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ORIGINAL ARTICLE

The efficacy of pelvic arterial embolisation for the treatment in massive vaginal haemorrhage in obstetric and gynaecological emergencies: a single-centre experience

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ABSTRACT

This study aimed to identify the role, efficacy and safety of pelvic arterial embolisation (PAE) in the management of massive vaginal haemorrhage occurring in 25 patients with obstetric and gynaecological emergencies where bleeding could not be controlled by conservative treatment methods. Nine of the cases had disseminated intravascular coagulation (DIC) and eight were haemodynamically unstable. PAE was successful in 23 of 25 patients without any major complication. Vascular blush was the most common (100%) angiographic finding. Active extravasation was observed in 9 of 25 of the cases. Permanent embolic agents including polyvinyl alcohol (PVA) particles or N-butyl-2-cyanoacrylate (NBCA) were used in all cases. Technical success in patients with disseminated intravascular coagulation (DIC), and in patients who were haemodynamically unstable were 9 of 11 and 6 of 8 cases, respectively. PAE was successful in all seven patients who had hysterectomy before PAE. PAE is a safe and effective alternative to surgical hysterectomy in obstetric and gynaecological emergencies when conservative management failed to control haemorrhage. It is an effective treatment option in cases of coagulation impairment and when bleeding cannot be controlled despite hysterectomy.

IMPACT STATEMENT

- **What is already known on this subject:** Postpartum haemorrhage (PPH) is one of the most common causes of maternal morbidity and mortality worldwide. Most patients with PPH are treated conservatively but where this approach fails, hysterectomy is the standard option with loss of reproductive ability. During the past 20 years, pelvic arterial embolisation (PAE) has emerged as a safe, effective and preferred minimally invasive technique in most tertiary centres as an alternative to surgical treatments including hypogastric artery ligation and hysterectomy. The reported success rate of PAE using temporary and permanent embolic agents is 75–90% in cases of massive vaginal bleeding due to obstetric and gynaecological reasons.
- **What the results of this study add?** PAE showed high success rate in patients with coagulation disorders and in haemodynamically unstable patients. Permanent embolic agents such as polyvinyl alcohol particles (PVAs) or, N-butyl-2-cyanoacrylate (NBCA) should be used for embolisation in coagulation disorders or haemodynamic instability. The most important advantage of NBCA is that the embolisation effect occurs independently of the inherent coagulation cascade.
- **What are the implications of these findings for clinical practice and/or further research?** PAE is an effective and minimally invasive treatment option in cases of coagulopathy and in patients with bleeding that cannot be controlled despite hysterectomy. Our results suggest that haemodynamic instability and DIC should not be considered a contraindication for PAE. Embolic agent selection and the long-term effects of permanent embolic agents on fertilisation is an important issue requiring further investigation.

KEYWORDS

Pelvic arterial embolisation; angiography; post-partum haemorrhage; obstetric; gynaecologic

Introduction

Postpartum haemorrhage (PPH) is seen in 2–11% of all births and is one of the most common causes of maternal morbidity and mortality worldwide (Lee et al. 2012; Kim et al. 2013). PPH is responsible for approximately 25% of maternal deaths (Sidhu et al. 2010; Lee et al. 2012; Kim et al. 2013). The most common causes of PPH are abnormal placentation including placenta accreta, increta, percreta and previa and retained placenta, genital tract laceration, vascular malformations including arteriovenous malformation (AVM), arteriovenous fistula (AVF), and ectopic pregnancy (Sentilhes et al. 2009; Cheong et al. 2014). Common causes of gynaecological haemorrhage include uterine fibroids, cancers, vascular pathologies and coagulopathies (Hongsakul et al. 2014). Primary conservative treatment of postpartum bleeding includes the use of uterotonic agents such as oxytocin, prostaglandins and uterine massage, and primary repair of laceration of the lower genital tract. Uterine balloon tamponade, vaginal

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packing, stepwise devascularisation of the uterus, hypogastric artery ligation or hysterectomy may be required when primary treatment methods are inadequate (Sentilhes et al. 2009). Due to the extensive collateral circulation among the pelvic arteries, the reported success rate of hypogastric artery ligation is 42–84% (Banovac et al. 2007; Sidhu et al. 2010). Hysterectomy may not be possible in some cases, and results in loss of fertility in patients with expectations of pregnancy (Sidhu et al. 2010; Lee et al. 2012; Hongsakul et al. 2014). Uterine or PAE is used as a less invasive and effective alternative to surgery in cases which bleeding cannot be controlled by conservative treatment (Sidhu et al. 2010; Lee et al. 2012; Kim et al. 2013; Cheong et al. 2014; Izumi et al. 2015). The purpose of this retrospective study was to identify the role, efficacy and safety of PAE in the management of massive vaginal haemorrhages in obstetric and gynaecological emergencies in our hospital.

