Original Article

Angiographic Embolization for Emergent and Prophylactic Management of Obstetric Hemorrhage: A Four-Year Experience

**Background.** To retrospectively evaluate the efficacy and safety of emergent and prophylactic arterial embolization for obstetric hemorrhage within the past 4 years.

**Methods.** We retrospectively collected 21 obstetric patients with treatment of selective arterial embolization between 1999 and 2002. Two groups of patients were identified. The first group consisted of 15 patients who experienced postpartum hemorrhage and underwent emergent embolization. The second group was made up of 6 patients who underwent prophylactic embolization with risk factors of severe obstetric bleeding. They had abnormal placenta antepartum diagnosed and accepted termination of pregnancy followed by hysterectomy.

**Results.** In the first group, 12 of 15 cases had a favorable outcome treated by single embolization session. One patient expired 4 days after embolization due to severe disseminated intravascular coagulopathy and multiple organ failure. One retained placenta with recurrent bleeding was controlled by repeated selective arterial embolization. One uterine subinvolution with persistent mild bleeding and genital tract infection was improved by conservative treatment. Further surgical procedure was not necessary for all cases. One woman delivered her next baby 13 months after embolization. In the second group, all women had abnormal placenta with histopathological confirmation, including 1 accreta, 3 increta, and 2 percreta. No immediate complication was noted after embolization. The estimated blood loss during operation ranged from 300 to 3000 mL (mean, 1770 mL).

**Conclusions.** Our study indicated that selective arterial embolization should be the early management for intractable postpartum hemorrhage after conservative treatment fails and before more invasive surgical intervention is considered. Our experience also confirms the effectiveness and safety of prophylactic selective arterial embolization for anticipated high morbidity or mortality of obstetric surgery.
persistent bleeding, surgical procedure with vascular ligation or hysterectomy may be required. Surgical treatment may sometimes be technically difficult and may fail to control hemorrhage. More recently, use of transcatheter arterial embolization (TAE) has been described for control of postpartum bleeding. This procedure is reported with high success rates and few complications, and allows the function of the reproductive organs to be preserved, in comparison with hysterectomy.

Great advance in diagnostic techniques offers an opportunity for planning and controlling anticipated high-risk obstetric conditions such as abnormal placental. Prophylactic TAE by interventional radiologists allows providing hemostasis and minimizing surgical complication.

We report our experience of transcatheter uterine artery embolization in the management of anticipated or actual severe obstetric hemorrhage.

METHODS

We retrospectively collected 21 obstetric patients (mean age, 31.6 years) with treatment of selective arterial embolization between 1999 and 2002. Two groups of patients were identified. The first group consisted of 15 patients who experienced unanticipated hemorrhage and underwent emergency embolization. The second group was made up of 6 patients who underwent prophylactic embolization with risk factors of severe obstetric hemorrhage.

Emergent selective arterial embolization group

Fifteen women with uncontrollable obstetric hemorrhage were treated with selective arterial embolization after failure of conservative treatment. Mean age of the women was 33 years (range, 22-41 years). Fourteen women suffered from primary PPH, and 1 (case 15) had delayed PPH. Thirteen patients delivered live fetuses with gestation age range from 29 to 41 weeks (mean, 37 weeks), including 7 vaginal deliveries and 6 cesarean sections. Two women (cases 14, 15) who decided to terminate their pregnancies by suction curettage or administration of RU486 both at 6 weeks of gestation age in other institution had serious PPH due to unanticipated cervical pregnancy. Six of 15 women were urgently transferred from other institutions (Table 1).

Prophylactic selective arterial embolization group

Six women had abnormal placenta (including 1 placenta accreta, 3 increta, and 2 percreta) that was diagnosed at clinic and antepartum ultrasound examination performed by obstetrician. Mean age of the women was 28.2 years (age range, 24-34 years). All cases had a history of operative delivery or suction curettage or both. The high morbidity and mortality rate of severe PPH with abnormal placenta was explained to all patients and their families. Termination of the pregnancy followed by hysterectomy was suggested by obstetrician. After all patients and their families understood the risk, they agreed to accept the treatment protocol. Prophylactic selective arterial embolization performed by interventional radiologist before operation was planned to decrease surgical bleeding. The mean gestation age was 20.3 weeks (range, 14-24 weeks) (Table 2).

