Placenta accreta

Publications Committee, Society for Maternal-Fetal Medicine,
with the assistance of Michael A. Belfort, MBBCH, MD, PhD

OBJECTIVE: We sought to review the risks of placenta accreta, increta, and percreta, and provide guidance regarding interventions to improve maternal outcomes when abnormal placental implantation occurs.

METHODS: Relevant documents were identified through a search of the English-language literature for publications including ≥1 of the key words "accreta" or "increta" or "percreta" using PubMed (US National Library of Medicine; January 1990 through January 2010); with results limited to studies involving human beings. Additional information was obtained from references identified within selected articles; from additional review articles; and from guidelines by organizations including the American College of Obstetricians and Gynecologists. Each included article was evaluated according to study design and quality in accordance with the scheme outlined by the US Preventative Services Task Force.

RESULTS AND RECOMMENDATIONS: Abnormal placentation–encompassing placenta accreta, increta, and percreta–is increasingly common. While randomized controlled trials and large observational cohort studies that can be used to define best practice are lacking, strategies to enhance early diagnosis, enhance preparation, and coordinate peripartum management can be undertaken. Women with a placenta previa overlying a uterine scar should be evaluated for the potential diagnosis of placenta accreta. Women with a placenta previa or "low-lying placenta" overlying a uterine scar early in pregnancy should be reevaluated in the third trimester with attention to the potential presence of placenta accreta. When the diagnosis of placenta accreta is made remote from delivery, the need for hysterectomy should be anticipated and arrangements made for delivery in a center with adequate resources, including those for massive transfusion. Intraoperatively, attention should be paid to abdominal and vaginal blood loss. Early blood product replacement, with consideration of volume, oxygen-carrying capacity, and coagulation factors, can reduce perioperative complications.

Key words: accreta, cesarean hysterectomy, increta, placenta percreta, postpartum hemorrhage

Introduction

Placenta accreta occurs when all or part of the placenta attaches abnormally to the myometrium. Three grades of abnormal placental attachment are defined according to the depth of invasion:

Accreta. Chorionic villi attach to the myometrium, rather than being restricted within the decidua basalis.

Increta. Chorionic villi invade into the myometrium.

Percreta. Chorionic villi invade through the myometrium.

Among patients with a histologic diagnosis of abnormal placental invasion, 81.6% of cases were placenta accreta, 11.8% of cases were placenta increta, and 6.6% were placenta percreta in 1 observational study.[1] In this document, the general term "placenta accreta" will refer to all 3 grades of abnormal placental attachment (placenta accreta, increta, and percreta) unless otherwise specified.

From the Society for Maternal–Fetal Medicine (Publications Committee), Washington DC; and the Maternal–Fetal Services of Utah (Dr Belfort), Salt Lake City, UT.

Received Aug. 9, 2010; accepted Sept. 12, 2010.

Reprint requests: The Society for Maternal-Fetal Medicine, 409 12 St. SW, Washington, DC 20024. pubs@smfm.org.

0002-9378/free

doi: 10.1016/j.ajog.2010.09.013

See related editorial, page 415

Because of abnormal attachment to the myometrium, placenta accreta is associated with an increased risk of heavy bleeding at the time of attempted placental delivery. The need for transfusion of blood products is frequent, and hysterectomy is commonly required to control life-threatening hemorrhage. Examples of complications associated with placenta accreta include: (i) damage to local organs (eg, bowel, bladder, ureters) and neurovascular structures in the retroperitoneum and lateral pelvic sidewalls from placental implantation and its removal; (ii) postoperative bleeding requiring repeated surgery; (iii) amniotic fluid embolism; (iv) complications (eg, dilutional coagulopathy, consumptive coagulopathy, acute transfusion reactions, transfusion-associated lung injury, acute respiratory distress syndrome, and electrolyte abnormalities) from transfusion of large volumes of blood products, crystalloid, and other volume expanders; and (v) postoperative thromboembolism, infection, multisystem organ failure, and maternal death.[2,3] The exact incidence of maternal mortality related to placenta accreta and its complications is unknown, but has been reported to be as high as 6-7% in case series and surveys.[4,5]

What are the risk factors for placenta accreta? (levels II and III evidence)

The reported incidence of placenta accreta has increased from approximately 0.8 per 1000 deliveries in the 1980s to 3 per 1000 deliveries in the past decade.[6-11] An important risk factor for placenta accreta is placenta previa in the presence of a uterine scar.[9,12,13] Hung et al,[14] in a multivariable analysis, found that although placenta previa was an independent risk factor for placenta accreta (odds ratio [OR], 54; 95% confidence interval [CI], 18–166), prior uterine surgery without an associated previa was not (OR, 1.5; 95% CI, 0.4–5.1). The in-

creasing incidence of placenta accreta is likely multifactorial, but partly due to factors such as the increasing number of cesarean deliveries, particularly since the areas of abnormal placental invasion are almost always in the area of the previous hysterotomy.[9,11,12] In a large prospective observational study that considered the number of prior cesarean deliveries and presence or absence of placenta previa, the risk of placenta accreta was 0.03% for those at their first cesarean delivery if there was no placenta previa, remained <1% for women having up to their fifth cesarean delivery, and increased to 4.7% for those having their ≥6th cesarean delivery (Table 1).[11] Alternatively, if placenta previa was present, the risk of placenta accreta was 3% at the first cesarean delivery and increased to 40% or more at the third cesarean delivery. Women with either an anterior or posterior placenta previa are at increased risk for placenta accreta and this risk increases markedly when the placenta overlies a uterine scar.[12] Additional reported risk factors for placenta accreta include maternal age and multiparity, other prior uterine surgery, prior uterine curettage, uterine irradiation, endometrial ablation, Asherman syndrome, uterine leiomyomata, uterine anomalies, hypertensive disorders of pregnancy, and smoking.[8,9,13,15-19] Although these and other risk factors have been described, their actual contribution to the frequency of placenta accreta remains unknown.

How is placenta accreta diagnosed? (levels II and III evidence)

When the antepartum diagnosis of placenta accreta is made, it is usually based on ultrasound findings in the second or third trimester. Sonographic findings that may be suggestive of placenta accreta are summarized in Table 2 and some common features are demonstrated in Figure 1.[20-24]

Twickler et al[20] reported the presence of myometrial thickness <1 mm or large placental lakes to be suggestive of placenta accreta. The presence of both findings together carried a high positive predictive value (72%). Alternatively, Wong et al[1] suggested that disruption of the placental-uterine wall interface and the presence of vessels crossing this area were the most valuable predictive criteria. These latter investigators reported 89% sensitivity and 98% specificity using a composite scoring system including 6 sonographic findings. Recently, the presence of "numerous coherent vessels in the basal view" on 3-dimensional power Doppler has been suggested to have a 97% sensitivity, 92% specificity, and positive predictive value of 76%.[24] However, the number of patients with placenta accreta included in these studies was small and there is not uniform agreement regarding which factors are most accurate in the diagnosis of placenta accreta.

