Interventional management for complications following caesarean section

¹S Y KO, MD, ¹S W PARK, MD, ²I S SOHN, MD, ²J Y LEE, MD, ²H S KWON, MD, ²H S HWANG, MD and ¹S I JUNG, MD

¹Department of Radiology and Research Institute of Medical Science and ²Department of Obstetrics and Gynaecology, Konkuk University Hospital, Seoul, Korea

Objectives: This study aimed to evaluate the efficacy and safety of interventional management for various intractable complications following caesarean section.

Methods: Between August 2005 and September 2009, 18 consecutive women were referred to interventional radiology for treatment of complications developing after caesarean section. Complications included vaginal bleeding ($n = 14$), haemoperitoneum with abdominal wall haematoma ($n = 2$), caesarean scar pregnancy (CSP) ($n = 1$) and post-caesarean fluid collection ($n = 1$).

Results: 17 women underwent transcatheter arterial embolisation (TAE) with a variety of embolic materials, and two women underwent percutaneous drainage (PCD) for fluid collection and haemoperitoneum. 5 of the 14 women with vaginal bleeding had extravasation of contrast media on angiography; the other 9 had no visible bleeding foci. The two women with haemoperitoneum with abdominal wall haematoma had injury to the inferior epigastric artery from angiography. TAE and PCD were successfully performed in both women. The CSP was successfully managed and the serum β -human chorionic gonadotropin (β -hCG) level finally normalised. Hysterectomy or dilatation and curettage was required in women with placenta accrete and undetectable bleeding foci.

Conclusion: Interventional management including TAE and PCD is effective and safe in controlling complications following caesarean section. Use of these procedures can help avoid high-risk surgery, but subsequent procedures including hysterectomy may be required in cases of placental abnormalities and undetectable bleeding foci.

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The incidence of caesarean deliveries has increased dramatically in many countries during the past 50 years [1]. Post-caesarean section maternal morbidity rate has been reported to be as high as 35.7% [2]. The most frequent complications of caesarean section are fever (24.6%), blood loss (4%), haematoma (3.5%) and urinary tract infections (3.0%) [1]. The recognised long-term complications are subsequent ectopic pregnancies, uterine rupture and placental disorder in future pregnancies [3], and delayed post-partum haemorrhage (PPH) with pseudoaneurysm or arteriovenous fistula [4].

Among these complications, PPH remains a major cause of maternal mortality world-wide [5]. In most cases, severe PPH can be managed with conservative treatment involving vaginal packing and administration of uterotonic drugs. In cases of persistent bleeding, however, surgical ligation of uterine or hypogastric vessels or haemostatic hysterectomy is performed. Surgical treatment may sometimes be technically difficult and may fail to control haemorrhage. In addition, surgical options lead to considerable maternal morbidity, mortality and infertility [6, 7]. For these reasons, transcatheter arterial embolisation (TAE) of the uterine arteries represents an interesting

alternative treatment for intractable PPH. The use of TAE to control PPH has a reported success rate of 90–95% [8].

Caesarean scar pregnancy (CSP) is an uncommon type of ectopic pregnancy. It results in uterine rupture and severe haemorrhage during the gestation. Therefore, life-saving emergency hysterectomy is usually the treatment of choice when there is profuse bleeding intraoperatively or after initial management [3, 9]. When there is massive blood loss, especially in reproductive women, the desire for preservation of the uterus is a dilemma for the physician [10].

The goal of this retrospective study was to evaluate the effectiveness and safety of a variety of interventional treatments to manage complications following caesarean section.

Methods and materials

Patient selection and evaluation

Between August 2005 and September 2009, 961 women underwent caesarean delivery in our hospital. A total of 18 (mean age 33.7 years, range 23–41 years) of these were referred to interventional radiology for angiography and possible interventional treatment of post-caesarean section complications (Table 1). 9 of these women (50%) were primiparas and 9 (50%) were multiparas. 5 of

Address correspondence to: Dr Sang Woo Park, Department of Radiology, Konkuk University Hospital, 4-12 Hwayang-dong, Gwangjin-gu, 143-729 Seoul, Korea. E-mail: psw0224@kuh.ac.kr