Materials and methods

This retrospective study was approved by the institutional review board. Twenty-five patients with massive vaginal bleeding due to obstetric and gynaecological pathologies in whom bleeding control could not be achieved with conservative methods and treated with PAE between January 2010 and May 2018 were enrolled. All patients provided written informed consent before endovascular embolisation procedures. Fifteen patients were initially treated at different centres and urgently referred to our hospital for PAE. Data available in the hospital information system were retrospectively evaluated before and after PAE. The study parameters included age, term of pregnancy, mode of delivery (caesarean or vaginal), obstetric and gynaecologic history, causes of PPH, coagulation disorders, placental abnormalities (placental accreta, increta, percreta, previa, and placental remnant), uterine vascular pathology (AVM and AVF), haemoglobin (Hb) levels (g/dL), total blood transfusion volume, disseminated intravascular coagulation (DIC) and haemodynamic stability or instability before embolisation .

Embolised arteries, embolic agents used during the embolisation, angiographic findings and embolisation efficacy and complications were investigated as embolisation parameters. All patients provided written informed consent before endovascular embolisation procedures.

Hemodynamic instability or shock criteria were (1) hypotension <90 mm Hg systolic blood pressure, (2) heart rate greater than 100 beats/min despite continuous fluid resuscitation, (3) catecholamine or inotropic drug requirement, and (4) decreased urine flow (Ertel et al. 2000). Obstetric DIC was diagnosed and scored based on the criteria published by 'The International Society of Thrombosis and Haemostasis' (Fletcher et al. 2001). Patients with score of 8 or more according to these criteria were diagnosed with obstetric DIC (Fletcher et al. 2001; Cheong et al. 2014; Soichiro O et al 2017).

Identified causes of massive vaginal haemorrhage treated with PAE were as following: uterine atony ($n = 13$), placental anomalies (placenta accreta, previa and placental remnant) ($n = 4$), vaginal laceration ($n = 2$), coagulation disorders ($n = 2$), vascular pathologies (AVM $n = 3$), and cervical pregnancy ($n = 1$). Two cases with molar pregnancy were associated with placenta previa and AVM (Table 1).

Table 1. The causes of massive vaginal haemorrhage in 25 patients underwent PAE.

The causes of haemorrhage	*N* (%)
Uterine atony	13 (52)
Placental pathologies	4 (16)
Placenta accreta	2 (8)
Placenta previa	1 (4)
Placenta remnant	1 (4)
Vascular pathologies (AVM)	3 (12)
Lower genital tract lacerations	2 (8)
Congenital coagulation disorders (vWF and FXI deficiency)	2 (8)
Cervical pregnancy	1 (4)

AVM: arteriovenous malformation; PAE: pelvic arterial embolisation; vWF: Von Willebrand factor.

All patients were treated conservatively before embolisation. Intravenous fluid resuscitation was carried out in hypovolemic cases, and transfusion of blood products was performed in patients with decreased haemoglobin, and haematocrit values. DIC patients were managed with hemodynamic and/or ventilatory support, fresh frozen plasma (FFP), red blood cell (RBC), and platelet concentrates. Patients with uterine atony had manual uterine massage in additional to uterotonic agents such as oxytocin, intramuscular or intravenous methylergonovin/ergometrine, prostaglandin E1 analogue misoprostol, prostaglandin E2 analogue sulprostone, and the antifibrinolytic agent tranexamic acid. Primary repair was carried out in cases with vaginal or genital tract laceration, and uterine evacuation was performed in cases of placental remnant. Patients with vaginal bleeding despite primary treatment were referred for PAE. Embolisation procedures were performed by experienced and well-trained interventional radiologists (S.O., M.H.O., and H.D., with 5, 20, and 25 years' experience, respectively) in the interventional radiology unit. Patients' pre-embolisation data was summarised in Table 2.

Embolisation technique

Biplane DSA equipments with 3 D reconstruction (Neurostar and Artis Q, Siemens Medical Solutions, Erlangen, Germany) were used for digital subtraction angiography (DSA) and endovascular embolisation procedures. A 5 F introducer sheath (Avanti sheath, Cordis, Miami Lakes, Florida, USA) was inserted into the right femoral artery, and non-selective abdominal–pelvic angiograms were obtained using a pigtail catheter (Boston Scientific, Boston, MA, USA). Both internal iliac and uterine arteries were then selectively studied. A Cobra diagnostic catheter (Boston Scientific, Boston, MA, USA) was used for the contralateral iliac arteries, and Cobra or Simmons 1, 2 catheters (Boston Scientific, Boston, MA, USA) for ipsilateral internal iliac arteries. Progreat (Terumo, Tokyo, Japan) or Direction (Boston Scientific, Boston, MA, USA) microcatheters were used for selective injections. When the uterine arteries were not selectively catheterised, embolisation was performed from the anterior division of the

Table 2. Patient characteristics before embolisation.