Although there are isolated case reports of placenta accreta being diagnosed in the first trimester or at the time of abortion <20 weeks' gestational age, the predictive value of first-trimester ultrasound for this diagnosis remains unknown.[5,25,26] Ultrasound in the first trimester should not be used routinely to establish or exclude the diagnosis of placenta accreta. Alternatively, because of their associations with placenta accreta, women with a placenta previa or "low-lying placenta" overlying a uterine scar early in pregnancy should undergo follow-up imaging in the third trimester with attention to the potential presence of placenta accreta.

Studies evaluating magnetic resonance imaging for confirmation or exclusion of placenta accreta have yielded conflicting results.[21,27] Current evidence that routine magnetic resonance imaging scanning of patients with sonographically suspected placenta accreta improves pregnancy management or outcomes is lacking. Magnetic resonance imaging may be helpful if ultrasound is inconclusive or if there is suspicion that the placenta has invaded the parametrium or surrounding organs.[21,28] Although some have reported the use of cystoscopy and sigmoidoscopy in the evaluation of selected patients with suspected placenta accreta, their routine use is unnecessary.

TABLE 1
Frequency of placenta accreta according to number of cesarean deliveries and presence or absence of placenta previa[11]

Cesarean delivery	Placenta previa	No placenta previa
First (primary)	3.3	0.03
Second	11	0.2
Third	40	0.1
Fourth	61	0.8
Fifth	67	0.8
≥Sixth	67	4.7

SMFM. Placenta accreta. Am J Obstet Gynecol 2010.

Are laboratory markers useful in identifying placenta accreta? (level III evidence)

At present, no analyte is considered a necessary component in the workup in women with suspected accreta. Elevated second-trimester maternal serum alpha-fetoprotein has been associated with placenta accreta and it has been suggested that there is a direct relationship between the extent of invasion and the elevation of this analyte.[5,29] Hung et al[14] found a maternal serum alpha-fetoprotein >2.5

TABLE 2
Sonographic findings that have been associated with placenta accreta

(1) Loss of normal hypoechoic retroplacental zone[15]

(2) Multiple vascular lacunae (irregular vascular spaces) within placenta, giving "Swiss cheese" appearance[21-23]

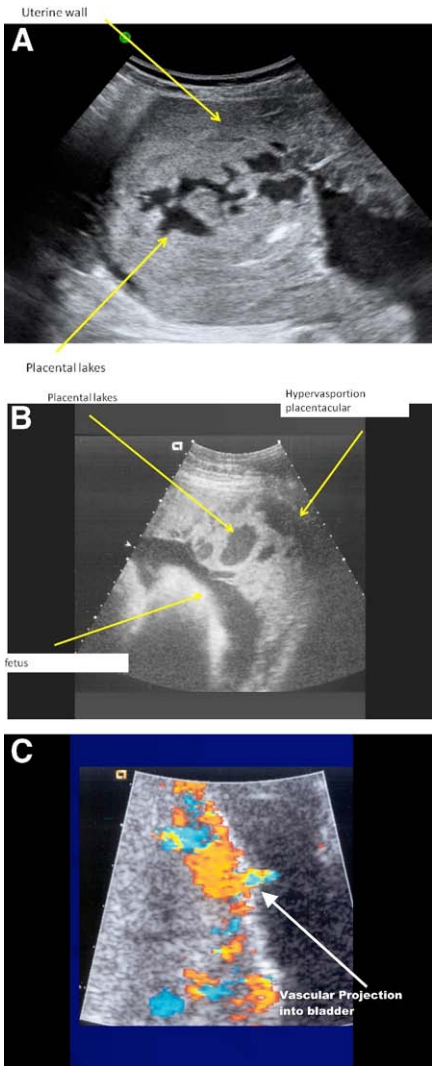
(3) Blood vessels or placental tissue bridging uterine-placental margin, myometrial-bladder interface, or crossing uterine serosa[1]

(4) Retroplacental myometrial thickness of <1 mm[15]

(5) Numerous coherent vessels visualized with 3-dimensional power Doppler in basal view[24]

SMFM. Placenta accreta. Am J Obstet Gynecol 2010.

FIGURE 1
Ultrasound appearance of placenta accreta



A and **B**, Conventional 2-dimensional ultrasound demonstrates large placental vascular lakes of irregular shape within placenta of patient with placenta accreta. **C**, Color Doppler ultrasound demonstrates vascular projections into bladder wall and cavity in patient with placenta percreta.

Photographs reprinted with permission of **A**, Dr Sean Blackwell and **B** and **C**, Dr Gary Dildy.

SMFM. Placenta accreta. Am J Obstet Gynecol 2010.

multiples of the median (OR, 8.3; 95% CI, 1.8–39.3) and a maternal serum-free beta-human chorionic gonadotropin >2.5 multiples of the median (OR, 3.9; 95% CI, 1.9–9.9) to be independently associated with placenta accreta. An elevated maternal serum level of creatine kinase also has been associated with placenta increta and percreta.[30] However, none of these markers have been evaluated prospectively to determine optimal screening or diagnostic thresholds.

How is the patient with an antenatal diagnosis of placenta accreta managed? (levels II-2 and III evidence)

Antepartum considerations

Because significant hemorrhage is common and it is likely that cesarean-hysterectomy will be required when placenta accreta is present, women with a suspected placenta accreta should be scheduled for delivery in an institution with appropriate surgical facilities and a blood bank that can facilitate transfusion of large amounts of various blood products. Supplementation with oral iron is recommended to maximize iron stores and oxygen-carrying capacity. In selected patients, erythropoietin administration and/or concurrent parenteral iron infusion may be needed preoperatively. The expected rise in hematocrit levels will be apparent within 2 weeks. Because placenta accreta itself has not been associated with an increased risk of fetal death or intrauterine growth restriction, antenatal fetal surveillance is not necessary unless otherwise clinically indicated.[12]

The optimal timing for scheduled delivery will depend on clinical circumstances, and the extent of placental invasion. When the diagnosis of placenta accreta is suspected predelivery, emergent preterm birth is often required because of pregnancy complications.[31] However, cases of elective term deliveries after a predelivery diagnosis of placenta accreta have been reported.[31,32] In a study involving 99 cases of placenta accreta diagnosed before delivery, 4 of 9 with delivery >36 weeks required emergency delivery for hemorrhage.[31] If there is no antepartum bleeding or other complications, planned late preterm delivery is acceptable to reduce the likelihood of unscheduled emergent delivery at term.