Table 1. Clinical data describing patients treated with embolisation and PCD

Case no.	Age (years)	Parity	Placental abnormality	Previous delivery mode	Post-CS complication
1	41	G4P1AA2	No	CS	CSP
2	41	G6P4SA2	No	CS	Abdominal wall haematoma
3	36	G2P1AA1	No	CS	Abdominal wall haematoma
4	40	G2P2	No	CS	Vaginal bleeding
5	33	G2P2	No	NSD	Vaginal bleeding
6	24	G2P1AA1	No	No	Vaginal bleeding
7	27	G1P1	No	No	Vaginal bleeding
8	28	G1P1	No	No	Vaginal bleeding
9	31	G1P1	No	No	Vaginal bleeding
10	23	G1P1	No	No	Post-caesarean fluid collection
11	39	G2P2	No	CS	Vaginal bleeding
12	34	G3P2SA1	Accreta	NSD	Vaginal bleeding
13	39	G3P1AA2	Placenta previa	No	Vaginal bleeding
14	30	G3P2SA1	Placenta previa	NSD	Vaginal bleeding
15	32	G3P3AA1	Placenta previa, accreta	CS	Vaginal bleeding
16	36	G2P2	No	CS	Vaginal bleeding
17	34	G2P1SA1	No	No	Vaginal bleeding
18	39	G3P1AA2	Placenta previa	No	Vaginal bleeding

AA, artificial abortion; CS, caesarean section; CSP, caesarean scar pregnancy; NSD, normal spontaneous vaginal delivery; PCD, percutaneous drainage; SA, spontaneous abortion.

the 18 women delivered infants at a peripheral clinic and were transferred to our hospital for emergent treatment, and the other 13 women delivered in our hospital. Reasons for referral for interventional radiology were intractable PPH owing to vaginal bleeding ($n = 14$), haemoperitoneum with abdominal wall haematoma ($n = 2$), the collection of a large amount of fluid in the peritoneal cavity ($n = 1$) and CSP with vaginal bleeding ($n = 1$).

The cases of haemoperitoneum with abdominal wall haematoma were diagnosed by ultrasound, and fluid collection in the peritoneal cavity was confirmed by CT. In the CSP case, the patient presented with vaginal bleeding and abdominal pain at 12 weeks gestation. Laboratory analysis demonstrated that her serum level of β -human chorionic gonadotropin (β -hCG) was 3717 mIU ml^{-1} ; transvaginal and transabdominal ultrasound showed a $6.3 \times 2.3 \text{ cm}$ heterogeneous mixed echogenic mass within the anterior myometrium of the lower uterine segment. CSP was strongly suspected because of these findings.

In all cases, the decision to perform the embolisation was made after discussion among the obstetrician, anaesthesiologist and interventional radiologist. After initial evaluation and stabilisation, all women were transferred to the interventional procedure room. The severity of the haemorrhage was evaluated on the basis of the clinical and haemodynamic parameters of each patient. Initial resuscitation consisted of correction of hypovolemic shock and the treatment of disseminated intravascular coagulation when present. Uterine atony was managed by bimanual uterine massage, vaginal packing, and early administration of intravenous oxytocin and prostaglandin- E_2 analogue before embolisation. No patient had surgical vascular ligation before the embolisation. In five women, abnormal placentation, including two placenta accreta and four placenta previas, was suspected upon antepartum ultrasound examination.

Written informed consent was obtained and approved by the Institutional Review Board. The consent form delineated the predictive result and potential complications of this method. In addition, this retrospective study was approved by the Institutional Review Board.

Procedure

The patients were brought to the interventional procedure room and were placed in the supine position. Using the right common femoral artery approach, a 5-French catheter (Cook, Bloomington, IN) was advanced into the contralateral and ipsilateral internal iliac arteries sequentially and an angiogram was carried out to detect the site of bleeding in the 13 women with post-partum haemorrhage and the woman with CSP. Superselective catheterisation of both uterine arteries using a coaxial method was attempted in all cases using a 3-French microcatheter (Boston Scientific, Natick, MA).

In the two patients with haemoperitoneum and abdominal wall haematoma, aortoiliac arteriography suggested active bleeding from the inferior epigastric artery, and a 5-French catheter was advanced into the ipsilateral and contralateral external iliac arteries. An angiogram was carried out and selective angiography of the inferior epigastric artery with a microcatheter was performed.

Successful embolisation was performed with gelfoam or N-butyl-2-cyanoacrylate (NBCA) (B Braun AG, Melsungen, Germany). Post-embolisation angiography was performed in all cases to confirm the absence of residual extravasation of contrast agent. In addition, the patient who had the CSP received intramuscular injection of methotrexate (MTX) to treat the ectopic pregnancy itself.

