ORIGINAL ARTICLE

Endovascular management of postpartum hemorrhage of placental origin

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Abstract *Aim:* To evaluate the potential role, efficacy, and complications of endovascular management of postpartum hemorrhage induced by variable placental abnormalities.

Materials and methods: Ten patients with placental abnormalities underwent pelvic arterial embolization in Assiut University Hospital, because of postpartum hemorrhage. Placental abnormalities were; retained placenta ($n = 4$), placenta accrete vera ($n = 1$), placenta increta ($n = 2$), placenta percreta ($n = 1$), and choriocarcinoma ($n = 2$). Only three patients were embolized on emergency bases, while the other 7 patients were scheduled for embolization.

Results: The mean hemoglobin level before embolization was 6 g/dL (range: 4.5–8 g/dL). Severe coagulation disorders were present in one patient. Postembolization pelvic angiogram showed total devascularization of the pathological arteries in 7(70%) patients, and subtotal devascularization in 3(30%) patients. The clinical success is 100%.

Conclusion: Whatever the placental disease, pelvic embolization with long-lasting embolizing agents is very effective and safe treatment of associated postpartum hemorrhage.

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1. Introduction

Placental diseases that may cause postpartum hemorrhage (PPH) include placenta accreta (PA), gestational trophoblastic neoplasm (GTN), and retained placenta and products of conception. PA has been defined as placental penetration into the myometrium. Conventional extirpation management of PA carries out high risk of severe hemorrhage with mortality rates approaching 25% (1). If emergency hysterectomy was performed, mortality rate might be reduced to 6% (1), but the patient will lose her potential for future fertility. To reduce mortality and morbidity and preserve the patient fertility, a conservative method of management, leaving the uterus and the placenta inside, was developed aiming at spontaneous resorption of the placenta (2–4). Pelvic arterial embolization has been shown to be effective in the treatment of PA induced postpartum hemorrhage after extirpative or conservative management (5–10). Uterine hemorrhage might occur in women with GTN, as the uterus is usually enlarged with hypervascular and friable tumor inside. Traditionally, hysterectomy has been

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the main solution to this serious condition. However, selective angiography and transcatheter embolization have become more popular (11–13), because most of these tumors are chemosensitive and usually cured without need for hysterectomy. Accordingly, we report our experience involving 10 consecutive patients with different placental diseases presented by postpartum hemorrhage. We aimed to evaluate the potential role and efficacy of pelvic embolization in the management of these patients and to report any complications of this procedure.

2. Patients and methods

This retrospective study did not require institutional review board approval. Between January 2009 and September 2014, ten patients with placental abnormalities underwent pelvic arterial embolization in Assiut University Hospital, because of postpartum hemorrhage. Their ages ranged from 20 to 38 years with mean age 27.4 years. All but two women were referred from outside of our institution. Six patients presented after normal vaginal delivery, and the other four patients presented after cesarean section (Table 1). When the ultrasound examination showed intrauterine placenta without description of the degree of myometrial invasion, we termed it "retained placenta". Prenatal diagnosis of placenta accreta occurred in only one patient based on typical ultrasonographic and color Doppler findings. The diagnosis of placenta accreta in the other 4 patients occurred when total manual removal of the placenta was impossible ($n = 3$), or when bleeding from the implantation site started just after forced placental extirpation ($n = 1$). Choriocarcinoma ($n = 2$) was diagnosed when the beta-human chorionic gonadotrophin (B-HCG) was very high and raised sequentially for 2 weeks.

In all patients pelvic ultrasonographic examination was the first imaging modality to detect the cause of hemorrhage. MRI was performed for patients with placenta accreta or choriocarcinoma ($n = 6$). Cystoscopy was performed to confirm bladder wall invasion for one patient with placenta percreta invading the urinary bladder on MRI. Only 2 patients had primary postpartum hemorrhage (within 24 h) and the other 8 patients presented after 24 h of delivery (secondary postpartum hemorrhage) (Table 1). The embolization was performed on emergency bases for 3 patients; two presented after suction evacuation of retained placenta, and the third one who underwent placenta accreta extirpation. These procedures were performed with anesthetist and obstetrician supervision. For nonemergent secondary hemorrhage, the decision to perform embolization was made on the basis of active continuing hemorrhage despite appropriate medical and obstetric treatment. All patients received prophylactic antibiotics (amoxicillin clavulanate and metronidazole) just before embolization and continued for 5–7 days after embolization. Informed consent was obtained before the procedure.