Preoperative consultation with anesthesiology and notification of the blood bank are indicated before scheduled surgery when placenta accreta is diagnosed antenatally. Additional surgical services such as gynecologic oncology, urology, general surgery, and/or vascular surgery may provide additional surgical expertise if needed. Anesthesia considerations include large-bore venous access to allow rapid crystalloid and blood product infusion, availability of high flow rate infusion and suction devices, hemodynamic monitoring capabilities (central venous and peripheral arterial access), compression stockings and devices to prevent thromboembolism, padding and positioning to prevent nerve compression, and avoidance and treatment of hypothermia. In addition to the potential for severe intraoperative hemorrhage with cardiovascular instability during surgery, the possible need for access to the upper abdomen is an important consideration when surgery for placenta accreta is anticipated. The American Society of Anesthesiologists task force on obstetric anesthesia has suggested that neuraxial techniques are preferred to general anesthesia for most cesarean deliveries, but that the decision to use a particular anesthetic technique for cesarean delivery should be individualized.[33] The task force also suggested that general anesthesia may be the most appropriate choice in some circumstances, including severe hemorrhage. Surgery for placenta accreta is typically prolonged, with recent publications reporting mean operative times of 2-3 hours regardless of whether the diagnosis of placenta accreta is made before or at delivery.[31-33]

The required amounts of infused blood products (eg, whole blood, packed red blood cells, fresh frozen plasma, platelets, and cryoprecipitate) are difficult to predict. Women undergoing cesarean hysterectomy typically will have an intraoperative blood loss of 2000-5000 mL.[12,31,32,34] In some cases, ≥10 L blood loss has been reported.[32] It is important to evaluate preoperatively whether the blood bank has available stores to meet emergent needs and the ability to make arrangements for adequate blood products at the time of scheduled surgery. Additional time to secure sufficient quantities of blood products may be needed for patients with rare

blood types or antibodies to blood group antigens.

Preoperative considerations

Immediate preoperative ultrasound mapping of the placental location can assist in determining the optimal approach to abdominal wall and uterine incisions to provide adequate visualization and to avoid disturbing the placenta before delivery of the fetus.

When prenatal imaging has identified involvement of the lower segment by the placenta accreta, some have suggested that perioperative ureteric stent placement can facilitate palpation of the ureters intraoperatively to allow early identification of ureteral trauma. While 1 retrospective cohort study of 76 cases suggested that preoperative stent placement reduced "early morbidity" (defined as ≥1 maternal intensive care unit admission for >24 hours, transfusion of ≥4 U of packed red blood cells, coagulopathy, ureteral injury, or early reoperation), ureteric trauma was not significantly reduced with this approach (0% vs 7%; $P = .31$).[35] The role of preoperative ureteric stent placement when placenta accreta is suspected remains to be determined.

Preoperative pelvic artery occlusion has also been proposed to reduce intraoperative blood loss.[36,37] However, this strategy has not been confirmed to improve outcomes, and catheter placement can result in complications such as insertion site hematoma, abscess, tissue infarction, and necrosis.[35,38,39] Correspondingly, routine use of this modality is not currently recommended. If considered necessary, the catheter balloon should not be inflated before the infant is delivered as this can be anticipated to reduce placental perfusion. One recent small case series reported on preoperative placement of bilateral femoral artery sheaths with deflated common iliac balloon catheters.[32] Intraoperative common iliac artery occlusion was performed when there was significant hemorrhage, and the patient was transferred under general anesthesia to a radiology suite for selective uterine vascular supply embolization prior to hysterectomy when there was not sig-

TABLE 3
The following tool may be helpful if consolidated in the patient record for easy access and quick reference should an emergency occur[a]

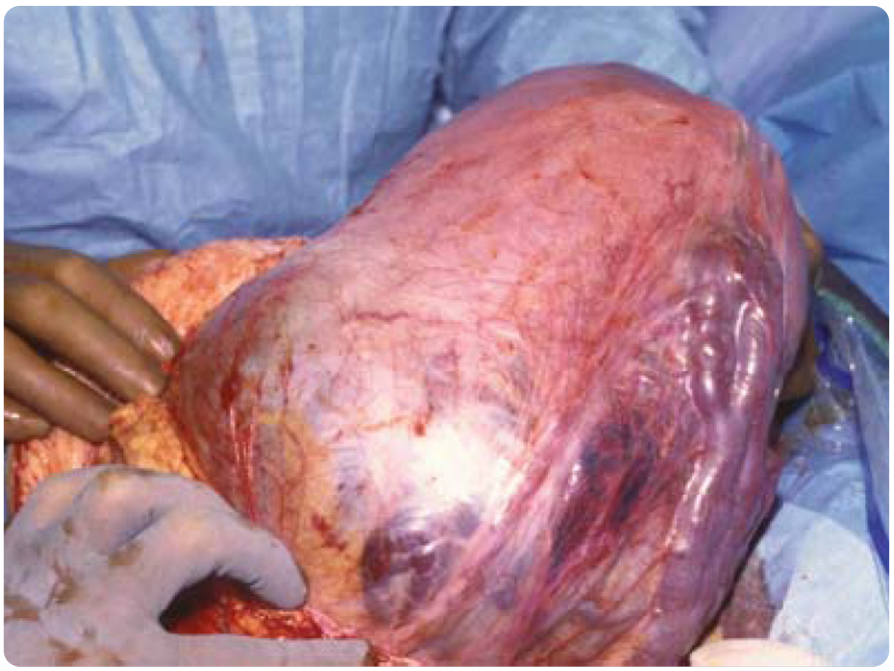
Patient name	
Medical record no.	
Estimated due date	
Preoperative diagnosis of accreta; specify:	accreta/increta/percreta
Placenta location	
Relevant ultrasound findings	
Relevant MRI findings	
Obstetric history	
No. of prior cesarean deliveries	
Other prior uterine surgery	
Blood type	
Antibody screen	
Date and value of most recent hematocrit/hemoglobin	
Date and value of most recent creatinine	
Iron supplementation; if yes, specify type, dose	yes/no
Epogen in this pregnancy; if yes, give dates	yes/no
Transfusion in this pregnancy; if yes, give dates	yes/no
Date of planned surgery	
Planned surgery location and contact no.	
Gestational age at planned delivery	
Antenatal glucocorticoids; if yes, give dates	yes/no
Primary obstetrician; list name and contact no.	
Preoperative consultations and notifications[a]	If yes, list name and contact no.
Obstetric anesthesiologist/anesthesiologist	no/yes _____
Maternal fetal medicine specialist	no/yes _____
Neonatologist/pediatrician	no/yes _____
Gynecologic oncologist/pelvic surgeon	no/yes _____
Urologist	no/yes _____
General surgeon	no/yes _____
Vascular surgeon	no/yes _____
Interventional radiologist	no/yes _____
Blood bank specialist/hematologist	no/yes _____
Cell-saver specialist	no/yes _____
Laboratory specialist	no/yes _____
Intensive care specialist	no/yes _____

MRI, magnetic resonance imaging.