NO	Age	GA (weeks)	Obstetric and gynaecologic procedure	Pre-embolisation diagnosis	Hb (g/dL)	Transfusion RBC and/or FFP (unit)	DIC	HI or shock	Referred from other centres
1	45	41	Caesarean	Uterine atony	9	16	–	–	–
2	26	24	Vaginal delivery	Uterine atony	12	4	–	–	+
3	33	13	Suction curettage, sHST	Molar pregnancy, P accreta	5	15	+	+	+
4	35	38	Vaginal delivery	Vaginal laceration	5	16	+	+	+
5	37	37	Caesarean S, sHST R HA ligation	Uterine atony	5	34	+	+	+
6	27	38	Caesarean	Uterine atony	6	21	+	+	–
7	40	–	Oocyte retrieval procedure	vWF deficiency	12	4	–	–	–
8	48	–	HST	FXI deficiency	9	30	+	–	–
9	39	39	Caesarean, HST	P previa, P accreta	8	13	–	–	–
10	20	39	Caesarean, HST	Uterine atony	7	19	+	+	+
11	42	39	Vaginal delivery, HST	Uterine atony	7	7	+	+	+
12	35	12	D&C	Cervical pregnancy	13	0	–	–	–
13	26	33	Caesarean	Uterine atony	14	7	–	–	+
14	37	35	Caesarean	Uterine atony	13	8	–	–	–
15	38	36	Caesarean	Placental remnant	8	2	–	–	+
16	29	37	Caesarean	Uterine atony	14	0	–	–	–
17	48	40	Vaginal delivery, HST	Uterine atony	10	2	–	–	+
18	27	37	Caesarean	P previa	9	9	–	–	+
19	38	19	Suction curettage	Molar pregnancy, AVM	9	3	–	–	–
20	29	37	Caesarean, HST	Uterine atony	5	47	+	+	+
21	36	12	D&C	AVM	12	0	–	–	–
22	47	–	HST	AVM	9	11	–	–	+
23	26	39	Vaginal	Uterine atony	9	4	–	–	+
24	26	38	Vaginal	Vaginal laceration	7	37	+	+	+
25	40	39	Caesarean	Uterine atony	9	3	–	–	+

AVM: arteriovenous malformation; DIC: disseminated intravascular coagulation; D and C: dilation and curettage; FFP: fresh frozen plasma; GA: gestational age; HI: hemodynamic instability; HST: hysterectomy; P accrete: placenta accrete; P previa: placenta previa; RBC: red blood cell; R HA ligation: right hipogastric artery ligation; sHST: subtotal hysterectomy; vWF: von Willebrand factor.

internal iliac artery. In terms of angiographic findings, the presence of active bleeding or vascular hypertrophy, vascular blush, pseudoaneurysm, AVM and AVF were investigated before embolisation. After the microcatheter had been placed in the target artery, embolisation was continued under fluoroscopic control until stasis was observed in arterial flow without reflux. After embolisation, control angiograms were taken to check for abnormal vascularisation or active bleeding. Polyvinyl alcohol (PVA) particles (355-500 μm in size; Boston Scientific, Natick, Mass., USA), N-butyl-2-cyanoacrylate (NBCA) (Histoacryl, B. Braun Melsungen, Germany) mixed with iodizedoil, (Lipiodol, Guerbet, Tokyo, Japan) at a ratio of 1: 3-5, and microcoils (Microvention, Terumo) were used for pelvic arterial embolisation.

Follow up

Technical success was defined as successful catheterisation and embolisation of the uterine or target pelvic arteries and as the absence of pathological vessels such as vascular blush or active extravasation (Lee et al. 2012). Clinical success was defined as sustained haemostasis is provided after the first embolisation without rebleeding within 30 days after the embolisation (Hongsakul et al. 2014).

Results

Patient's characteristics and angiographic findings are summarised in Tables 2 and 3, respectively. The ages of the patients ranged from 20 to 49 years (mean 35 years). Twenty-two of the 25 cases were embolised due to obstetric causes and three for cases with gynaecological reasons. Fifteen cases were referred to our hospital from other centres. Embolisation was performed due to uterine atony in 13 of the 22 obstetric patients. Four cases were embolised due to placental pathologies. Placenta accreta with molar pregnancy and placenta accreta with placenta previa were present in two cases (Figure 1). Placenta previa only was present in the third case and retained placenta (placental remnant) was determined in the fourth. PAE was successful in all four cases with placental pathologies.