One of the two patients who had a history of haemoperitoneum had abdominal distension; and one patient who had a history of peritoneal fluid collection

had signs of peritonitis, including fever, abdominal pain and leukocytosis. Therefore, percutaneous drainage catheters (Sungwon, Seoul, Korea) were inserted into the right lower abdomen of these women and antibiotics were administered to the patient in whom peritonitis was suspected. Percutaneous puncture was performed under ultrasound guidance and a 0.035 inch guide wire was inserted. After the guide wire was inserted, the needle was withdrawn and the drainage catheter was placed over the wire and inserted into the peritoneum.

Follow-up and assessment

Technical success was defined as a successful selective embolisation of post-caesarean haematoma and successful percutaneous drainage of fluid collection. Clinical success was defined by the stabilisation of vital signs and control of vaginal bleeding, the relief of abdominal distension and peritonitis, and no requirement for subsequent procedures such as dilatation and curettage or surgery. For the CSP, the clinical success was defined by control of vaginal bleeding and normalising of the serum β -hCG levels.

Results

Haemodynamic parameters revealed hypotension or hypovolemic shock in 11 of the 14 women with vaginal bleeding and in the two patients who had haemoperitoneum with abdominal haematoma at the time of referral to the interventional radiology service. 8 of the 14 women with vaginal bleeding presented with major vaginal blood loss of greater than 1000 mL. Their mean haemoglobin level before embolisation was 8.61 g dL^{-1} (range $3.3\text{--}12.2 \text{ g dL}^{-1}$). Three women presented with disseminated intravascular coagulopathy. 13 women received blood transfusions (mean 5.3 units; range 1–9 units).

Tracheal intubation, assisted ventilation and emergency cardiac arrest management was required for one

woman who had a seizure during induction and was semicomatose and in hypovolemic shock (heart rate $118 \text{ beats min}^{-1}$, blood pressure $89/49 \text{ mmHg}$, haemoglobin 5.4 g dL^{-1} , haematocrit 16.9%) at admission from a peripheral clinic.

Obstetric procedures consisted of manual exploration of the uterus in all 14 women with vaginal bleeding. Medical management consisted of intravenous administration of uterotonic drugs such as oxytocin or prostaglandin- E_2 analogue to nine patients. Patients received an intravenous injection of oxytocin ($n = 7$) alone or in combination with intrarectal prostaglandin- E_2 analogue ($n = 5$). Despite this, vaginal bleeding was still brisk enough that all of the patients were haemodynamically unstable.

Among the 14 women with post-caesarean vaginal bleeding, selective angiography showed extravasation of contrast agent in 5 (36%) (Figure 1). The bleeding arose from the uterine artery ($n = 4$) and the right cervicovaginal artery ($n = 1$). Absorbable gelatin sponge was used to embolise the extravasation of the uterine artery. There was one case of marked vascular collapse owing to haemodynamic instability with difficulty in catheterisation of one uterine artery. Embolisation of the contralateral internal iliac artery was performed to permit a shorter procedure time and to reduce radiation exposure.

The remaining nine women with post-caesarean vaginal bleeding underwent selective uterine artery angiograms, which showed that both uterine arteries were enlarged without extravasation of contrast media. In these cases, absorbable gelatin sponge was also used as an embolic material.

There were two cases of post-caesarean haemoperitoneum and abdominal wall haematoma without vaginal bleeding, and angiography showed injury to the inferior epigastric artery in both of these cases. Both patients presented with abdominal pain and reduced haemoglobin levels within 6 hours following caesarean section. Abdominal ultrasound showed diffuse fluid collection and heterogeneous echoic swollen abdominal walls, which was deemed haemoperitoneum with abdominal wall haematoma. Angiography showed extravasation of

Figure 1. 34-year-old woman with massive vaginal bleeding following a caesarean section. (a) Selective left uterine artery angiogram shows a hypertrophied left uterine artery with extravasation of contrast media (arrow). (b) Post-embolisation angiogram shows complete occlusion (arrow) of the left uterine artery and the extravasation has disappeared.

contrast media from the muscular branch of the inferior epigastric artery (Figure 2). NBCA was used to embolise the source of extravasation of the inferior epigastric artery. Post-embolisation angiography showed complete occlusion of the feeding arteries and confirmed no residual extravasation of contrast agent in all of the patients. All 16 women with vaginal bleeding and haemoperitoneum who were treated by successful TAE attained immediate haemodynamic stability.