[a] Individual practices and circumstances will vary. This example does not indicate that certain evaluations or consultations are anticipated or expected in all cases.

SMFM. Placenta accreta. Am J Obstet Gynecol 2010.

FIGURE 2
Placenta percreta with bladder invasion at cesarean delivery



Lower uterine segment is bulbous with areas of hemorrhage beneath visceral peritoneum and prominent distended vessels. Fundal and posterior hysterotomy was performed to avoid disruption of placenta before hysterectomy was completed.

Reprinted with permission of Wolters Kluwer Health.

SMFM. Placenta accreta. Am J Obstet Gynecol 2010.

nificant bleeding. An earlier case series described intraoperative arterial embolization after cesarean delivery followed by delayed hysterectomy (10 and 6 weeks).[40] One patient developed pulmonary emboli, and both had significant residual placenta despite methotrexate therapy. While these staged techniques have been successful in some cases, further research regarding the optimal intraoperative approach is needed.

When the need for hysterectomy is anticipated, antibiotic prophylaxis should be administered in the hour before surgery. Prophylactic antibiotics can be repeated if surgery is prolonged (≥3 hours) or if heavy bleeding occurs.[41]

A preoperative summary, or checklist, may be helpful to confirm that needed preparations have been made and to identify the name and contact information for consultants in case they are needed for intraoperative or perioperative assistance (Table 3).

What are general operative considerations regarding placenta accreta? (levels II and III evidence)

Preoperatively, the anticipated intraoperative approach should be clarified with the patient. In many cases it is anticipated that cesarean hysterectomy will be required when placenta accreta is suspected antenatally. When the patient requests conservative management to preserve fertility or for other reasons, the risks and benefits of this approach and criteria for abandoning conservative surgery should be discussed and documented. If the diagnosis of placenta accreta is uncertain preoperatively, a period of observation for placental separation without excessive bleeding is appropriate.

Optimally, if childbearing is complete and the diagnosis of accreta is made preoperatively, hysterectomy should be considered after delivery of the infant. Typically, there should be no planned attempt to remove the placenta before hysterectomy is undertaken. In rare circumstances, removal of the uterus will not be possible or will be deemed too dangerous because of extensive invasion into surrounding pelvic tissues. Case reports and small case series have described successful conservative therapy in which the placenta and uterus are left in situ, or compressive sutures are applied to the uterus.[42] However, the potential need for delayed hysterectomy due to recurrent bleeding should be considered. Postoperative methotrexate therapy and selective arterial embolization have been reported in some cases under this circumstance. The safety and efficacy of these interventions are unknown, and serious complications have been reported with conservative management (eg, severe hemorrhage, septic shock, pulmonary embolism).[43-46]

Intraoperative considerations

Dorsal lithotomy positioning, with the hips abducted but with limited hip flexion, can allow direct evaluation of intraoperative vaginal bleeding, provide access for placement of a vaginal pack or ureteral stents if needed, and allow additional space for an assistant to stand between the patient's legs.[47] While usually a Pfannensteil incision is used, a median or paramedian vertical skin incision may offer improved visualization and improved access for a fundal or posterior uterine wall hysterotomy and for hysterectomy.

Once the abdomen is entered, the uterine serosa may be distended by dilated vessels over the region of placental insertion (Figure 2). It is recommended that the uterine incision be located to avoid the placenta during entry into the uterine cavity if possible. If needed, intraoperative ultrasound, with an ultrasound probe covered by a sterile sleeve, can guide the location of the uterine incision if the optimal site cannot be determined based on preoperative imaging and intraoperative findings. In some cases, a posterior uterine wall incision after exteriorization of the uterus may be desired.

When the index of suspicion for placenta accreta is low and further childbearing is desired, an initial attempt of

placental removal may be acceptable. However, if hysterectomy is planned, the placenta should be left in situ after the umbilical cord is ligated and cut, and then the uterus should be closed to limit bleeding from the incision edges.

During hysterectomy, careful dissection of the retroperitoneal space and judicious devascularization away from the uterine wall can reduce tearing through the friable and vascular tissue near the uterine corpus and placenta. Attention should be paid to avoiding puncture of the uterine serosa overlying the placenta, if feasible, as heavy bleeding can ensue. When rapid control of the uterine blood supply is needed to achieve control of massive vaginal bleeding, some have reported a technique in which the uterine vessels are progressively clamped and cut but the pedicles are not ligated until the after the entire uterine blood supply has been interrupted.[48] While this approach may prove useful in certain circumstances, it has not been proven to be superior to the technique of sequential clamping, cutting, and ligation of the vascular pedicles.

If bladder involvement is suspected, cystotomy may be needed to clarify the extent of invasion after devascularization of the uterus is achieved.[49] If the involved bladder does not include the trigone and is irremediably adherent to the uterus, the involved portion can be excised or left attached to the uterus. Attempts to dissect adherent bladder wall from the uterus are discouraged because of the risk of significant bleeding and placental disruption. In cases of placenta percreta with extension into the bladder, much of the placental blood supply can be derived from collateral vessels from the bladder. Despite ligation of the uterine arteries, massive hemorrhage can occur from the placenta/bladder interface.

Subtotal hysterectomy has been reported to be successful in some cases of persistent postpartum hemorrhage, but persistent bleeding from a lower uterine segment/cervical placental implantation site may preclude this approach as an alternative to total hysterectomy.[34]

If the diagnosis of placenta accreta is uncertain or unanticipated preoperatively, and if a focal area of partial placenta is identified upon removal of placenta, placement of deep myometrial sutures in multiple 3-cm squares in this area may achieve hemostasis in some cases. Cho et al[50] reported successful use of this technique in 23 cases of refractory bleeding with apparently normal uterine cavities on follow-up evaluation. Successful use of an intrauterine tamponade balloon after persistent bleeding from a localized area of accreta has also been reported.[51]

What intraoperative blood product and fluid administration strategies are recommended? (levels II and III evidence)