In our series, vascular pathologies consistent with uterine AVM were detected in three cases (Table 2). Pelvic arterial embolisation was successful in three cases with AVM. Two molar pregnancies were detected. Placenta accreta with molar pregnancy was also present in one of the cases of AVM (Figure 2).

Coagulation abnormalities were present in two of the three gynaecological patients treated with PAE (cases 7 and 8). One of the patients with coagulopathy had von Willebrand disease (vWh) due to lack of von Willebrand factor for 3 years. Severe factor XI deficiency was determined incidentally in the second case.

Patients' pre-embolisation Hb levels ranged between 5 and 14 g/dL (8.8 g/dL), and total blood transfusion requirements (FFP plus RBC units) were between 0 and 47 units (12–48). Nine of 25 cases presented with DIC while eight were haemodynamically unstable before embolisation. Seven

Table 3. Angiographic features and embolisation procedures in 25 patients.

			Angiographic findings				
Patient No	Embolised vessles	Embolic materials	Vascular blush	Tortuous Hypertrophied UA	Extravasation	AVM	Embolisation results
1	R + L UAs	PVA particles	+	+	+	−	Successful
2	R + L UAs	PVA particles	+	+	−	−	Successful
3	R + L IIA	PVA particles	+	−	−	−	Successful
4	R + L UAs	PVA particles, glue	+	−	+	−	Successful
5	R IIA, L UA	PVA particles	+	+	−	−	Successful
6	R IIA, L UA	PVA particles	+	+	+	−	Successful
7	R + L UAs	PVA particles	+	−	−	−	Successful
8	R UA, L IIA	PVA particles, glue	+	−	+	−	Successful
9	R + L UAs	PVA particles, glue	+	+	+	−	Successful
10	R + L UAs	PVA particles	+	+	+	−	Unsuccesfull
11	R + L UAs	PVA particles	+	+	−	−	Unsuccesfull
12	R + L UAs	PVA particles	+	+	−	−	Successful
13	R UA, L IIA	PVA particles, glue	+	−	−	−	Successful
14	R + L UAs	PVA particles	+	+	−	−	Successful
15	R + L UAs	PVA particles	+	−	−	−	Successful
16	R UA, L IIA	PVA particles	+	+	−	−	Successful
17	R IIA + L UAs	PVA particles	+	+	−	−	Successful
18	R + L UAs	PVA particles	+	+	+	−	Successful
19	R + L UAs	PVA particles, glue	+	+	−	AVM	Successful
20	R + L IIAs	PVA particles	+	−	+	−	Successful
21	R + L UAs	PVA particles, coils	+	+	−	AVM	Successful
22	R IIA	PVA particles, glue	+	−	−	AVM	Successful
23	R + L UAs	PVA particles	+	+	+	−	Successful
24	R + L UAs	PVA particles	+	+	−	−	Successful
25	R ± L UAs	PVA particles	±	±	−	−	Successful

R + L UAs: right and left uterine arteries; R + L IIA: right and left internal iliac arteries.
AVM: arteriovenous malformation; PVA: polyvinyl alcohol particles; UA: uterine artery.