2.1. Embolization procedure

Pelvic angiography was performed under local anesthesia through the right common femoral artery approach using a 4–5 F vascular sheath (Cordis Corporation, Europa N.V., the Netherlands). Cobra catheter (Optitorque, Terumo corporation, Tokyo, Japan or Imager, Boston scientific, USA) was used to catheterize the uterine artery, beginning with the left side then the right side by looping the catheter in the abdominal aorta. Microcatheters (2.7/2.9 F Progreat, Terumo, Tokyo, Japan) were used coaxially when the Cobra catheter could not be advanced into the distal uterine artery (beyond the cervico-vaginal artery) or when embolization of another small pelvic artery was required e.g. vesical branch. PVA particles 500–700 μm-followed by 700–1000 particles (Contour; Boston Scientific) were used in all women. NBCA/Lipiodol mixture and steel coils were used in 2 patients with choriocarcinoma to occlude large arterio-venous fistulas.

Table 1 Types of abnormal placentation, mode of delivery and timing and methods of embolization.

Patient no.	Age (y)	Placentation	Mode of delivery and management	Time between delivery and UAE	Embolized arteries	Embolizing materials
1	23	Retained portion	Normal	4 days	Bilateral uterine	PVA
2	28	Retained portion	Normal	7 days	Bilateral uterine	PVA
3	32	Retained portion	Normal and trial of suction evacuation after 12 days	12 days (just after trial of evacuation)	Bilateral uterine	PVA
4	31	Retained portion	Normal and trial of suction evacuation after 16 days	16 days (just after trial of evacuation)	Bilateral uterine	PVA
5	34	Accreta	Cesarean and extirpation	The same day	Bilateral uterine	PVA
6	29	Increta	Cesarean and partial conservation	8 days after	Bilateral uterine	PVA
7	26	Increta	Cesarean and full conservation	15 days after	Bilateral uterine	PVA
8	20	Percreta with bladder invasion	Cesarean and full conservation	The same day	Bilateral uterine, bilateral inferior vesical and left internal pudendal	PVA
9	28	Choriocarcinoma	Vaginal delivery	6 weeks	Bilateral uterine, left inferior vesical, left inferior gluteal right internal pudendal	PVA, NBCA, and coils
10	23	Choriocarcinoma	Vaginal delivery	12 weeks	Bilateral uterine, left inferior vesical, right inferior vesical, right internal pudendal	PVA, NBCA, and coil

Postembolization control angiography was performed to assess the degree of devascularization of the pathological vessels.

2.1.1. Follow-up

During hospital stay, all patients underwent close follow-up with clinical examination, serum (B-HCG) measurement, and pelvic ultrasonography. Clinical success was defined as control of bleeding without repeating embolization or surgical intervention. Hospital stay ranged from 24 h to two weeks. After discharge they continued follow-up at home through repeated visits to the obstetric clinic. MRI was performed once or twice during the follow-up period for patients with placenta percreta and choriocarcinoma. The follow-up period ranged from 6 to 30 months (mean: 8 months ± 5).

3. Results

All patients were multiparas and their average gravidity was 2. The mean hemoglobin level before embolization was 6 g/dL (range: 4.5–8 g/dL). Severe coagulation disorders were present in one patient. Blood transfusion (mean number of blood units: 4; range: 3–9 units) was required for 5 patients before embolization. The time from delivery to embolization ranged from few hours to 12 weeks (Table 1). On angiography, all patients showed blush of hypervascular uterus with or without the placenta inside. Arterio-venous shunt was detected in association with choriocarcinoma and placenta percreta ($n = 3$). Bilateral uterine artery embolization was sufficient to devascularize the abnormal hypervascular blush in 7 patients (Fig. 1). In 3 patients (placenta percreta or choriocarcinoma), additional arteries were found to participate in uteroplacental perfusion (Figs. 2 and 3). These arteries were the right inferior vesical artery ($n = 2$), the left inferior vesical artery ($n = 3$), the right internal pudendal artery ($n = 2$), left internal pudendal ($n = 1$), and left inferior gluteal artery ($n = 1$). In all patients, the embolization was technically successful in achieving stasis of the uterine arteries. Postembolization pelvic angiogram showed total devascularization of the pathological arteries in 7(70%) patients, and subtotal devascularization in 3(30%) patients (with placenta percreta and choriocarcinoma).