Frequent assessment of volume status (blood loss, maternal vital signs, urine output) and laboratory parameters (hemoglobin/hematocrit, platelets, coagulation factors and function) can enable the operative team to initiate fluid resuscitation and transfusion in a timely manner. Initial crystalloid and/or volume therapy may be helpful during the management of acute blood loss. Prompt blood product transfusion is generally needed with heavy bleeding such as that seen at cesarean hysterectomy.[52] Additional monitoring, including serum electrolytes and blood gases can assist in optimizing or evaluating the need for and effectiveness of resuscitative interventions. Historically, when blood products were required, platelets and coagulation factors have been given after a defined number of packed red blood cell units (eg, after 4 or 6 U) or based on the presence of documented coagulopathy. Recent data from the battlefield and from civilian life suggest that, in the setting of large hemorrhage, the administration of fresh frozen plasma and platelets in a 1:1 ratio with packed red blood cells can result in more rapid correction of coagulopathy, decreased need for packed red blood cell transfusion in the intensive care unit, and reduced mortality.[53-56] There are no comparable data in pregnancy regarding optimal ratios. It has been reported that the use of recombinant activated Factor VIIa may be beneficial in the treatment of uncontrollable obstetric hemorrhage.[57] Typically, this intervention is more effective in the presence of fibrinogen levels >100 mg/dL. However, caution is advised because of the potential for vascular thrombosis and thromboembolic events, including cardiac and cerebral ischemia, with this treatment.[58,59]

Cell-saver autotransfusion has not been widely used in obstetric practice because of the theoretical concern that fetal cellular debris and amniotic fluid may result in the amniotic fluid embolism syndrome. Currently available filtering technology obviates this concern.[60-63] However, fetal red blood cells may remain in the final product (range, 0.13–4.35%) with a resultant risk of alloimmunization.[63] Importantly, when cell-saver autotransfusion is performed, fresh frozen plasma, cryoprecipitate, and/or platelet transfusion may still be needed because a proportion of the coagulation factors and platelets are excluded in the reconstitution process.[64-67] While the use of intraoperative cell-saver technology appears to be appropriate for emergent use during obstetric hemorrhage, prospective studies of this technique are needed.

What are the options for management of persistent hemorrhage? (levels II and III evidence)

Pelvic artery ligation and embolization

Some have suggested that intraoperative ligation of the hypogastric artery be performed if needed for severe obstetric hemorrhage.[68] However, Eller et al[35] did not show benefit from prophylactic hypogastric artery ligation at surgery for cesarean hysterectomy. When considering this approach, potential risks such as tissue/limb ischemia should be weighed against the potential benefits, and attention should be paid to ligation of the vessel distal to the posterior branch of the internal iliac artery. Recent reports suggest that x-ray–guided pelvic artery embolization is appropriate for persistent but noncatastrophic obstetric bleeding.[41,42,69-71] However, transportation from the operating room for intraoperative arterial embolization is not generally suitable for the acutely unstable patient.

Pelvic pressure packing

In some circumstances there will be persistent diffuse nonarterial bleeding that is not amenable to surgical control. In

such cases, placement of pelvic pressure packing (eg, laparotomy sponges or a gauze bandage) may be considered as a temporizing step to allow time for hemodynamic stabilization, correction of coagulopathy, and eventual completion of surgery.[72] Wide-bore negative pressure pelvic drains may be helpful to warn of significant persistent or recurrent bleeding in this circumstance.

Aortic compression and clamping

Temporary compression of the infrarenal abdominal aorta can decrease blood flow to the pelvis and allow time for resuscitation with blood products.[73] Temporary balloon occlusion of the aorta and counterpulsation have been reported to be of benefit in extreme cases.[74,75] If aortic compression, balloon occlusion, or clamping is deemed necessary, the potential for distal thrombosis and ischemia should be considered, and a vascular surgeon consulted if available.

When persistent uncontrolled bleeding occurs, aortic compression/clamping or occlusion and/or pelvic and abdominal packing, with temporary closure of the abdominal wall to increase the tamponade effect, may provide time for fluid and blood product resuscitation, correction of acidosis and coagulopathy, and rewarming of the patient prior to continuation of surgery.[73-75]

What are specific considerations for postoperative care after hysterectomy for placenta accreta? (level III evidence)

The patient requiring hysterectomy for placenta accreta is at risk for postoperative complications related to intraoperative hypotension, persistent coagulopathy and anemia, and prolonged surgery. Renal, cardiac, and other organ dysfunction is common and should be considered. Sheehan syndrome (both transient and permanent) has been reported after massive postpartum hemorrhage, and hyponatremia may be an early sign.[76] If large volumes of crystalloids and blood products are given intraoperatively, the patient is also at risk for pulmonary edema, transfusion-related acute lung injury, and/or acute respiratory distress syndrome.[11,77]

Quality of evidence

The quality of evidence for each article was evaluated according to the method outlined by the US Preventive Services Task Force:

I	Properly powered and conducted randomized controlled trial (RCT); well-conducted systematic review or metaanalysis of homogeneous RCTs
II-1	Well-designed controlled trial without randomization
II-2	Well-designed cohort or case-control analytic study
II-3	Multiple time series with or without the intervention; dramatic results from uncontrolled experiments
III	Opinions of respected authorities, based on clinical experience; descriptive studies or case reports; reports of expert committees

Recommendations are graded in the following categories:

Level A
The recommendation is based on good and consistent scientific evidence.

Level B
The recommendation is based on limited or inconsistent scientific evidence.

Level C
The recommendation is based on expert opinion or consensus.

Specific attention should be paid to frequent evaluation of vital signs (blood pressure, heart and respiratory rate). Urine output should be measured via an indwelling urinary catheter. Intensive care admission, central venous monitoring, and assessment of peripheral oxygenation by pulse oximetry can be helpful in some cases. Correction of coagulopathy and severe anemia with blood products should be undertaken. The patient should be clinically evaluated for potential blood loss from the abdominal incision and vagina, and for recurrent intraabdominal or retroperitoneal bleeding. There should be a low threshold for reexploration if recurrent bleeding is suspected. Renal function should be evaluated and serum electrolyte abnormalities should be treated as needed until the patient is stabilized. If there is persistent hematuria or anuria, the possibility of unrecognized urinary tract injury should be considered. Early ambulation, and intermittent compression devices for those requiring bedrest, can reduce the risk of thromboembolic complications.

RECOMMENDATIONS

Levels II and III evidence, level A recommendation

1. Women with a placenta previa overlying a uterine scar should be evaluated for the potential diagnosis of placenta accreta. Women with a placenta previa or "low-lying placenta" overlying a uterine scar early in pregnancy should undergo follow-up imaging in the third trimester with attention to the potential presence of placenta accreta.

Level III evidence, level B recommendation

2. While obstetric ultrasound is the primary tool for the diagnosis of placenta accreta, magnetic resonance imaging can be helpful if ultrasound is inconclusive or if placenta percreta is suspected.

