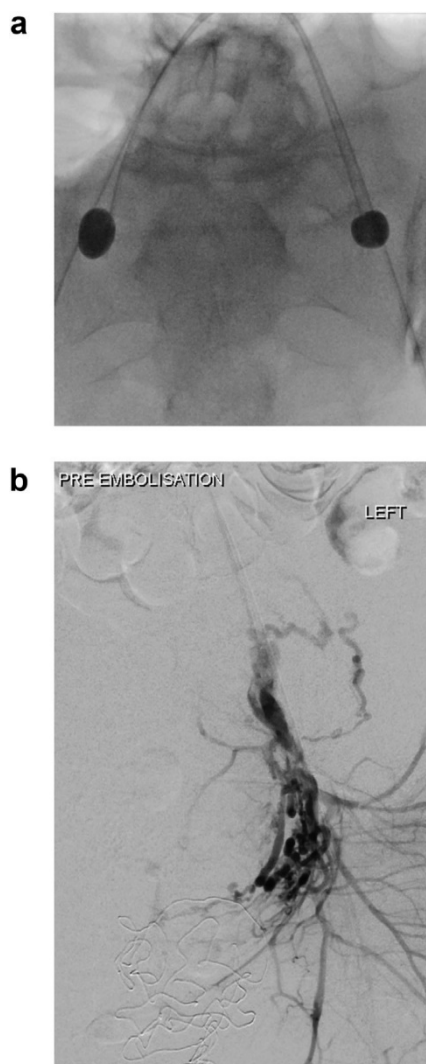


Fig. 1. An Occlusion balloons in situ and inflated within the internal iliac arteries in patients with ongoing hemorrhage postdelivery. Although not stopping hemorrhage entirely, this reduces flow sufficiently to enable transfer to the angiography suite for rapid, controlled embolization with arterial access already in place. b. Angiogram shows hyper vascular flow to the uterus and artefact inferiorly from the swabs used to pack the uterus. No focal bleeding point is seen and bilateral uterine artery embolization was performed using Gel foam.

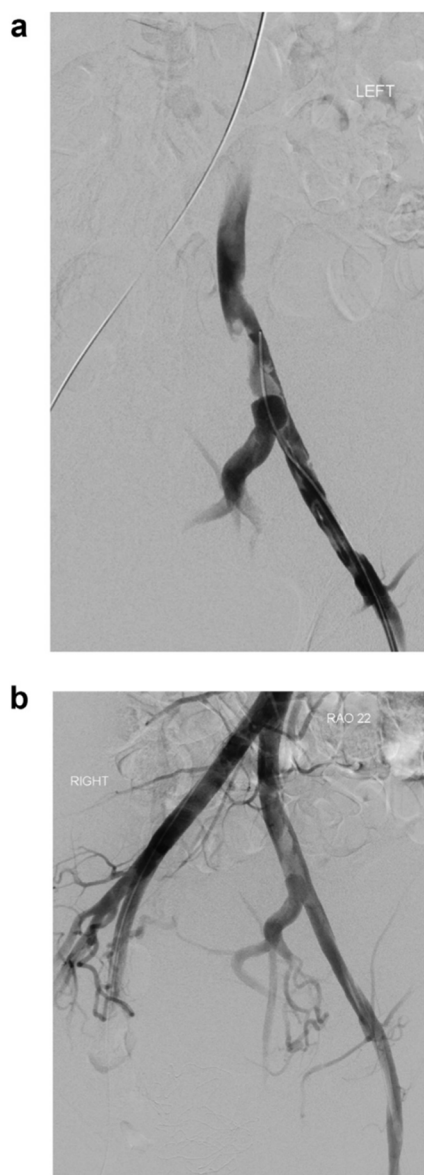


Fig. 2. A Complication of prophylactic occlusion balloon placement. Thrombus is in the left common and external iliac arteries as filling defects. Patient still asymptomatic with warm, well-perfused leg throughout. b. Post thrombus aspiration. Some residual thrombus still; however, significant amount of the thrombus was aspirated and removed through the left common femoral artery sheath using a valveless sheath and guide catheter. Run off vessels all intact. Leg monitored and duplex ultrasound subsequently confirmed resolution of thrombus. No adverse sequelae.