Pelvic embolization controlled the bleeding for all patients and none of our patients required repeated embolization or hysterectomy (the clinical success is 100%). All the 3 hemodynamically unstable patients became stable after embolization. Only one patient needed blood transfusion after the procedure to correct anemia of previous blood loss. Also the coagulation disorder that was noted in one patient improved markedly after embolization. None of our patients developed significant rebleeding; however, 2 patients had drops of altered blood 2–3 days after embolization. Also, the patient with placenta percreta continued intermittent minimal hematuria for 4 days after embolization. Pieces of placenta tissue were spontaneously passed vaginally after uterine artery embolization in all patients. Patients with retained small placental parts (retained placenta, accreta and increta, $n = 6$) showed complete placental resorption in a mean time of 4 weeks (range 1–6 weeks). In patient with placenta percreta, the uterus became totally empty of placenta after 21 weeks. Low grade fever was noted in 4 (44%) patients after the procedure. No general or local complications were noticed and no mortality occurred during the period of follow-up. Two patients became pregnant 16 and 20 months consequently after uterine artery embolization. Both of them had an uneventful intrauterine full term pregnancy and both had Cesarean section delivery.

4. Discussion

Retained placenta was reported as the most common cause of secondary PPH (14). In such cases, suction evacuation and curettage are often successful in stopping the hemorrhage,
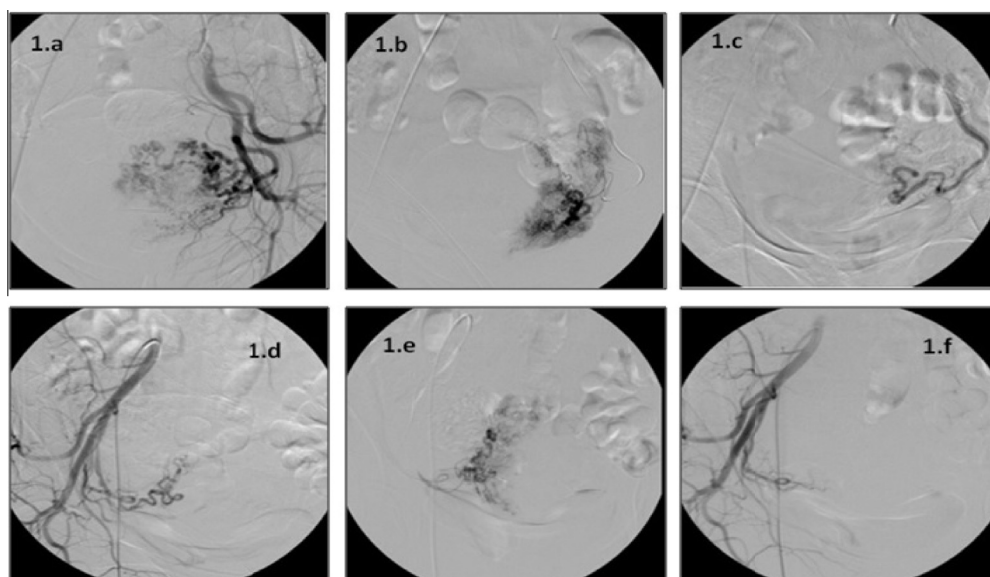