Level III evidence, level C recommendation

3. When the diagnosis of placenta accreta is suspected antenatally, delivery should be scheduled in an institution with appropriate expertise and facilities including the ability to manage severe hemorrhage.

Levels II-2 and III evidence, level B recommendation

4. Because the availability of adequate facilities and resources to manage severe hemorrhage at delivery is important, scheduled late preterm delivery is acceptable when placenta accreta is suspected antenatally.

Levels II and III evidence, level C recommendation

5. The potential need for hysterectomy should be anticipated when the diagnosis of placenta accreta is made. Hysterectomy with the placenta left in situ after delivery of the fetus should be considered.

Levels II and III evidence, level B recommendation

6. Intraoperatively, attention should be paid to abdominal and vaginal blood loss. Early blood product replacement, with consideration of volume expansion, increasing oxygen-carrying capacity, and normalization of coagulation factors, can reduce perioperative complications.

Level III evidence, level C recommendation

7. When surgery for placenta accreta is planned, the potential need for postoperative intensive care unit admission should be considered.

Levels II and III evidence, level B recommendation

8. Arterial embolization is appropriate for the hemodynamically stable patient with persistent intrapelvic bleeding despite surgical measures. However, transport from the operating room to accomplish this intervention is not generally suitable for the hemodynamically unstable patient.

Randomized clinical trials and large cohort studies regarding the diagnosis and treatment of placenta accreta are lacking. Studies of these types are needed to determine optimal antenatal diagnosis and peripartum management of this potentially morbid condition. ■

This opinion was developed by the Publications Committee of the Society for Maternal-Fetal Medicine with the assistance of Michael A. Belfort, MBBCH, MD, PhD, and was approved by the executive committee of the society on May 11, 2010. Dr Belfort and each member of the publications committee (Brian Mercer, MD, Vincenzo Berghella, MD, Michael Foley, MD, Sarah Kilpatrick, MD, PhD, George Saade, MD, William Grobman, MD, MBA, George Macones, MD, Lynn Simpson, MD, Sean Blackwell, MD, Cynthia Gyamfi, MD, Michael Varner, MD, Ariste Sallas-Brookwell, BA) have submitted a conflict of interest disclosure delineating personal, professional, and/or business interests that might be perceived as a real or potential conflict of interest in relation to this publication.

REFERENCES

1. Wong HS, Cheung YK, Zuccollo J, Tait J, Pringle KC. Evaluation of sonographic diagnostic criteria for placenta accreta. J Clin Ultrasound 2008;9:551-9. Case-control level II-2.

2. Styron AG, George RB, Allen TK, Peterson-Layne C, Muir HA. Multidisciplinary management of placenta percreta complicated by embolic phenomena. Int J Obstet Anesth 2008; 17:262-6. Case report level III.

3. Mathelier AC, Karachorlu K. Placenta previa and accreta complicated by amniotic fluid embolism. Int J Fertil Womens Med 2006;51: 28-32. Case report level III.

4. Washecka R, Behling A. Urologic complications of placenta percreta invading the urinary bladder: a case report and review of the literature. Hawaii Med J 2002;61:66-9. Systematic review of case series level III.

5. O'Brien JM, Barton JR, Donaldson ES. The management of placenta percreta: conservative and operative strategies. Am J Obstet Gynecol 1996;175:1632-8. Case series level III.

6. Flood KM, Said S, Geary M, Robson M, Fitzpatrick C, Malone FD. Changing trends in peripartum hysterectomy over the last 4 decades. Am J Obstet Gynecol 2009;200:632.e1-6. Multiple time series level II-3.

7. Imudia AN, Awonuga AO, Dbouk T, et al. Incidence, trends, risk factors, indications for, and complications associated with cesarean hysterectomy: a 17-year experience from a single institution. Arch Gynecol Obstet 2009; 280:619-23. Multiple time series level II-3.

8. Wu S, Kocherginsky M, Hibbard JU. Abnormal placentation: twenty-year analysis. Am J Obstet Gynecol 2005;192:1458-61. Cohort level II-2.

9. Clark SL, Koonings PP, Phelan JP. Placenta previa/accreta and prior cesarean section. Obstet Gynecol 1985;66:89-92. Cohort level II-2.

10. Read JA, Cotton DB, Miller FC. Placenta accreta: changing clinical aspects and outcome. Obstet Gynecol 1980;56:31-4. Case series level III.

11. Silver RM, Landon MB, Rouse DJ, et al; National Institute of Child Health and Human Development Maternal-Fetal Medicine Units Network. Maternal morbidity associated with multiple repeat cesarean deliveries. Obstet Gynecol 2006;107:1226-32. Cohort level II-2.

12. Usta IM, Hobeika EM, Musa AA, Gabriel GE, Nassar AH. Placenta previa-accreta: risk factors and complications. Am J Obstet Gynecol 2005;193:1045-9. Case-control level II-2.

13. Miller DA, Chollet JA, Goodwin TM. Clinical risk factors for placenta previa/placenta accreta. Am J Obstet Gynecol 1997;177:210-4. Case-control level II-2.

14. Hung TH, Shau WY, Hsieh CC, Chiu TH, Hsu JJ, Hsieh TT. Risk factors for placenta accreta. Obstet Gynecol 1999;93:545-50. Case-control level II-2.

15. Gielchinsky Y, Mankuta D, Rojansky N, Laufer N, Gielchinsky I, Ezra Y. Perinatal outcome of pregnancies complicated by placenta accreta. Obstet Gynecol 2004;104:527-30. Case-control level II-2.

16. Norwitz ER, Stern HM, Grier H, Lee-Parritz A. Placenta percreta and uterine rupture associated with prior whole body radiation therapy. Obstet Gynecol 2001;98:929-31. Case report level III.

17. Hoffman MK, Sciscione AC. Placenta accreta and intrauterine fetal death in a woman with prior endometrial ablation: a case report. J Reprod Med 2004;49:384-6. Case report level III.

18. Shellhaas CS, Gilbert S, Landon MB, et al; Eunice Kennedy Shriver National Institutes of Health and Human Development Maternal-Fetal Medicine Units Network. The frequency and complication rates of hysterectomy accompanying cesarean delivery. Obstet Gynecol 2009; 114:224-9. Cohort level II-2.

19. Henriet E, Roman H, Zanati J, Lebreton B, Sabourin JC, Loic M. Pregnant noncommunicating rudimentary uterine horn with placenta percreta. JSLS 2008;12:101-3. Case report level III.

20. Twickler DM, Lucas MJ, Balis AB, et al. Color flow mapping for myometrial invasion in women with a prior cesarean delivery. J Matern Fetal Med 2000;9:330-5. Cohort level II-2.