### B. Advantages

In comparison with embolization, the main advantage of this preventive technique is that it is completely reversible. This methodology is additionally simpler and quicker than embolization, which can once in a while be complex and require prolonged utilization of fluoroscopy and as such the mother's exposure to ionizing radiation is lower.

### C. Disadvantages

The utilization of iliac occlusion balloons remains in the studies, its higher risk of complications when compared with embolization and an absence of comparative studies demonstrating its advantage [24]. Complications that have been reported for arterial thrombosis, dissection and rupture (Fig. 2a). Rarely, leg ischemia has been reported with regards to thrombosis influencing the common or external iliac veins or distal embolization into the lower limb arterial system. Such complications managed

conservatively with positive results however there have been reported for cases in which surgical thromboembolism, arterial bypass or stent placement has been necessary [24,25] (Fig. 2b).

As the balloon catheters are inserted utilizing fluoroscopic guidance before delivery, this method includes radiation exposure to the fetus, which is an extra important consideration [26]. The utilization of low-dose pulsed fluoroscopy at a rate of 2 frames per second has been displayed to decrease fetal absorbed radiation dose [27]. A small field of view and limited utilization of amplified and angled fluoroscopy are additionally suggested. the mean fetal radiation dose noticed utilizing this method has been accounted for at 4.4 mGy ( $\pm 3.5$  mGy), which is altogether lower than dosages revealed at different centers. This fetal radiation dose level addresses a likelihood of birth without deformity or childhood cancer of roughly 95.88% compared to 95.93% in children without radiation exposure. This likelihood is just 0.05% higher than children born without radiation exposure during pregnancy [21]. The need to limit radiation dose upholds the suggestions that these procedures are carried in high-volume centers by experienced operators utilizing meticulous procedures.

#### **D. Evidence**

The proof for the utilization of iliac occlusion balloons in the published studies stays controversial [28]. A several studies have shown decreased intraoperative estimated blood loss (EBL) with the utilization of iliac occlusion balloons, when compared with no balloon's occlusion [29,30]. More recently, Californian registry data were utilized to compare results of women and PAS problems who went through cesarean hysterectomy with aortic/internal iliac artery occlusion compared with the individuals who went surgical ligation of internal iliac artery and the individuals who had no adjunctive methods. The aortic/internal iliac artery occlusion balloon group was displayed to have lower EBL, transfusion requirements, intensive care unit admission rates and adverse events rates when compared with the other two groups [31].

In any case, many investigations have shown no advantage, with reports of high EBL and high rates of hysterectomy despite of iliac balloon occlusion [25,32]. Just one randomized preliminary has compared utilization of iliac balloon catheters and a control group without balloon catheters. This study showed no differences between the two groups when comparing the number of women and blood loss more than 2500 ml, number of blood products transfused, duration of surgery, peripartum complications and length of hospital stay [33].

The occlusion balloons are inflated usually after the umbilical cord is clamped. in one study balloon inflation was only performed during delivery if excessive bleeding occurred [34]. In this study, just 30/59 (51%) cases required balloon inflation, proposing that in roughly 50% of women with PAS issues, the utilization of iliac balloon inflation is unnecessary. Hence, the actual efficacy of interior iliac occlusion balloon can't be confidently determined in the current writing.