Fig. 1 Twenty-three year old woman presented with PPH due to retained placenta. (a) Left IIA angiogram showing hypervascular uterus and placenta. (b) Selective catheterization of the left uterine artery with a microcatheter. (c) Control angiogram after embolization of the left uterine artery. Right IIA (d), and selective uterine artery (e) angiogram. (f) Control angiogram after embolization of the right uterine artery.
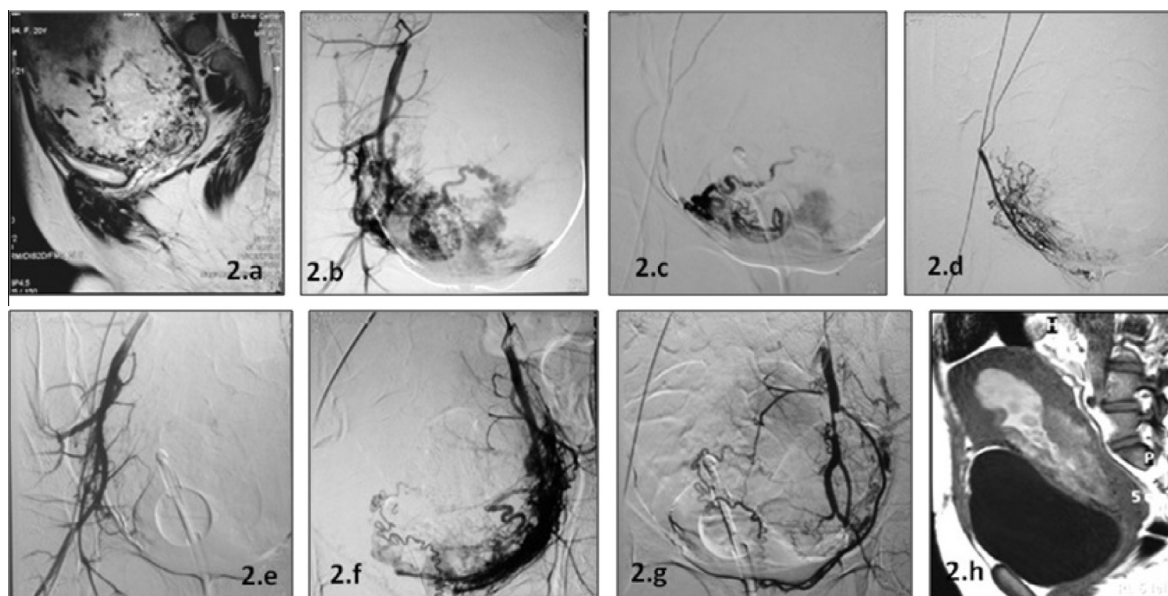
Fig. 2 Twenty year old woman presented with PPH due to placenta percreta invading the urinary bladder. (a) Sagittal MRI of the pelvis showing hypervascular placenta infiltrating the anterior uterine wall. (b) Right IIA angiogram showing hypervascular uterus and placenta with arterio-venous shunt. Selective uterine (b), and inferior vesical (c) catheterization. (e) Post-embolization angiogram of the right IIA. Pre-embolization (f) and postembolization (g) angiography of the left IIA. (h) Sagittal MRI 3 months after embolization showing marked regression of the placenta. The placenta was expelled completely after 21 weeks.
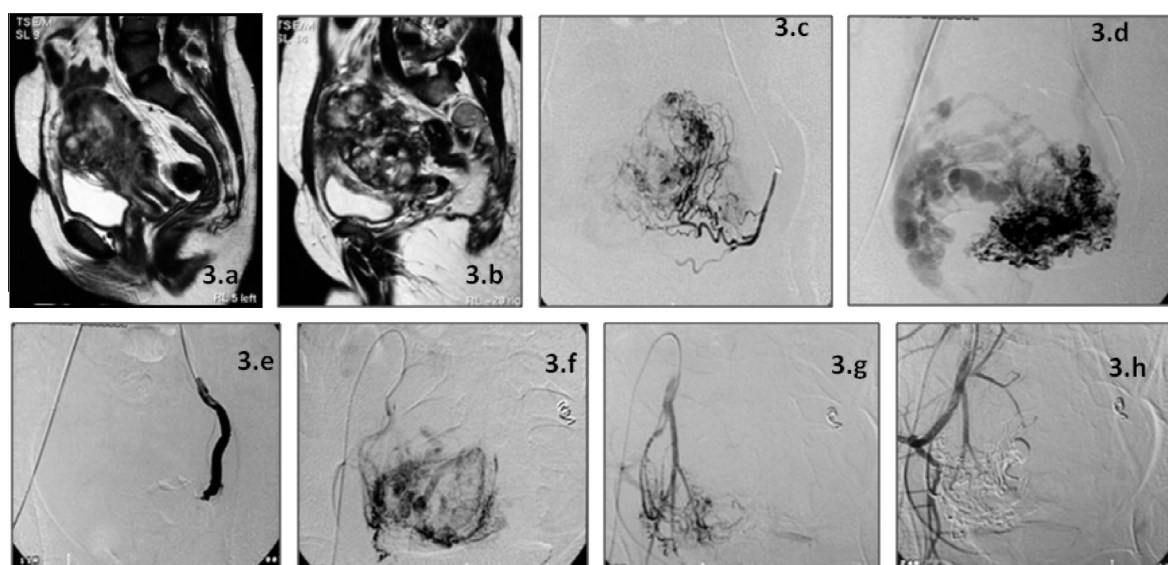
Fig. 3 Twenty-three year old woman presented with PPH due to choriocarcinoma. (a and b) Sagittal MRI showing uterine and extrauterine extension of the choriocarcinoma. Selective angiography of the left inferior vesical (c), and uterine arteries (d), showing extensive arterior-venous shunt. (e) Postembolization angiography of the left uterine artery. (f) Catheterization of the right uterine (f), and pudendal-vesical common trunk (g). (h) Control angiography of the right IIA showing NBCA filling the pathological vessels.

but it may also increase placental bleeding (15). This scenario occurred in 2 of our patients, who bled profusely after trial of evacuation of retained placental portion. Because, all cases with retained placenta treated for spontaneous or iatrogenic PPH, responded well to UAE with complete expulsion of the placental remnants, it is better to avoid attempt of suction evacuation of the retained placenta.