The patient (G2P1, 41 years) with CSP who was diagnosed by ultrasound and laboratory tests had a history of a caesarean section 14 years previously and was referred to us to control her vaginal bleeding and abdominal pain. Aortoiliac angiography showed bilateral enlarged uterine arteries, and selective uterine artery angiography showed a hypervascular lesion (Figure 3). Bilateral uterine artery embolisation using a gelfoam was performed; in addition, intramuscular MTX was subsequently injected. The patient's serum β -hCG levels declined continuously and reached a level of 1110 mIU ml^{-1} by the 7th day after uterine artery embolisation. The patient's bleeding had been minimal after TAE and ceased by the seventh day post-treatment. By the 19th day after uterine artery embolisation, serum β -hCG levels had normalised (1.59 mIU ml^{-1}) and resolution of the scar pregnancy was confirmed. No further medical or surgical interventions were required.

A post-caesarean patient with haemoperitoneum and an abdominal wall haematoma who had abdominal distension and a patient with peritoneal fluid collection were both treated successfully with PCD and their symptoms were much improved. The PCD catheters were removed a couple of weeks later and their signs and symptoms did not recur.

Of the 17 women who underwent TAE and stabilised haemodynamically immediately after embolisation, subsequent blood transfusions were given to six women (mean 3.8 units; range 2–14 units) and fresh-frozen plasma (6 units) was given to 1 woman. Three women had only slight vaginal spotting that ceased spontaneously on

the third and fourth days following embolisation. One patient from this group went on to have a subsequent haemostatic hysterectomy because of recurrent vaginal bleeding 4 hours later. This woman had a history of total placenta previa and two prior dilatations and curettages, and we were unable to find an obvious bleeding focus during embolisation. In addition, another woman with placenta accreta diagnosed at antepartum underwent embolisation without an obvious bleeding focus and experienced intermittent episodes of vaginal spotting. She underwent dilatation and curettage 1 month after embolisation. Therefore, the success rate of TAE for intractable PPH and haemoperitoneum following caesarean section was 87.5% (14/16) and the success rate for uterine preservation was 93.7% (15/16).

No major complications associated with the embolisation procedure were observed in our series. However, minor complications such as pelvic pain and back pain were noted in 5 patients (5/17, 29.4%) from the first day after their embolisation procedures; this resolved within several days and was controlled with conservative treatment. In one case, false aneurysm was discovered in the puncture site after TAE. This regressed spontaneously after manual compression.

Discussion

Hager et al [11] reported that the incidence of more than one intraoperative or post-operative complication in caesarean delivery was 21.4%, and post-partum complications were more serious than those for vaginal delivery [12].

PPH is often managed satisfactorily with conservative treatment such as vaginal packing and intravenous administration of oxytocic drugs and prostaglandin- E_2 analogues. In refractory cases, however, hysterectomy or hypogastric artery ligation might be performed to control intractable PPH. This surgical procedure is associated with a high morbidity and mortality and with loss of subsequent fertility. This procedure may also fail to stop

Figure 2. A 36-year-old woman with intraoperative uncontrollable abdominal wall haematoma during caesarean section. (a) Selective left inferior epigastric artery angiogram shows an extravasation (arrow) of contrast media into the peritoneal cavity from the muscular branch of the inferior epigastric artery. (b) A mixture of 0.5 ml of NBCA and 1.5 ml of iodised oil (Lipiodol) was injected through a microcatheter. No further extravasation of contrast media is present (arrow) following embolisation of the inferior epigastric artery.

Figure 3. A 41-year-old woman with vaginal bleeding caused by CSP. (a, b) Bilateral uterine arterial angiograms show the area of hypervascularity (arrow) that suggests ectopic pregnancy.

the bleeding. The disadvantages of surgical treatment also include the low success rate of hypogastric artery ligation (<50%) [13]. Evans and McShane [14] reported that post-partum haemorrhage continued after hypogastric artery ligation in 57% of the patients.

Greenwood et al [6] reported several mechanisms by which hysterectomy may fail to control bleeding. They include bleeding from extrauterine sites, the presence of abundant collateral vessels such as middle sacral, last lumbar and inferior epigastric arteries, or inadequate arterial ligation. In addition, they insisted that it can be difficult to locate the bleeding site because of engorged and friable pelvic vessels in the post-partum state [6].

The TAE technique for PPH was first described in 1979 [15]. Unlike hysterectomy, TAE is a procedure with a high technical success rate (96%), few complications (6%) and the potential of preserving fertility [3, 7, 16]. Many studies have reported the effectiveness and safety of TAE in the control of post-operative, post-abortion and post-partum intractable bleeding [7, 16].