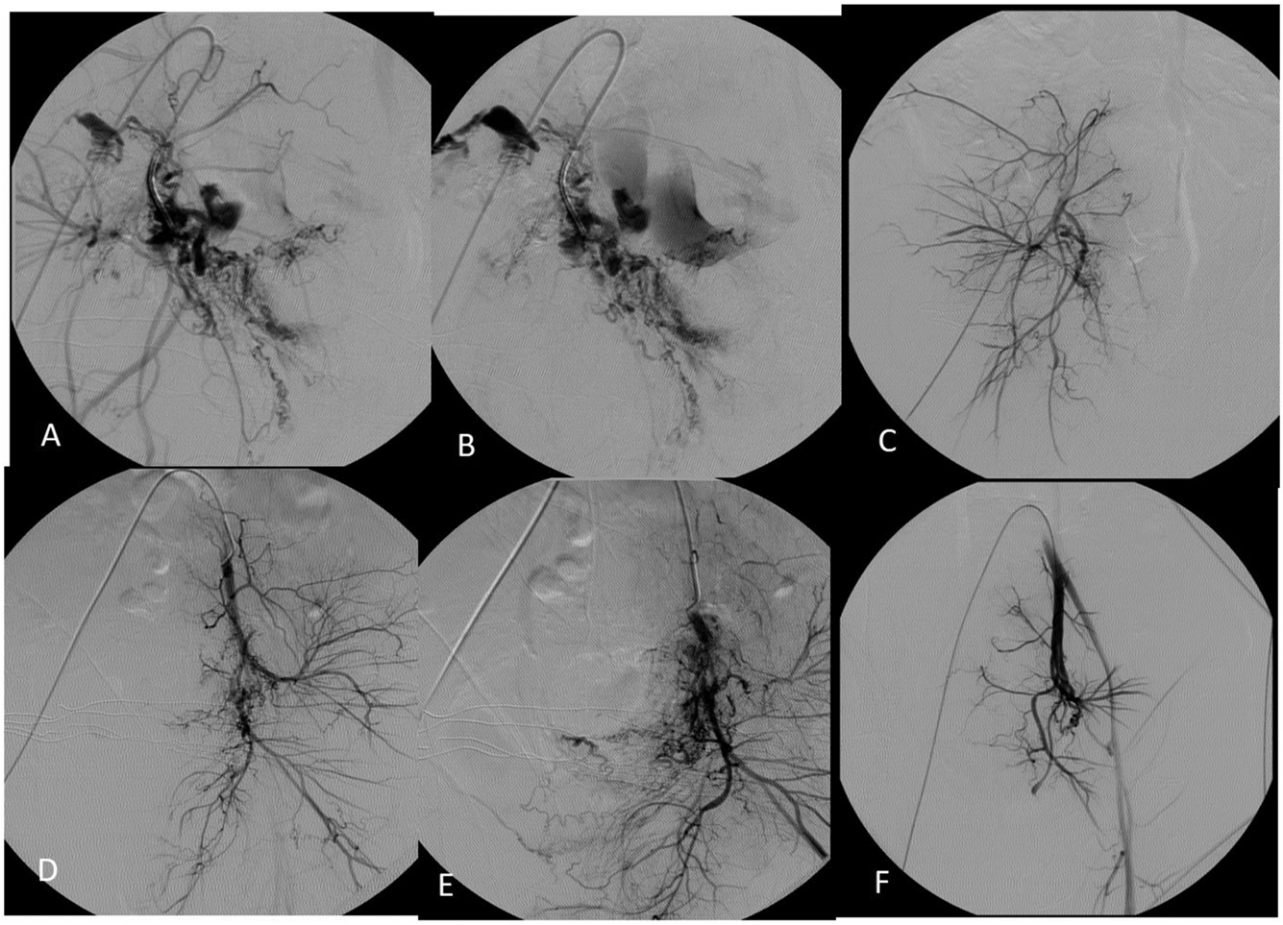


Figure 1. A 40-year-old female patient with placenta accreta and placenta previa with caesarean section, and, massive vaginal bleeding persisted despite hysterectomy. Pre-embolisation angiograms from the right IIA show tortuosity, hypertrophy, vascular staining and extravasation of contrast material in the right uterine artery braches (A, B). The post-embolisation angiogram (C) shows complete disappearance of abnormal vessels and contrast extravasations after PVA and NBCA embolisation. The abnormal vascular staining (D, E) from the left IIA was also embolised (F) with PVA particles.