Internal iliac occlusion balloons are utilized as an adjunct to the Triple P Procedure, which was created in 2010 as a moderate careful option to peripartum hysterectomy to diminish serious maternal morbidity. This three-step careful surgical approach, perioperative localization of the placental edge and delivery of the fetus over the upper line of the placenta, pelvic devascularization and placental non-separation with myometrial extraction [35]. Analysis of our initial 50 patients managed utilizing the Triple P Procedure for PAS problems recommends that it is a more safe than peripartum hysterectomy without cases of ureteric injuries and with significantly reduced probability of intraoperative bleeding, need for blood transfusion and decreased hospital stay. The average operative blood loss was 2318 mL, which is less than the reported mean estimated blood loss during a peripartum hysterectomy of 5300 mL. Three women (6.0%) got blood arterial thrombosis without long term complications and none of the patients required peripartum hysterectomy. Post procedural adverse out-come rates are kept low by the utilization of strict protocols for identifying any complications, for example, blood arterial thrombosis and prompt management of these complications [22].

### **2. Temporary balloon occlusion of the abdominal aorta**

#### **A. Technique**

In PAS problems, there are frequently extensive blood vessel collaterals supplying the abnormal placenta. The uterine arteries consistently add to placental vascularization, yet the placenta might get blood vessel supply from the ovarian, vesical and vaginal arterial systems as well as the lumbar, median sacral, inferior mesenteric and iliolumbar arteries. Blood vessel anastomoses from the external iliac arteries are also possible [36,37]. It has been recommended that the collateral arterial supply to the placenta limits the hemostatic effect of internal iliac balloon occlusion [32].

Balloon occlusion of the abdominal aorta is an alternative preventive technique and gives a more proximal occlusion. This preventive procedure has likewise been utilized as an extra to conservative surgery procedure and has the advantage of furthermore blocking supply to the placenta from the external iliac arteries just as arresting flow in the median sacral, low lumbar and, sometimes, the inferior mesenteric artery.

In fact, the procedure is like internal iliac occlusion balloon catheter insertion, and is performed by means of femoral access under fluoroscopic monitoring prior a surgery. Methods requiring unilateral and bilateral femoral access have been described. The occlusion balloon is normally sited underneath the origins of the renal arteries to stay away from ischemia of the kidneys or abdominal viscera. The balloon is inflated after delivery of the fetus. Foot oxygen saturation tests are observed to affirm effective aortic occlusion. As prolonged periods of aortic occlusion might prompt reperfusion injury, thrombosis or embolism into the lower limb arteries, the occlusion time ought to be just about as short as possible. Ischemic damage of the extremities is uncommon if the aorta is occluded for under 60 minutes. Cases with aortic occlusion time going from 25 to 80 minutes have been reported [38,39], (Fig.3).



**(Fig.3)** Temporary aortic balloon occlusion followed by uterine artery embolization for the management of placenta accreta." *Clinical radiology* 70.9 (2015)

### **B. Disadvantages**

Fewer adverse effects have been accounted when compared with internal iliac balloon occlusion. Be that as it may, cases of lower limb arterial thrombosis and femoral nerve ischemic injury have been reported [40]. One study revealed 11 cases (9%) of arterial thrombosis in 121 women with PAS issues treated with this method during cesarean delivery. Eight of these complications required arterial thrombo-embolism, while the rest were treated conservatively [41].

Like internal iliac balloon occlusion, as the aortic balloon catheter is inserting fluoroscopic guidance before delivery, this strategy additionally brings about radiation exposure to the fetus. In any case, as the strategy is most regularly performed by means of unilateral access and arrangement of the aortic balloon catheter is similarly quick and simple, the fluoroscopic exposure time is typically more limited. Fetal radiation dosages going from 0.27 to 4.2 mGy have been reported [42,43].

### **C. Evidence**

Several studies have detailed positive results with the utilization of aortic balloon occlusion in the management of PAS problems with low EBL, decreased necessities for blood transfusion and low hysterectomy rates.

Panici et al., performed prospective study of 33 consecutive patients with PAS disorders in which patients were randomized to go through cesarean section joined with temporary aortic balloon occlusion or cesarean section alone. The group that under-went

endovascular treatment had a median EBL of 950 ml and hysterectomy rate of 13% (2/15); the group without endovascular treatment had significantly higher median EBL of 3375 ml and hysterectomy rate of 50% (9/18) [23].