21. Levine D, Hulka CA, Ludmir J, Li W, Edelman RR. Placenta accreta: evaluation with color Doppler US, power Doppler US, and MR imaging. Radiology 1997;205:773-6. Case series level III.

22. Hull AD, Salerno CC, Saenz CC, Pretorius DH. Three-dimensional ultrasonography and diagnosis of placenta percreta with bladder involvement. J Ultrasound Med 1999;18:853-6. Case report level III.

23. Comstock CH, Love JJ Jr, Bronsteen RA, et al. Sonographic detection of placenta accreta in the second and third trimesters of pregnancy. Am J Obstet Gynecol 2004;190: 1135-40. Cohort level II-2.

24. Shih JC, Palacios Jaraquemada JM, Su YN, et al. Role of three-dimensional power Doppler in the antenatal diagnosis of placenta accreta: comparison with gray-scale and color Doppler techniques. Ultrasound Obstet Gynecol 2009; 33:193-203. Cohort level II-2.

25. Harden MA, Walters MD, Valente PT. Postabortal hemorrhage due to placenta increta: a case report. Obstet Gynecol 1990;75:523-6. Case report level III.

26. Woolcott RJ, Nicholl M, Gibson JS. A case of placenta percreta presenting in the first trimester of pregnancy. Aust N Z J Obstet Gynaecol 1987;27:258-60. Case report level III.

27. Lam G, Kuller J, McMahon M. Use of magnetic resonance imaging and ultrasound in the antenatal diagnosis of placenta accreta. J Soc Gynecol Investig 2002;9:37-40. Case series level III.

28. Warshak CR, Eskander R, Hull AD, et al. Accuracy of ultrasonography and magnetic resonance imaging in the diagnosis of placenta accreta. Obstet Gynecol 2006;108:573-81. Cohort level II-2.

29. Zelop C, Nadel A, Frigoletto FD Jr, Pauker S, MacMillan M, Benacerraf BR. Placenta accreta/percreta/increta: a cause of elevated maternal serum alpha-fetoprotein. Obstet Gynecol 1992;80:693-4. Case series level III.