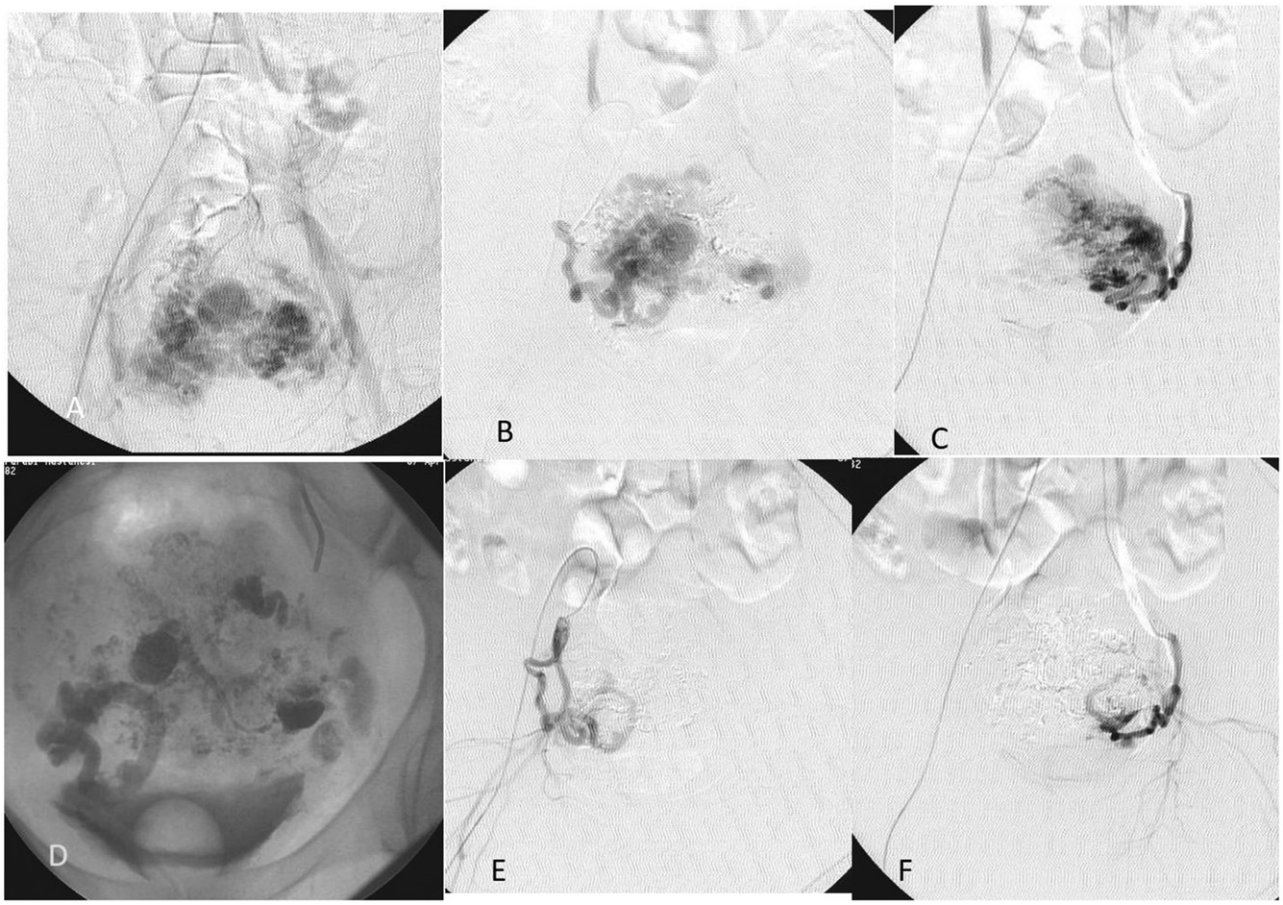


Figure 2. A 38-year-old women with a history of vacuum evacuation due to molar pregnancies. Non-selective pelvic (A), selective right (B) and left (C) UA angiograms show bilateral hypertrophic uterine arteries and an abnormal vessel network with nidus consistent with AVM. Non-subtracted DSA (D) shows the NBCA cast accumulated within the abnormal vascular network of vessels with AVM. Post-embolisation angiograms (E, F) show complete occlusion of AVM after PVA and NBCA embolisation.

of the eight cases with DIC and haemodynamic instability were referred from other centres. PAE exhibited technical success in 9 of 11 of the patients with coagulation disorders and in 6 of 8 of the haemodynamically unstable patients. Haemoglobin values in nine cases with DIC ranged between 5 and 9 g/dL (mean of 6.2 g/dL), while blood transfusion requirements were 7–47 units (25 units on average) of FFP or RBC. PAE was successful in 9 of the 11 patients with coagulation disorder (congenital $n = 2$, acquired $n = 9$).

A total of 9 of 25 cases underwent hysterectomy. Seven of the nine patients had hysterectomy before embolisation. In two of nine patients, hysterectomy were performed because of PAE was unsuccessful. In patients with hysterectomy, six had DIC and five were haemodynamically unstable before surgery. PAE was successful in all seven patients undergoing hysterectomy before PAE.

Embolisation Findings; PAEs were performed on bilateral selective uterine arteries (UAs) in 16 out 25 cases, the unilateral UA-internal iliac artery (IIA) in six, and the bilateral IIA in two cases, while unilateral IIA embolisation was performed in one. In one case (case 5), right UA ligation was performed surgically. In this case, right IIA angiogram showed that the collaterals arising from branches of the IIA were refilling the distal right UA. PAE was therefore performed from the IIA. Two of 25 cases underwent a second embolisation due to recurrent bleeding after the first procedure. Uterine atony was present in one of the re-embolised cases, and AVM in the other. Angiographic findings were vascular blush in 25 of 25 cases, hypertrophic UA in 17, and active contrast material extravasation compatible with active bleeding in 9. Hypertrophic UAs and abnormal vessel networks indicative of nidus were observed in three (12%) cases compatible with AVM.

The technical success rate in our study was 92%. Technical success rate in patients with congenital and acquired coagulopathy (DIC) was 9 of 11 patients. Hysterectomy was performed in two cases with uterine atony due to embolisation failure. These two cases were haemodynamically unstable and DIC was present at time embolisation. Hysterectomy was performed in one case referred to us from other centre (case 20) due to uterine atony following caesarean delivery. This patient developed DIC, shock, and sepsis, and was referred to our hospital following intubation. Bleeding control was achieved by two consecutive embolisation sessions. Mortality occurred 26 days subsequently due to deep venous thrombosis, sepsis and multiorgan failure. PVA was used for PAE in 18 of 25 cases, glue with PVA in 6 and PVA together with coils in one.