Selective arterial embolization protocol

In all cases, the protocol for treatment was determined by means of consensus between interventional radiologist and obstetrician. All angiography was performed using digital subtraction technique with Advantx LCA (GE Medical Systems, Milwaukee, WI, USA) or Neuro Star (Siemens, Muenchen, Germany). A unilateral right femoral arterial approach was used, and a 6F vascular sheath (Daig, Minnetonka, MN, USA) was inserted. Diagnostic aortoiliac angiography with use of a 5F pig-tail catheter (Mallinckrodt Medcal, Velasco Angleton, TX, USA) and selective contralateral internal iliac angiography with use of a 4F RC1 catheter (Cordis, Johnson & Johnson, Miami, FL, USA) were performed first to detect the bleeding site and the anastomotic vessels. Superselection with embolization of the uterine artery was attempted preferentially with absorbable gelatin sponge (Spongostan, Johnson & Johnson, Gargrave, Skipton, UK). The ipsilateral internal iliac angiography and embolization of uterine artery were then performed and...
Table 1. Emergency selective arterial embolization group

<table>
<thead>
<tr>
<th>Case</th>
<th>Age (years)</th>
<th>GA</th>
<th>Parity</th>
<th>Delivery</th>
<th>Other history</th>
<th>Evolution</th>
<th>Active bleeding</th>
<th>Embolized material and artery</th>
<th>Discharged after TAE (days) and prognosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>32</td>
<td>38</td>
<td>NSD</td>
<td>G3P0SA2</td>
<td>Huge uterine myomas</td>
<td>Uterine atony</td>
<td>LUA</td>
<td>Gelfoam cubes in BU/A</td>
<td>5 days</td>
</tr>
<tr>
<td>2</td>
<td>30</td>
<td>36</td>
<td>C/S</td>
<td>G1P0</td>
<td>Placenta previa and abruptio placenta</td>
<td>Placenta previa</td>
<td>LUA</td>
<td>Gelfoam cubes in BU/A</td>
<td>7 days</td>
</tr>
<tr>
<td>3</td>
<td>33</td>
<td>37</td>
<td>C/S, EBL = 3160 mL</td>
<td>G1P0</td>
<td>Thalassemia carrier</td>
<td>Placenta previa accreta</td>
<td>LUA</td>
<td>Gelfoam cubes in BU/A</td>
<td>6 days. Delivered next baby 13 months after TAE</td>
</tr>
<tr>
<td>4</td>
<td>35</td>
<td>29</td>
<td>NSD</td>
<td>G3P0AA2</td>
<td>GDM+PPROM</td>
<td>Retained placenta R/O placenta accreta</td>
<td>1st TAE—Gelfoam cubes in BAIIA</td>
<td>1st TAE—4 days. Recurrent bleeding 1 month later. 2nd TAE—Gelfoam cubes in BAIIAs</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>31</td>
<td>37</td>
<td>C/S</td>
<td>G5P2AA2</td>
<td>PPROM</td>
<td>Placenta previa R/O placenta accreta</td>
<td>Gelfoam cubes in BU/A</td>
<td>5 days</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>38</td>
<td>35</td>
<td>C/S</td>
<td>G3P2</td>
<td>PPROM</td>
<td>R/O placenta previa accreta</td>
<td>Gelfoam cubes in BU/A</td>
<td>2 steel coils in RUA</td>
<td>2 days</td>
</tr>
<tr>
<td>7</td>
<td>39</td>
<td>38</td>
<td>C/S</td>
<td>G3P1</td>
<td>Laparotomy for ectopic pregnancy</td>
<td>Uterine atony</td>
<td>RUA</td>
<td>Gelfoam cubes in BU/A</td>
<td>2 days</td>
</tr>
<tr>
<td>8</td>
<td>30</td>
<td>39</td>
<td>NSD</td>
<td>G1P0</td>
<td>NSD &amp; total hysterectomy in other institution</td>
<td>Consciousness loss &amp; DIC when transferred</td>
<td>Uterine atony</td>
<td>Gelfoam cubes in BU/A</td>
<td>4 days</td>
</tr>
<tr>
<td>9</td>
<td>36</td>
<td>41</td>
<td>NSD</td>
<td>G3P1</td>
<td>NSD, placenta adhesion over surgical wound</td>
<td>Uterine myometrectomy 9 years ago</td>
<td>3rd degree of EP wound</td>
<td>Gelfoam cubes in BU/A</td>
<td>4 days</td>
</tr>
<tr>
<td>10</td>
<td>41</td>
<td>34</td>
<td>C/S</td>
<td>G1P0</td>
<td>Uterine myectomy 9 years ago</td>
<td>Placental previa R/O placenta increta</td>
<td>Gelfoam cubes in BAIIA</td>
<td>1 steel coil in LOA. 1 steel coil in Rt internal pudendal a.</td>
<td>5 days</td>
</tr>
<tr>
<td>11</td>
<td>26</td>
<td>40</td>
<td>NSD</td>
<td>G1P0</td>
<td>NSD in other institution</td>
<td>Consciousness loss when transferred</td>
<td>Uterine atony</td>
<td>Gelfoam cubes in BAIIA</td>
<td>Massive vaginal bleeding improved, but clinical condition got worse with DIC, severe brain edema, and multiple organ failure. Expired 4 days after TAE</td>
</tr>
<tr>
<td>12</td>
<td>22</td>
<td>40</td>
<td>NSD</td>
<td>G1P0</td>
<td>NSD in other institution</td>
<td>Hypovolemic shock &amp; DIC when transferred</td>
<td>Uterine atony</td>
<td>Gelfoam cubes in BAIIA</td>
<td>13 days</td>
</tr>
<tr>
<td>13</td>
<td>31</td>
<td>38</td>
<td>NSD</td>
<td>G1P0</td>
<td>Vaginal hysterectomy</td>
<td>Vulvovaginal hematoma, 4th degree of EP wound</td>
<td>Graft obturator a. &amp; Rt internal pudendal a.</td>
<td>Gelfoam cubes in BU/A</td>
<td>4 days</td>
</tr>
<tr>
<td>14</td>
<td>34</td>
<td>6</td>
<td>G3P2</td>
<td>Termination of pregnancy by D&amp;C in other institution</td>
<td>Cervical pregnancy</td>
<td>Graft obturator a. &amp; Rt internal pudendal a.</td>
<td>Gelfoam cubes in BU/A</td>
<td>8 days</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>37</td>
<td>6</td>
<td>G4P2AA2</td>
<td>Termination of pregnancy by administration of RU486 &amp; D&amp;C in other institution</td>
<td>Cervical pregnancy</td>
<td>Graft obturator a. &amp; Rt internal pudendal a.</td>
<td>Gelfoam cubes in BU/A</td>
<td>10 days</td>
<td></td>
</tr>
</tbody>
</table>