Wu et al., performed a large retrospective study of 230 women treated with aortic balloon occlusion and compared results and 38 women who had no endovascular intervention. They revealed lower EBL, blood transfusion requirements and lower hysterectomy rates in the aortic balloon occlusion group. There were no major complications [44].

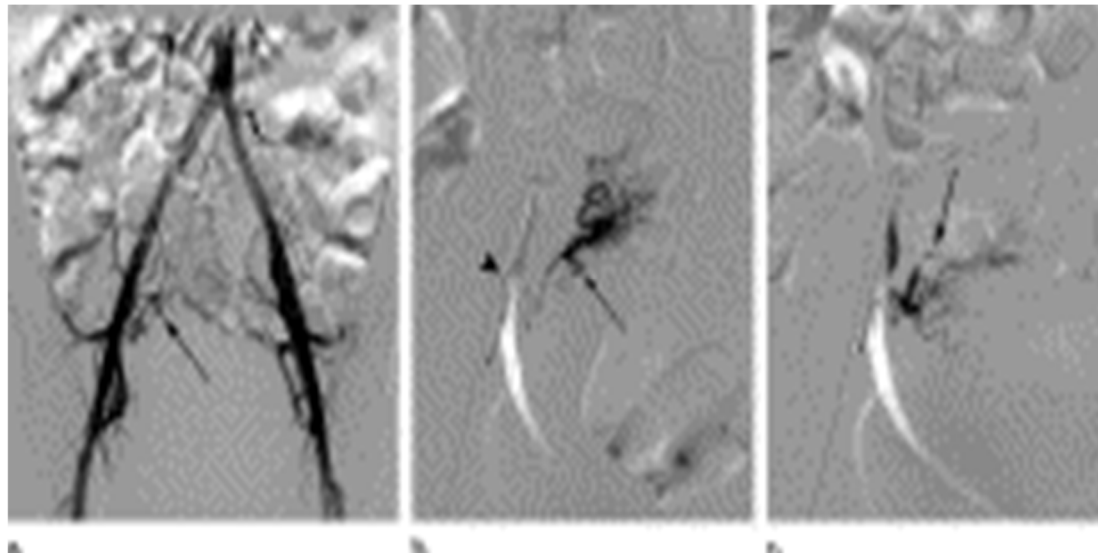
Nonetheless, one retrospective study showed no significant difference in EBL, transfusion requirements or hysterectomy rate when comparing groups treated and without prophylactic aortic inflatable occlusion. Out of 38 women, 12 in this study likewise proceeded to require uterine artery embolization to control hemorrhage. This features the transitory hemostatic effect of aortic inflatable occlusion and shows that dependence on this strategy alone isn't feasible [45].

On this basis, Duan et al., proposed combining temporary aortic balloon occlusion with uterine arteries embolization and have published encouraging results. In their study, 42 women with PAS issues went through temporary aortic balloon occlusion as an adjunct to conservative surgical procedure followed by uterine artery embolization. Of them, 41 women had successful uterus-saving conservative surgery and hysterectomy was just needed in one case (3.1%). The announced EBL of  $586 \pm 355$  ml additionally compares favorably and other studies. There were no complications identified with femoral access or aortic balloon occlusion reports in this study [43].

### **3. Prophylactic uterine artery catheterization and/or prophylactic embolization**

#### **A. Technique**

Another preventive technique including partial catheterization of the uterine arteries under fluoroscopic guidance preceding a surgery, to work with rapid embolization if there is massive PPH. Prophylactic uterine artery embolization has likewise been proposed and includes inserting uterine artery catheterization and performing embolization preceding delivery, determined to lessen intraoperative blood loss. A variety of this method includes embolization of the uterine arteries after delivery, however before "the hysterectomy" [48]. In the latter, the catheterization of the uterine arteries takes place before delivery, with the embolization carried out after, (Fig.4).