No major complication such as uterine and vaginal necrosis, bladder fistula, distal embolisation, pulmonary emboli and death was detected during embolisation. Entry site haematoma (postoperative resorption without additional

intervention) was observed as minor complication occurred in one case and post-embolisation syndrome (PES) in five cases. Pain, low-grade fever, nausea, vomiting, loss of appetite and mild leukocystosis without clinical signs of infection were encountered in the first few days following PAE in patients with PES. Non-steroidal anti-inflammatory drugs (NSAD) and intravenous (IV) antiemetics were used to manage the patients. NSAIDs failed to provide sufficient analgesia after embolisation in two patients with severe pelvic pain and IV narcotic pain pumps were used in these cases.

Discussion

In the present study, PAE was performed on 25 patients with massive vaginal haemorrhage who failed to respond to conservative treatment. Patients were divided into six categories based on causes of massive vaginal haemorrhage (Table 1). Uterine atony was the most common cause of obstetrical bleeding group (13 of 22). Previous studies have also described, uterine atony as the most common cause of bleeding in patients who undergoing PAE due to obstetric bleeding (Lee et al. 2012; Kim et al. 2013; Cheong et al. 2014; Hongsakul et al. 2014). In Kim et al's (2013) series of 257 patients, the most common causes of PPH were uterine atony (61%), placental pathologies (22%) including retained placental fragments, placenta previa, placenta accreta, and genital tract laceration (17%). In another series of 98 cases with postpartum haemorrhage, Poujade et al. (2012) reported that 90% of cases undergoing PAE were due to uterine atony.

In our study, technical success was achieved with PAE in 9 out of 11 cases with coagulation disorder. Two cases in which embolisation was unsuccessful presented with DIC and were hemodynamically unstable. Lee et al (2012) reported that, multivariate analysis identified DIC and massive transfusion as independent factors related to clinical success. The only factors significantly associated with failed pelvic arterial embolisation were a higher rate of estimated blood loss (more than 1500 mL) and transfusion of more than 5 units of red blood cell (Sentilhes et al. 2009). However, some studies have described DIC as an independent predictive factor of failed embolisation (Lee et al. 2012; Poujade et al. 2012; Kim et al. 2013; Soichiro et al. 2017). Other studies have suggested that DIC and haemodynamic instability should not be regarded as a contraindication for PAE (Lee et al. 2012; Kim et al. 2013; Soichiro et al. 2017). Since our patient numbers were low, our series lacked sufficient statistical power for multivariance analysis. We were therefore unable to identify true predictive factors of failed PAE.

Fifteen cases undergoing PAE in our study were referred from other centres. It was particularly noteworthy that 7 out of 8 haemodynamically unstable patients and patients with DIC were referred from other centres. This raises doubts regarding patients referred from other centres before embolisation had received optimal medical treatment. Another possible reason for the high hemodynamic instability and DIC rates in patients referred from other centres is time loss time during transfer following conservative treatment. In contrast, hospital-to-hospital transfer has not been identified as a risk factor for failed embolisation in some previous studies (Lee et al. 2012; Poujade et al. 2012). Embolisation with gelatine sponge, a transient embolising agent in patients with coagulation disorders has been reported as another cause of unsuccessful embolisation (Kim et al. 2013). Gelatine sponge particles mostly resorb within 7–14 days and can cause recanalization (Vaidya et al. 2008; Lee et al. 2012; Kim et al. 2013). More stable or permanent embolic agents, such as PVA or NBCA, should therefore be used in coagulation disorders or hemodynamically instable patients (Kim et al. 2013; Soichiro et al 2017). In our study of the 11 cases with congenital and acquired coagulation defects, PAE was successful in nine patients who embolised with permanent embolisation agents (PVA and NBCA). The most important advantage of NBCA is that the embolisation effect occurs independently of the inherent coagulation cascade (Vaidya et al. 2008; Igarashi et al. 2013). No bleeding recurrence occurred in six cases using NBCA in our series.

Hysterectomy was performed in nine of 25 cases. Seven of these underwent hysterectomy before embolisation. PAE was successful in all these seven patients. In their series of 251 cases of postmenopausal bleeding, Lee et al. (2012) reported that 22 patients underwent PAE after failed surgical procedure (hysterectomy, UA ligation, peripartum B-Lynch suturing, etc). They demonstrated that PAE following failed surgical procedures was not associated with unfavourable clinical outcomes (Lee et al. 2012). Sentilhes et al. (2009) reported successful PAE in 12 (92%) out of 13 patients with failed surgery.