a. = artery; AA = artificial abortion; Age = maternal age (years); BAIIA = bilateral anterior division of internal iliac arteries; BU/A = bilateral uterine arteries; C/S = cesarean section; D&C = dilatation and curettage; DIC = disseminated intravascular coagulopathy; EBL = estimated blood loss during operation; EP = episiotomy; G = gravidity; GA = gestation age (weeks); GDM = gestational diabetes mellitus; Gelfoam cubes = absorption gelatin sponge; LOA = left ovarian artery; LUA = left uterine artery; NSD = normal spontaneous vaginal delivery; P = parity; PPROM = preterm premature rupture of membrane; PROM = premature rupture of membrane; RADIIA = right anterior division of internal iliac artery; R/O = clinical impression; Rt = right; RU/A = right uterine artery; SA = spontaneous abortion; TAE = transcatheter arterial embolization.
catheterized by use of the same puncture site. If it was difficult to completely occlude the artery with gelatin sponge, fibered steel coils (Cook, Bloomington, IN, U.S.A.) were added. In cases of technical difficulty in catheterization or arterial spasm, embolization of the anterior division of the internal iliac arteries was performed to shorten the procedure time because of the emergent clinical condition, and to reduce radiation exposure. Post embolization aortoiliac angiography was performed to ensure complete occlusion of the bleeding vessels. In cases of abundant anastomotic vessels or residual active bleeding from other arteries, such as sacroiliac arteries, ovarian arteries, internal pudendal arteries, obturator arteries, and vaginal branches, further superselective embolizations were performed.

RESULTS

Relevant patient data, obstetric history, mode of delivery, evolution, protocol of embolization, and patient’s outcome are summarized in Tables 1 and 2.

**Emergent selective arterial embolization group**

Initially, angiography showed extravasation of contrast medium in 10 of 15 cases (66.7%). Twelve of these 15 cases had a favorable outcome treated by single embolization session. One patient (case 11) expired 4 days after embolization due to severe disseminated intravascular coagulopathy (DIC) and multiple organ failure, in spite of improvement of massive vaginal bleeding after embolization. Two patients stabilized after arterial embolization, but recurrent (case 4) or mild persistent (case 12) bleeding persisted for one month. In case 4 of retained placenta, recurrent bleeding was controlled by repeated embolization. In case 12 of uterine subinvolution, persistent vaginal spotting and superinduced genital tract infection were covered after conservative treatment. No patient required additional surgical procedure such as vascular ligation or hysterectomy. One woman (case 3) delivered her next baby 13 months after embolization.