Three subtypes of PA are described: the first (80%) is superficial attachment to the myometrium (accreta vera); the second (15%) is subtotal invasion into the myometrium (increta); and the third (5%) is total invasion into the myometrium and serosa with or without pelvic organ invasion (percreta) (16). Women with placenta accreta, increta or percreta are at high risk of life-threatening hemorrhage with reported maternal

mortality rate up to 7% in women with placenta percreta (17). For prenatal diagnosis, the presence of risk factors for placenta accreta should be sought for. Prior Cesarean section and placenta previa are the two most important risk factors (18,19). Other risk factors are multiparity (>6 pregnancies), elevated maternal serum alphafetoprotein and maternal age more than 35 years (20). Doing ultrasonography, one could find irregular placental lacunae, thinning of myometrium overlying the placenta, loss of retroplacental non-lucent line, increased vascularity of the uterine serosa-bladder interface, protrusion of the placenta into the bladder, and turbulent blood flow through the lacunae on Doppler ultrasonography (21,22). MRI is the gold standard imaging modality for placenta accreta especially in case of placental invasion of pelvic organs. Unfortunately, most cases are identified during delivery when forcible attempts at manual removal of the placenta are unsuccessful and severe PPH ensues. The most common complications to PPH and massive blood transfusion are DIC, acute renal failure, infectious morbidities, and ARDS (23).

Treatment of placenta accreta is by either extirpative or conservative approaches. Extirpative approach which is the manual removal of the placenta (24), may result in severe hemorrhage that may require emergency hysterectomy (17). In addition, extirpative management results in a substantial increase in morbidity due to subsequent endometritis, ureteral and bladder damage and fistula formation (17). The conservative approach is either "cesarean hysterectomy" during which the abnormal placenta is removed along with the uterus or "full conservation" which is leaving both the uterus and the abnormal placenta inside (24,25). Full conservative approach reduced hysterectomy rate from 84% to 15% (24), but it carries risk of PPH (2,26). Many reports have described the successful use of pelvic embolization in cases of postpartum bleeding in women with placenta accreta or percreta (27,10). Sentilhes et al. in 2010 (28) reviewed conservative management in 167 cases of placenta accreta/percreta and found failure rate of 22% which required hysterectomy. Two of our patients were treated successfully by full conservative management without need of further hysterectomy. Prophylactic embolization of internal iliac or uterine arteries was suggested previously (29). However, in our study and in a study performed by Phillipe et al. (10), no cases of technical failure were observed and emergency pelvic embolization was feasible in all patients. Furthermore, Timmermans et al. (4) in their retrospective review of placenta accreta found that secondary PPH occurs in only 22–23% of patients treated with conservative management. Therefore, it is not wise to do prophylactic embolization and UAE is spared to treat PPH. Pelvic embolization of placental abnormalities should not be limited to the uterine arteries only but comprehensive analysis of the pelvic vasculature must be made also (30). Three of our patients who had extrauterine extension of the placenta (placenta percreta and choriocarcinoma) needed embolization of additional branches other than the uterine arteries. The reported success rate of UAE in cases of PPH ranged from 61% to 100% (31,32), and the global success rate reached 90% (33,34). Previous series reported a lower pelvic arterial embolization success rate in cases of placenta accreta/percreta, which ranged between 60% and 83% (35). On the contrary, other authors reported higher success rate (2,24,36). We have 100% clinical success in this study which may be due to the use of PVA particles that give longer time of occlusion