Angiography helps to localise the bleeding site if there is extravasation of contrast material. However, the bleeding foci can be concealed on angiography because of a collapsed uterine artery caused by haemodynamic instability or misinterpretation of angiographic findings from an engorged uterine artery. Indeed, no obvious extravasation of contrast media from the uterine artery was shown in 50% of our patients. Despite the failure to locate the focus of bleeding in our patients, blind TAE of both uterine arteries preserved the uterus in all but one case. Therefore, even when there is no obvious extravasation of contrast media on angiography, TAE should be considered in preference to hysterectomy as a primary treatment modality for PPH after caesarean section.

Persistent or recurrent bleeding can be treated by repeating embolisation of the same or different vessels [4, 15]. Unfortunately, in our one case of re-bleeding despite successful TAE, emergent hysterectomy was performed because the patient was deteriorating haemodynamically. Another case with intermittent vaginal spotting during follow-up needed a subsequent dilatation and curettage. These cases had two obvious risk factors: placental abnormality and inadequate embolisation of feeding

arteries. For them, haemorrhagic foci were not adequately identified during angiography. Therefore, these risk factors can strongly contribute to the need for subsequent procedures or surgery despite successful TAE. Folie et al [5] reported that the success rate of arterial embolisation after delivery is reduced in the setting of abnormal placentation, leading to hysterectomy because of the high rate of complications (*e.g.*, incomplete arterial occlusions, sepsis and persistent bleeding because of placental migration).

Two cases of post-caesarean haemoperitoneum with abdominal wall haematoma presented with extravasation of the inferior epigastric artery, as diagnosed by angiography. Massive bleeding into the abdominal wall from the inferior epigastric artery can be difficult to recognise initially and injury of the inferior epigastric artery is not common; therefore, abdominal wall haematoma is often overlooked as a potential cause of pelvic haemorrhage. However, the inferior epigastric artery should be considered as a possible source of arterial haemorrhage and a selective angiogram should be done if the main haemorrhage is not vaginal bleeding but a haemoperitoneum, if no obvious abnormality is identified during uterine artery angiography, or if obvious abdominal wall haematoma is identified by laparotomy or on ultrasound or CT scan. There have been some published reports of successful embolisation to treat pseudoaneurysm of the inferior epigastric artery in patients with PPH after caesarean section [17].

Vendantham et al [18] reported complication rates of 6–7% after post-partum pelvic embolisation. Complications of this procedure are relatively rare; they include fever, pelvic or genital infection, irreversible ischaemia of pelvic organs (uterine necrosis, transient ovarian failure or bladder wall necrosis), vaginal fistula, muscle pain, neurological damage, irreversible damage to the ovaries, vaginal abscess, small-bowel infarct, and external iliac artery perforation or occlusion [16]. We noted no major complication in association with the TAE procedure. Minor complications such as pelvic pain and back pain were noted in four patients, mostly on the first day after treatment, resolving within several days and all controllable with conservative treatment.

The incidence of CSP is correlated with caesarean section and is growing. There was one case of CSP in our study which was treated successfully by embolisation of the uterine artery and MTX therapy. An ectopic pregnancy in this location can be life-threatening, resulting in myometrium rupture overlying the gestational sac and uncontrollable bleeding. The operative treatments that have been reported for CSP are dilatation and curettage and excision of trophoblastic tissues using either laparotomy or laparoscopy [9]. Recently, conservative treatment with locally and/or systemically administered MTX has been reported [9]. Embolisation of the uterine artery may be an alternative treatment modality for CSP that does not respond to systemic MTX, even up to 12 weeks of gestation [19]. Conservative treatment of scar pregnancy can prevent the need for laparotomy and uterine loss, and can help to prevent uncontrollable bleeding [9]. Hois et al [20] reported a case of CSP that was successfully managed with bilateral uterine artery embolisation and intramuscular administration of MTX. Sugawara et al [9] reported three cases of viable CSP that were treated safely by selective uterine artery embolisation in combination with subsequent dilatation and curettage and/or MTX therapy.

Conclusion

Interventional management including TAE and PCD are effective and safe in controlling complications following caesarean section. Use of these procedures may eliminate the need for high-risk surgery, but TAE does not always guarantee haemostasis in the presence of placental abnormalities and bleeding foci that are undetectable on angiography; subsequent procedures including hysterectomy may be required.

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