<table>
<thead>
<tr>
<th>Case</th>
<th>GA (weeks)</th>
<th>Parity</th>
<th>Material</th>
<th>Artery embolized</th>
<th>Estimated blood loss (mL)</th>
<th>Discharged after TAE (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>16</td>
<td>27</td>
<td>1</td>
<td>BUA</td>
<td>BUA</td>
<td>600</td>
<td>6</td>
</tr>
<tr>
<td>17</td>
<td>26</td>
<td>20</td>
<td>BUA</td>
<td>BUA</td>
<td>1500</td>
<td>4</td>
</tr>
<tr>
<td>18</td>
<td>24</td>
<td>1</td>
<td>BUA</td>
<td>BUA</td>
<td>3000</td>
<td>8</td>
</tr>
<tr>
<td>19</td>
<td>24</td>
<td>24</td>
<td>BUA</td>
<td>BUA</td>
<td>2722</td>
<td>6</td>
</tr>
<tr>
<td>20</td>
<td>24</td>
<td>24</td>
<td>BUA</td>
<td>BUA</td>
<td>400</td>
<td>2</td>
</tr>
<tr>
<td>21</td>
<td>26</td>
<td>2</td>
<td>BUA</td>
<td>BUA</td>
<td>2700</td>
<td>7</td>
</tr>
</tbody>
</table>

AA = artificial abortion; Age = gestational age; G = gestational age; Gelfoam cubes; LUA = left uterine artery; P = parity; SA = spontaneous abortion; TAE = trans-arterial embolization.
Prophylactic selective arterial embolization group

All women with abnormal placentation had histopathological confirmation, including 1 accreta, 3 increta, and 2 percreta. They had a smooth condition without intermediate complication after embolization. The estimated blood loss during operation was 300-3000 mL (mean, 1770 mL) (Fig. 3).

DISCUSSION

Severe PPH that can not be controlled by conservative treatment is usually at high risk of surgery and general anesthesia under emergent conditions. Surgical procedure of ten fails to stop the bleeding due to the recurrent bleeding from abundant collateral vessels or extrauterine bleeding. In our series, 2 women (case 6 and 8) underwent hysterectomy in other institutions but in vain. TAE is less invasive than surgical procedure. Angiography helps to localize the bleeding site and to effectively treat the active bleeding by superselective technique. Postembolization arteriography immediately evaluates the therapeutic effectiveness. Persistent or recurrent bleeding can be treated with repeat ing embolization of the same or different vessels. All except 1 patient (case 4) in our series were treated by single embolization. In case 4, recurrent bleeding due to retained placenta was
controlled well by repeating embolization of the same vessels. Furthermore, the high incidence of DIC is noted in patients under emergent condition. It has reported that DIC generally disappeared rapidly after embolization. The outcome of case 8 was compatible with the reported result. The other reason for TAE superiority to surgical hysterectomy is fertility preservation. One woman of our series (case 3) delivered her next baby 13 months after embolization. Normal menstruation resumed in all women except the 2 patients who underwent hysterectomy and the one who expired.

The detection rate of extravasation of contrast medium was reported from 33% to 100%. In our series, it was 66.7% (10 of 15 cases) in the emergent embolization group (Figs. 1 and 2). In absence of extravasation, we still carried out embolization of the uterus for reasons of the possibility of intermittent bleeding and the difficult detection on angiography of bleeding rate less than 0.5 mL/min.

Gelatin sponge is the most useful embolic material, providing a short-term (10–30 days) occlusion with potential for recanalization and prevention of ischemia. The temporal embolization of gelatin sponge was useful to prevent irreversible ischemia of pelvic or gans and preserve fertility. How ever, the use of steel coils may be suitable for providing more definitive devascularization.

Vulvovaginal hematoma is a less common cause of PPH that is limited above the urogenital diaphragm. Surgical management is usually inadequate due to difficulty of identifying bleeding vessels. One woman who had vulvovaginal hematoma in our series (case 13) underwent vaginal delivery with 4th-degree laceration of episiotomy wound. She recovered after embolization of the internal pudendal and obturator arteries. The recommended criteria for embolization included the diameter of vulvovaginal hematoma larger than 8 cm or in creating in size and failure of conservative management.