compared with Gelfoam used in most studies; embolization of all accessible supplying branches (uterine and extrauterine pelvic arteries), and the use of long time of broad spectrum antibiotic presenting sepsis. Many authors believe that Gelfoam is the embolizing materials of choice in treatment of PPH, because it dissolves early preventing permanent vessel occlusion (37,38). Recently, the use of potentially non-absorbable particles such as PVA or embosphere particles has been recommended for treatment of placenta accreta (39,35). In this study we used potentially non-absorbable particles in all patients due to the following reasons. Firstly, embolization of placenta accreta/percreta may need longer time of arterial occlusion as placental expulsion may occur after months, and Gelfoam may recanalize before complete regression or expulsion causing rehemorrhage. This scenario was described by Minna et al. (40) who presented a case report of a woman bled massively 7 weeks after cesarean section and gelfoam embolization, and hysterectomy was the end result. Secondly, in a review of cases developed uterine necrosis (41), no definite relationship between the type of embolizing materials and necrosis could be identified. Uterine necrosis together with other ischemic complications such as urologic complications, ovarian failure and definitive amenorrhea have been described related to the small sized particles, rather than the type of the embolic materials (absorbable or inabsorbable) (27,42,39,43). Lastly, there are a lot of publications reporting normal pregnancy after embolization of uterine arteries with non-absorbable particles for treatment of fibroids and PPH. This also happened in two of our patients who became pregnant after embolization.

Most of our patients had free uterus of placenta within 4 weeks after embolization, except the patient with placenta percreta invading the bladder who needed 21 weeks for placental expulsion. The previously reported resorption interval ranged from 4 to 60 weeks (28). Placenta percreta invading urinary bladder is a challenging condition that may cause hematuria, bladder laceration, urinary fistula, and ureteral injury (44). Noriyuki et al. (45) published a case report of placenta percreta invading the urinary bladder causing hematuria. They treated the patient by cesarian hysterectomy, leaving a part of the anterior lower uterine segment adherent to the posterior bladder wall together with the invading portion of the placenta to absorb spontaneously. This patient developed hemorrhage, and vesicovaginal fistula, and partial cystectomy was performed. After 7 months the patient suddenly died because of sepsis. Lam et al. (46) reported a case of successful conservative management of placenta previa accreta. The patient resumed menstruation 5 months after delivery. In 2009, Abdoulaye et al. (39) published a case report of placenta percreta invading the urinary bladder. She was treated conservatively with adjuvant prophylactic UAE using calibrated particles (Embosphère) in complement with absorbable gelatin. The placental portion invading the bladder wall was treated with cystoscopic resection, and peritumoral coagulation. We treated a patient with placenta percreta invading the urinary bladder fully conservative. Bilateral uterine and inferior vesical arteries were embolized with PVA particles. The placenta was expelled after 21 weeks without surgical or cystoscopic intervention.

Patients with non-metastatic (stage I) and low-risk metastatic (stages II and III) gestational trophoblastic neoplasm (GTN) can be treated with single-agent chemotherapy, with

resulting survival rates approaching 100% (47). Aggressive treatment such as multiagent chemotherapy, adjuvant radiation or surgery has reserved to cure high risk metastatic disease with cure rates of 80–90% (47). GTN is highly vascular and is usually associated with uterine vascular malformations. Overall, 1–2% of these uterine vascular malformations cause vaginal or intraperitoneal hemorrhage (48). Since the majority of such vascular malformations are supplied predominantly by the uterine arteries, pelvic embolization has been successfully used to treat GTN-associated genital bleeding (49,11,50). Keepanasseril et al. (51) studied 8 women with GTN presented with massive hemorrhage and the embolization was successful in 85.7% of the patients. In our two patients presented with uterine bleeding due to choriocarcinoma, it was difficult to achieve complete devascularization due to multiple arterial supply and extensive arterio-venous shunt. After embolization the patient stopped bleeding and was cured completely with chemotherapy treatment without need for hysterectomy.

The most commonly reported adverse effect of UAE is fever noted in 4(44%) of our patients. Fever may represent an inflammatory response to tissue necrosis especially with the use of prophylactic broad-spectrum antibiotic therapy, and rarely as a result of sepsis or endometritis. Other rare complications include septic shock, peritonitis, uterine necrosis, injury to the adjacent organs, acute pulmonary edema, acute renal failure, deep vein thrombophlebitis, pulmonary embolism, bladder wall necrosis, vesicovaginal fistula, labial or vaginal necrosis, and partial small bowel necrosis (52–55). Despite resulting in an incidence of uterine synechiae of 11.7%, UAE did not seem to compromise subsequent fertility among a series of 68 women (56). Also in this study we reported two full term pregnancies after UAE.

In conclusion, whatever the placental disease, pelvic embolization with long-lasting embolizing agent is very effective and safe treatment for associated postpartum hemorrhage.

Conflicts of interest

Both authors declare that there was no conflict of interest.

Informed consent was obtained from all individual participants included in the study.

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