In our series, PAE was successful in all four cases of placental pathology. Abnormal placentation is one of the most common causes of postpartum haemorrhage and the most frequent indication for emergency peripartum hysterectomy (Lim et al. 2013; Pan et al. 2017; Wang 2018). Hysterectomy requirements are significantly high in placenta previa with a relative risk of 30% to 40% (Ossola et al. 2011; Lim et al. 2013). Soyer et al. (2011) reviewed 12 patients with placental abnormalities treated with pelvic embolisation due to severe post-partum haemorrhage. Pelvic embolisation successfully stopped the bleeding in 10 of the 12 women (83%). In contrast, failed embolisation requiring subsequent hysterectomy was observed in two women (17%).

Three cases in our series underwent PAE due to AVM. We considered that the AVMs were acquired in our series due to histories of molar pregnancy, D and C and hysterectomy. PAE was successful in three cases of AVM, although embolisation was performed twice in one case. In two cases, PAE was performed instead of hysterectomy due to subsequent expectations of pregnancy. Permanent embolisation agents such as PVA, NBCA and coil were used in embolisation in cases of AVM.

Traditional management of AVM includes medical management of symptomatic bleeding, blood transfusion, UAE and hysterectomy (Grivell et al. 2005; Brown et al. 2008; Vijayakumar et al. 2013). Patients with a single episode of bleeding who are haemodynamically stable can be treated conservatively. Many AVMs will remain asymptomatic and may regress spontaneously (Vijayakumar et al. 2013).

Several studies have described successful treatment of AVMs with embolisation alone (Yokomine et al. 2009; Vijayakumar et al. 2013). Transarterial embolisation protects the uterus should be preferred as a treatment option in cases of pregnancy expectancy. Preoperative embolisation can be used as a definitive treatment or to minimise intraoperative bleeding before surgery (Brown et al. 2008). Peitsidis et al. (2011) reported that 59% of their 100 cases were treated with UAE and 29% with total abdominal hysterectomy. Spontaneous resolution of AVM occurred in six (6%) patients, while recurrence was observed after treatment with UAE in 17 (17%). Those authors recommended the use of gelfoam, which resorbs within 10–14 days, over permanent particles as first-line embolic agents in women wishing to preserve fertility (Peitsidis et al. 2011). In fact, gelfoam sponge has been used as a safe and effective embolic agent for more than 30 years in UAE and other interventional procedures. It is also the most popular embolising agent for UAE in women with expectations of pregnancy (Delplanque et al. 2018). Although gelfoam particles are regarded as temporary embolising agents, embolisation has also been reported to induce permanent occlusion (Song et al. 2013). More recent studies have recommended polyvinyl alcohol particles or NBCA as agents of choice (Vijayakumar et al. 2013; Vilos et al. 2015).

The technical success rate in our study was 92%. Embolisation with PVA particles failed to control bleeding in two cases. Bleeding control was achieved with hysterectomy in both cases. The failure of embolisation in these cases was due to intense collateral circulation of the pelvic arteries, leading to post-embolisation rebleeding (Bros et al. 2012). Technical success rates for PAE in similar cases in the literature ranges between 80% and 100% (Sentilhes et al. 2009; Sidhu et al. 2010; Lee et al. 2012; Hongsakul et al. 2014).

Major and serious complications are rare in PAE. The overall complication rate in previous studies ranges from 5% to 9%, including vaginal necrosis with bladder fistula, pain, haematoma formation at the puncture site, infection, and transient ovarian failure (Lee et al. 2012; Cheonget al. 2014; Hongsakul et al. 2014). No major and severe complications, such as uterine and vaginal necrosis, bladder fistula, distal embolisation, pulmonary emboli and death, were observed in our series. Minor complications included, a haematoma at the entrance site, post-embolisation syndrome in five cases, and severe pelvic pain treated with IV narcotic pump in two. Complications were resolved by conservative treatment without additional intervention.

The most important limitations of our study are its retrospective character and the low number of cases. This lack of statistical power did not permit us to perform multivariable analysis and we were therefore unable to identify the true predictive factors of failed pelvic arterial embolisation. Our study results were therefore expressed as numbers. Since most of our cases were referred from other centres, the different treatments provided at these may have affected patients' prognosis although this could not be confirmed. Long-term fertility after PAE was not investigated. Further studies with larger case numbers are now needed on this subject.

In conclusion, PAE exhibited a high success rate (92%) in patients with severe vaginal haemorrhages in obstetric and gynaecological pathologies. The technical success rate was in 9 out of 11 cases of congenital and acquired coagulation disorder (DIC). No major complications were observed. PAE is an effective treatment option in cases of coagulopathy and in patients with bleeding that cannot be controlled despite hysterectomy.

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Disclosure statement

No potential conflict of interest was reported by the authors.

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