(Fig. 4) "Uterine artery embolization in the treatment of postpartum uterine hemorrhage." *Journal of Vascular and Interventional Radiology* 22.2 (2011)

#### **B. Disadvantages**

One of the main concerns with performing uterine artery embolization before delivery is the higher fetal radiation dose caused by a longer and more complex fluoroscopic procedure. One study revealed a mean uterine radiation dose of 15.61 mGy (range

8.15e38.18 mGy), when performing prophylactic embolization with the fetus inside the uterus [46]. This figure is essentially higher than the dosages detailed with insertion of iliac or aortic occlusion balloon. There is a risk of oxygen deprivation to the fetus. In the utilization of this specific procedure, it is basic to have an exceptionally brief time frame between the end of embolization and delivery of the embryo to limit oxygen deprivation time. In this study [46], the mean time between the end of the UAE (uterine artery embolization) and fetal delivery was 6 min 4 s (range, 4 min 18 s - 8 min 12 s). For this strategy to be reachable, highly experienced team of interventional radiologists and obstetricians should be available. No adverse outcome to the neonate was reported.

Likewise, with other preventive approaches that are performed as a two-step method, there is a risk of catheter dislodgement during patient transfer from angiography suite to the operating theater. This shortfall might actually be overwhelmed with the utilization of a cross hypered operating room taking into consideration catheter placement, prophylactic embolization and surgery in a same setting without need for patient transfer [47].

### **C. Evidence**

There are conflicting results in the studies regarding to the utilization of prophylactic uterine catheterization or prophylactic embolization. Various studies have reported these procedures with variable results. One study compared results in women treated with prophylactic embolization preceding cesarean delivery with women treated with cesarean delivery only and tracked down no significant differences in EBL, hysterectomy rate and blood transfusion necessities between the two groups. In this study, 11/26 women experienced adverse effects identified with embolization, including transient buttock pains (4 women) and uterine necrosis (1 woman). This study additionally revealed high mean fetal radiation dose of 30.6 mGy [48].

Different studies have revealed significantly lower EBL with the utilization of prophylactic embolization compared with control groups however no distinction in hysterectomy rate [49,50]. Bouvier et al. 14 women with PA disorders who went through caesarean delivery in an angiography suite with femoral blood vessel access in situ before delivery and uterine artery embolization was performed regularly after delivery. In 7/14 women, there was no significant blood loss after delivery, proposing that no trans arterial intervention is essential in half women with PAS disorders. Of the seven patients with PPH, two were considered excessively unsteady for embolization and rapid hysterectomy was performed featuring the problematic role of prophylactic catheterization. Generally, the hysterectomy rate in this examination was 6/14 (43%) [51].

## **3. Reactive procedures**

### **3.1 Arterial embolization**

Arterial embolization is a minimally invasive alternative compared to hysterectomy in the management of obstetric hemorrhage that is refractory to conservative surgical management. Embolization is frequently used when adjunct to conservative surgery, for example, surgical ligation of the iliac arteries or temporary balloon occlusion have failed to control hemorrhage.

High achievement rates drawing closer 90% have been accounted for when arterial embolization is performed to treat PPH [52,53]. Nonetheless, embolization for hemorrhage related with PAS disorders is an all the more technically demanding procedure and truly, higher failure rates have been reported for, owing to the complexity of the arterial supply to the placenta in these cases [54]. recently, with propels in innovation and developing interventional expertise, some studies have reported improved clinical achievement rates in the management of PAS disorders. The essential point of embolization is to stop hemorrhage and reduce surgical morbidity. In cases, of retained placenta, the secondary objective is to induce ischemia in the residual placental tissue and improve the rate of placental resorption [28].

#### **A. Procedure**

The methodology is typically performed through one-sided femoral blood vessel access [55,56]. Pelvic angiography is performed to identify the uterine artery and other potential sites of hemorrhage. Angiography can likewise show multiple collateral vessels including middle rectal, iliolumbar, or lumbar arteries that participate to uterine vascularization. In situations when surgical blood vessel ligation has been performed, angiography may evil presence state numerous and complex anastomotic blood vessel arteries and can uncover incomplete and ineffective ligation, hence clarifying persistent bleeding.