Our success rate of TAE for PPH with out further surgery is similar to the 85–95% in previous reports. One failed case, case 11, was a woman who underwent vaginal delivery. She was transferred to our hospital under deteriorating clinical condition with consciousness loss due to severe PPH. Angiography was performed in the 11th hour after delivery and it showed diffuse vessels with spurts. After embolization with use of some gelatin sponge, massive vaginal bleeding was improved. Unfortunately, she expired 4 days later with signs of severe DIC, generalized brain edema and multiple organ failure. TAE is recommended as early as possible after conservative treatment fails (within 3 hours). There fore, un suited timing of embolization with presence of hypovolemic shock and diffuse vessels could explain the failure of the procedure.

Abnormal placentation (including placenta accreta, increta, and percreta) is often recognized until the attempted removal of the placenta at delivery and can
cause serious PPH. The incidence is increasing nowadays as more women with a history of operative delivery or receiving uterine curettage. Other risk factors included placenta previa, advanced maternal age, and multiparity. Termination of pregnancy followed by hysterectomy to avoid anticipated life-threatening PPH is suggested by obstetricians in our hospital, if abnormal placentation antepartum diagnosed. Early termination of pregnancy (during 14-24 weeks, in our series) is suggested for preventing abundant vascularity of the full-term uterus. Following with hysterectomy avoids additional blood loss and uterus in jury when the placenta is removed. Prophylactic TAE helps to decrease surgical blood loss.

Termination of pregnancy is a difficult decision. It is necessary to explain the high risk of PPH to each patient. In any case, the most important in decision is the agreement of the patient and her family. The estimated blood loss during the operation of a woman undergoing prophylactic TAE in our series was 300-3000 mL (average age, 1770 mL). The average blood loss was 1561 mL in 2 percreta cases, 2400 mL in 3 increta cases, and 300 mL in 1 accreta case. These out comes are favorable when compared with the cases with out prophylactic TAE in our series and previous literature. In Case 3 of placenta accreta, the estimated blood loss was 3160 mL. One study of 62 patients with placenta previa and accreta who underwent hysterectomies reported blood loss of more than 2000 mL in 41 patients, 5000 mL in 9, 10,000 mL in 4, and 20,000 mL in 2. In 1 case report of placenta previa and increta, the blood loss was 7000 mL. Other literature reported 1 placenta percreta with operative bleeding as more than 15 L.

Complications of this procedure are relatively rare; they include fever, pelvic organ infection, irreversible ischemia of pelvic organs, and irreversible radiation damage of ovaries. Complication rates of 6-7% have been reported. No major complications associated with the procedure of TAE was noted in our series except the contraversial situations in case 12 of persistent vaginal spotting with genital infection that recovered after conservative treatment.

However, TAE does require skill and equipment. Digital subtraction angiography (DSA) makes vascular anatomy easily defined and bleeding vessels detectable. We used unilateral femoral artery approach instead of bilateral approach as the literature reported to decrease the risk of complications of focal hematoma, especially in the patients of coagulopathy under emergent condition. Time required for the whole procedure varies because of individual anatomic considerations and the experience of the interventional radiologist. It also depends on the number of bleeders and the ease of catheterization and embolization of the vessels. Our procedure time generally ranges from 1 to 2 hours, with hemostasis of the major bleeders usually within 1 hour. Be cause pa tients undergo the toxicity from the angiographic contrast medium and the damage from radiation exposure during examination, patient selection is crucial to maximize the benefit-to-risk ratio. No serious toxic allergic reaction was noted in any patient of our series. Further more, there is no re-portal of infertility in postembolization patients up to date, and successful post-procedure pregnancies have been reported in the literature and our series (case 3).

Our study indicates that selective arterial embolization should be the early management for intractable postpartum hemorrhage after conservative treatment fails and before surgical intervention is considered. The advantages of angiographic embolization applied prior to surgery include higher success rates, lower complications, minimal invasion, fertility preservation, shorter hospitalization, avoidance of surgery and anesthesia in critical condition. Surgery is still available if embolization fails. Our experience also confirms the efficacy and safety of prophylactic selective arterial embolization for anatomic high-risk cases such as abnormal placentation.

REFERENCES

3. Feinberg BB, Resnik E, Hurt WG, Bump RC, Kubota R, Cho SR. Angiographic embolization in the man age ment of late...