30. Ophir E, Tendler R, Odeh M, Khouri S, Oettinger M. Creatine kinase as a biochemical marker in diagnosis of placenta increta and percreta. Am J Obstet Gynecol 1999;180: 1039-40. Case report level III.
31. Warshak CR, Ramos GA, Eskander R, et al. Effect of predelivery diagnosis in 99 consecutive cases of placenta accreta. Obstet Gynecol 2010;115:65-9. Cohort level II-2.
32. Angstmann T, Gard G, Harrington T, Ward E, Thomson A, Giles W. Surgical management of placenta accreta: a cohort series and suggested approach. Am J Obstet Gynecol 2010; 202:38e1-9. Case series level III.
33. American Society of Anesthesiologists Task Force on Obstetric Anesthesia. Practice guidelines for obstetric anesthesia: an updated report by the American Society of Anesthesiologists Task Force on Obstetric Anesthesia. Anesthesiology 2007;106:843-63. Expert opinion level III.
34. Clark SL, Phelan JP, Yeh SY, et al. Hypogastric artery ligation for obstetric hemorrhage. Obstet Gynecol 1985;66:353-6. Case series level III.
35. Eller AG, Porter TF, Soisson P, Silver RM. Optimal management strategies for placenta accreta. BJOG 2009;116:648-54. Case series level III.
36. Bodner LJ, Nosher JL, Gribbin C, Siegel RL, Beale S, Scorza W. Balloon-assisted occlusion of the internal iliac arteries in patients with placenta accreta/percreta. Cardiovasc Intervent Radiol 2006;29:354-61. Case series level III.
37. Shih JC, Liu KL, Shyu MK. Temporary balloon occlusion of the common iliac artery new approach to bleeding control during cesarean hysterectomy for placenta percreta. Am J Obstet Gynecol 2005;193:1756-8. Case report level III.
38. Greenberg JI, Suliman A, Iranpour P, Angle N. Prophylactic balloon occlusion of the internal iliac arteries to treat abnormal placentation a cautionary case. Am J Obstet Gynecol 2007; 197:470.e1-4. Case report level III.
39. Sewell MF, Rosenblum D, Ehrenberg H. Arterial embolus during common iliac balloon catheterization at cesarean hysterectomy. Obstet Gynecol 2006;108:746-8. Case report level III.
40. Lee PS, Bakelaar R, Fitpatrick CB, Ellestad SC, Havrilesky LJ, Alvarez Secord A. Medical and surgical treatment of placenta percreta to optimize bladder preservation. Obstet Gynecol 2008;112:421-4. Case report level III.
41. American College of Obstetricians and Gynecologists Committee on Practice Bulletins–Gynecology. ACOG practice bulletin no. 104: antibiotic prophylaxis for gynecologic procedures. Obstet Gynecol 2009;113:1180-9. Expert opinion level III.
42. Gungor T, Simsek A, Ozdemir AO, Pektas M, Danisman N, Mollamahmutoglu L. Surgical treatment of intractable postpartum hemorrhage and changing trends in modern obstetric perspective. Arch Gynecol Obstet 2009;280: 351-5. Case series level III.
43. Alkazaleh F, Geary M, Kingdom J, Kachura JR, Windrim R. Elective non-removal of the placenta and prophylactic uterine artery embolization postpartum as a diagnostic imaging approach for the management of placenta percreta: a case report. J Obstet Gynaecol Can 2004;26:743-6. Case report level III.
44. Butt K, Gagnon A, Delisle MF. Failure of methotrexate and internal iliac balloon catheterization to manage placenta percreta. Obstet Gynecol 2002;99:981-2. Case report level III.
45. Teo SB, Kanagalingam D, Tan HK, Tan LK. Massive postpartum hemorrhage after uterus-conserving surgery in placenta percreta: the danger of the partial placenta percreta. BJOG 2008;115:789-92. Case report level III.
46. Dinkel HP, Dürig P, Schnatterbeck P, Triller J. Percutaneous treatment of placenta percreta using coil embolization. J Endovasc Ther 2003; 10:158-62. Case report level III.
47. Pelosi MA III, Pelosi MA. Modified cesarean hysterectomy for placenta previa percreta with bladder invasion: retrovesical lower uterine segment bypass. Obstet Gynecol 1999;93:830-3. Case report level III.
48. Plauche WC, Gruich FG, Bourgeois MO. Hysterectomy at the time of cesarean section: analysis of 108 cases. Obstet Gynecol 1981; 58:459-64. Cohort level II-2.
49. Matsubara S, Ohkuchi A, Yashi M, et al. Opening the bladder for cesarean hysterectomy for placenta previa percreta with bladder invasion. J Obstet Gynaecol Res 2009;35:359-63. Case report level III.
50. Cho JH, Jun HS, Lee CN. Hemostatic suturing technique for uterine bleeding during cesarean delivery. Obstet Gynecol 2000;96: 129-31. Case series level III.
51. Ferrazzani S, Guariglia L, Triunfo S, Caforio L, Caruso A. Conservative management of placenta previa-accreta by prophylactic uterine arteries ligation and uterine tamponade. Fetal Diagn Ther 2009;25:400-3. Case report level III.
52. Shander A, Goodnough LT. Update on transfusion medicine. Pharmacotherapy 2007; 27:57-68S. Expert opinion level III.
53. Gonzalez EA, Moore FA, Holcomb JB, et al. Fresh frozen plasma should be given earlier to patients requiring massive transfusion. J Trauma 2007;62:112-9. Cohort level II-2.
54. Holcomb JB, Wade CE, Michalek JE, et al. Increased plasma and platelet to red blood cell ratios improves outcome in 466 massively transfused civilian trauma patients. Ann Surg 2008;248:447-58. Cohort level II-2.
55. Gunter OL Jr, Au BK, Isbell JM, Mowery NT, Young PP, Cotton BA. Optimizing outcomes in damage control resuscitation: identifying blood product ratios associated with improved survival. J Trauma 2008;65:527-34. Cohort level II-2.
56. Malone DL, Hess JR, Fingerhut A. Massive transfusion practices around the globe and a suggestion for a common massive transfusion protocol. J Trauma 2006;60:S91-6. Expert opinion level III.
57. Pepas LP, Arif-Adib M, Kadir RA. Factor VIIa in puerperal hemorrhage with disseminated intravascular coagulation. Obstet Gynecol 2006;108:757-61. Case report level III.
58. Alfirevic Z, Elbourne D, Pavord S, et al. Use of recombinant activated factor VII in primary postpartum hemorrhage: the Northern European registry 2000-2004. Obstet Gynecol 2007;110:1270-8. Case series level III.
59. Franchini M, Franchi M, Bergamini V, Salvagno GL, Montagnana M, Lippi G. A critical review on the use of recombinant factor VIIa in life-threatening obstetric postpartum hemorrhage. Semin Thromb Hemost 2008;34: 104-12. Expert opinion level III.
60. Thornhill ML, O'Leary AJ, Lusson SA, Rutherford C, Johnson MD. An in vitro assessment of amniotic fluid removal from human blood through cell saver processing. Anesthesiology 1991;75:A830. Case series level III.
61. Catling SJ, Williams S, Fielding AM. Cell salvage in obstetrics: an evaluation of the ability of cell salvage combined with leucocyte depletion filtration to remove amniotic fluid from operative blood loss at cesarean section. Int J Obstet Anesth 1999;8:79-84. Case series level III.
62. Bernstein HH, Rosenblatt MA, Gettes M, Lockwood C. The ability of the Haemonetics 4 Cell Saver System to remove tissue factor from blood contaminated with amniotic fluid. Anesth Analg 1997;85:831-3. Case series level III.
63. Waters JH, Biscotti MD, Potter PS, Phillipson E. Amniotic fluid removal during cell salvaged in the cesarean section patient. Anesthesiology 2000;92:1531-6. Case series level III.
64. Rees SG, Boheimer NO. Autologous blood transfusion. Br J Anaesth 1998;80:56. Expert opinion level III.
65. Catling SJ, Freites O, Krishnan S, Gibbs R. Clinical experience with cell salvage in obstetrics: 4 cases from one UK center. Int J Obstet Anesth 2002;11:128-34. Case report level III.
66. Rainaldi MP, Tazzari PL, Scagliarini G, Borghi B, Conte R. Blood salvage during cesarean section. Br J Anaesth 1998;80:195-8. Cohort level II-2.
67. Rebarber A, Lonser R, Jackson S, Copel JA, Sipes S. The safety of intraoperative autologous blood collection and autotransfusion during cesarean section. Am J Obstet Gynecol 1998;179:715-20. Cohort level II-2.
68. Judlin P, Thiebaugeorges O. The ligation of hypogastric arteries is a safe alternative to balloon occlusion to treat abnormal placentation. Am J Obstet Gynecol 2008;199:e11; author reply e12-3. Expert opinion level III.
69. Boulleret C, Chahid T, Gallot D, et al. Hypogastric arterial selective and superselective embolization for severe postpartum hemorrhage: a retrospective review of 36 cases. Cardiovasc Intervent Radiol 2004;27:344-8. Case series level III.
70. Uchiyama D, Koganemaru M, Abe T, Hori D, Hayabuchi N. Arterial catheterization and embolization for management of emergent or anticipated massive obstetrical hemorrhage. Radiat Med 2008;26:188-97. Cohort level II-2.
71. Pirard C, Squifflet J, Gilles A, Donnez J. Uterine necrosis and sepsis after vascular embolization and surgical ligation in a patient with

postpartum hemorrhage. Fertil Steril 2002;78:412-3. Case report level III.
72. Dildy GA, Scott JR, Saffer CS, Belfort MA. An effective pressure pack for severe pelvic hemorrhage. Obstet Gynecol 2006:108;1222-6. Case series level III.
73. Keogh J, Tsokos N. Aortic compression in massive postpartum hemorrhage–an old but lifesaving technique. Aust N Z J Obstet Gynaecol 1997;37:237-8. Case report level III.
74. Paull JD, Smith J, Williams L, Davison G, Devine T, Holt M. Balloon occlusion of the abdominal aorta during cesarean hysterectomy for placenta percreta. Anaesth Intensive Care 1995;23:731-4. Case report level III.
75. Bell-Thomas SM, Penketh RJ, Lord RH, Davies NJ, Collis R. Emergency use of a transfemoral aortic occlusion catheter to control massive hemorrhage at cesarean hysterectomy. BJOG 2003;110:1120-2. Case report level III.
76. Munz W, Seufert R, Knapstein PG, Pollow K. Early postpartum hyponatremia in a patient with transient Sheehan's syndrome. Exp Clin Endocrinol Diabetes 2004;112:278-80. Case report level III.
77. Alexander JM, Sarode R, McIntire DD, Burner JD, Leveno KJ. Whole blood in the management of hypovolemia due to obstetric hemorrhage. Obstet Gynecol 2009;113:1320-6. Cohort level II-2.

The practice of medicine continues to evolve, and individual circumstances will vary. This opinion reflects information available at the time of its submission for publication and is neither designed nor intended to establish an exclusive standard of perinatal care. This publication is not expected to reflect the opinions of all members of the Society for Maternal-Fetal Medicine.