Many authors advocate particular catheterization of the uterine arteries just when possible. Catheterization of the anterior division of the internal iliac artery is a faster procedure and embolization from this position can be performed safely with no compromise in

terms of effectiveness [57]. A 5French cobra-molded catheter is effective in achieving selective catheterization in 97% cases however microcatheter access might be important in a small proportion of cases, especially if super selective embolization of a little caliber bleeding vessel is required [55]. Embolization by means of a microcatheter precludes the utilization of certain embolic agents (for example pledgets of gelatin sponge) and this is thusly not preferable as a first-line alternative. Embolization should be performed bilaterally as unilaterally embolization might fail to stop hemorrhage attributable to anastomoses between the two uterine arteries. The point of treatment is to administer embolic agents into the objective artery or arteries until prolonged stasis or complete occlusion is accomplished as determined angiographically.

#### **4. Types of embolic agents**

Different embolic agents or devices have been utilized in the management of PPH. Each embolic agent or device might have specific benefits or disadvantages dependent on the clinical context and desired end-point. Gelatin sponge (Gel foam) is a regularly utilized temporary embolic agent and is ordinarily delivered as hand-cut pledgets or 'torpedoes', which are infused by means of the catheter [57]. The large size of the pledgets mean that they lodge inside large type vessels and cause rapid, proximal occlusion. Gelatin sponge can likewise be administered in a liquid structure or 'slurry' by mixing little hand-cut cubes shapes with contrast medium and saline. When utilizing this structure, the smaller shapes stop all the more distally in more smaller type vessels. Some authors advocate the utilization of slurry in cases of retained placenta to all the more adequately induce ischemia in the remaining placental tissue [58]. Be that as it may, in different settings, there is an apparent higher risk of uterine necrosis with the utilization of gelatin sponge slurry [59]. For comparable reasons, the utilization of small diameter polyvinyl liquor (PVA) particles is generally not recommended [60]. Gelatin sponge slurry is utilized every now and again for embolization in cases of obstetric hemorrhage and is safe and effective in our experience.

Permeant or long-lasting embolic agents like superglue (Histoacryl/Glubran) or bigger aligned PVA particles have been utilized in mix with gelatin sponge in certain studies. Sentilhes et al., discovered no relationship between the embolic agent utilized and the rate of failure [61].

Metallic coils are rarely needed for embolization in this clinical context despite the fact that are often utilized in the management of hemorrhage in different situations like trauma. coils have been utilized to perform rapid, lasting occlusion of focal bleeding points, for example, ruptured uterine artery pseudoaneurysms in cases of hemorrhage secondary to PAS disorders. Coils are generally avoided from in the knowledge that the broad collateralization found in these cases may now and again require a recurrent embolization, and utilizing coils might prevent access into an artery that rebleeds.

#### **5. Comparison with other techniques**

Complications following arterial embolization are uncommon. By far most of complications are minor and self-restricting, for example, femoral puncture site hemorrhage, uterine artery dissection, transient sciatic nerve paresis or synechia's. Major complications are exceptionally uncommon yet cases of uterine rupture requiring hysterectomy, bladder gangrene, buttock necrosis and paraplegia have been reported [59,62]. acute lower limb occlusion because of non-target embolization is extraordinarily uncommon.

Instead of the preventive techniques described beforehand, embolization is typically performed because of uncontrolled hemorrhage after delivery of the baby and therefore there is no radiation exposure to the fetus. In any case, the technique is potentially complex and may require prolonged fluoroscopy with resulting maternal radiation dose. Good angiographic procedure to limit radiation exposure should be used.

Despite the fact that studies differ in plan and outcome measures, the literature recommends that most women don't have adverse menstrual and fertility results in the long-term following embolization for the treatment of hemorrhage. One systematic review showed monthly cycle happened in 87.1% of patients in the cohort of 177 patients treated with embolization for PAS issues. Three patients proceeded to have effective pregnancies consequently [63].

#### **6. Efficacy**

When compared with other techniques, blood vessel embolization is the therapeutic option with the highest level of proof supporting its utilization in the management of hemorrhage related with PAS disorders. A large systematic review incorporating 177 women

with PAS disorders treated with embolization revealed an accumulative success rate of 89.8% with a hysterectomy rate of 11.3% [63].

In one examination, 40 women with PAS disorders went through emergency arterial embolization for intractable PPH. Specialized achievement was accomplished in all cases (100%) and clinical achievement was accomplished in 33/40 patients (82.5%) following the primary embolization procedure. Three patients (7.5%) went through hysterectomy after embolization failed to quit bleeding within 24 h. The remaining patients went through a repeat embolization, which effectively stopped bleeding. In general, the clinical achievement rate (primary and secondary success rate combined) was 92.5%. There were no major complications [55]. In situations where there is retained placental tissue, embolization has been displayed to increase the rate of placental resorption. Soyer et al., detailed a postponement of 17 weeks until complete placental resorption with embolization compared with 32 weeks without any embolization [58].

### **III. SUMMARY**

Public health registry data recommend that just 50% women with PAS disorders experience PPH. Therefore, in half women with PA disorders, no interventional radiology system is essential [64]. These methods bring about maternal and fetal radiation exposure which can't be disregarded, just as a little risk of significant complications. It follows that the standard utilization of interventional radiology systems in all patients with PAS problems isn't proper. Almost certainly, patients with placenta percreta, the most extreme condition inside the range, would benefit most from adjunctive interventional techniques however further studies are needed to affirm this and allow optimal patient selection.

At last, the choice with respect to which, assuming any, interventional radiological procedure is utilized is dictated by local expertise, accessible resources and varies depending upon the arranged obstetric approach. There is a large volume of published data assessing the fundamental interventional procedures utilized in the management of PAS disorders however there is as of now no well-designed comparative study to determine which strategy is superior. Arterial embolization, performed as needed by experienced interventional radiologists, is the therapeutic alternative which is supported by the most extensive level of evidence and ought to be utilized in cases of PPH. The role of preventive procedures keeps on being debated because of conflicting result information and concerns in regards to potential morbidity. The most complex patients are probably going to benefit from management in high volume centers where conceivable. Nonetheless, the significance of a multidisciplinary approach, with full association of all specialties engaged with the patient's consideration, and the utilization of clear protocols for patient management can't be over emphasized.

### **IV. PRACTICE POINTS**

Arterial embolization, when performed by experienced interventional radiologists, is profoundly effective in the management of postpartum hemorrhage associated with placenta accreta spectrum disorders with reported clinical success rate of 89.8-92.5%, gelatin sponge is the most generally utilized embolic agent and is oftentimes delivered as hand-cut pledgets, and the role of preventive balloon occlusion strategies keeps on being debated in the literature yet some high-volume centers have reported favorable results with low rates of morbidity. A multidisciplinary group approach with careful planning and implementation using clear protocols is critical in the management of these unpredictable patients.

### **V. CONCLUSION**

Identifying patients in risk of developing post-partum hemorrhage is encouraged, however all pregnant women ought to be considered in risk, as many without realized risk factors will develop post pregnancy hemorrhage. Early identifying and intervention are basic to assist with decreasing morbidity and mortality. The utilization of oxytocin, uterine massage, and controlled umbilical cord traction are three essential components of the active management of the third stage of labor and may help in reducing the occurrence of post-partum hemorrhage. Utilizing a team-based group to deal with laboring woman and implementing hospital-specific protocols will assist with diminishing the mortality related with post-partum hemorrhage. will help reduce the mortality associated with postpartum hemorrhage.

### **CONFLICT OF INTEREST**

All authors declare no conflicts of interest.

## AUTHORS CONTRIBUTION

Authors have equally participated and shared every item of the work.

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