Placenta accreta is the leading cause of peripartum hysterectomy. While hysterectomy has long been the mainstay of treatment for placenta accreta, there has been a gradual shift over the last decade toward conservative management, both to avoid serious maternal morbidity and to preserve fertility. Nevertheless, there is no consensus regarding optimal strategies for the management of placenta accreta. The aim of this paper is to provide a comprehensive literature review regarding management of placenta accreta, especially from the point of view of its conservative treatment and strategies pursued in our practice.

Introduction

Placenta accreta is a life-threatening condition that requires careful preoperative planning to reduce maternal morbidity and mortality. In daily practice, placenta accreta is diagnosed when the placenta does not separate from the myometrium completely or partially and, in its most narrow definition, placental villi invade the surface of the myometrium. The condition is further histologically classified into placenta increta (placental villi extend into the myometrium) and placenta percreta (placental villi penetrate the uterine serosa), according to the degree of invasion into the myometrium. Placenta percreta is the most serious form of abnormally invasive placenta; the bladder is the most frequently invaded adjacent organ. In a clinical setting, the maximum degree of abnormally invasive placenta can be determined only when peripartum hysterectomy is performed. It is otherwise often difficult to make an accurate diagnosis, even when placenta percreta is suspected. Therefore, in this article, the term, “placenta accreta,” refers to all of the three types.

Placenta accreta is no longer a rare disease in a tertiary center. The incidence has increased from 1 in 2,510 (in 1994) to 1 in 533 deliveries (in 2002) probably due to the rising rate of cesarean sections. Cesarean hysterectomy has been the mainstay of treatment for placenta accreta, but it poses a great risk of massive hemorrhage and adjacent organ damage, such as, ureteral transection, bladder injury, and urinary fistula. The method of conservative management
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is to leave the placenta in situ to resorb or be expelled spontaneously. Recently, there has been a gradual shift towards conservative management, owing to advances in various methods to reduce blood loss, including adjunctive interventional radiology. However, there is currently no consensus regarding optimal strategies for the management of placenta accreta. The aim of this article is therefore to provide a comprehensive review of the literature and of procedures followed in our institution, primarily on the conservative management of placenta accreta.

Preoperative preparations

Multidisciplinary approach
Preoperative planning is crucial to obtain an optimal outcome in the management of a patient with suspected placenta accreta.8–11 The delivery should be performed at a tertiary center, and the management necessitates a multidisciplinary team, which may comprise experienced obstetricians, gynecologic oncologists, anesthetists, urologists, general surgeons, interventional radiologists, and neonatologists. Eller et al. reported that delivery at a tertiary center with a multidisciplinary care team decreases the risk of maternal morbidity by more than 50% among all cases of placenta accreta, and by nearly 80% risk among those with prenatally suspected placenta accreta.8)

Blood transfusion
The average blood loss at delivery is 3,000 ml.14) O’Brien et al. reported that blood transfusion was necessary in 90% of patients with placenta accreta, and 40% of them required more than 10 units of packed red blood cells.15) Because of a potential risk of massive hemorrhage, adequate blood products should be available and the use of cell salvage considered where available. Transfusion of packed red blood cells and fresh frozen plasma in a 1:1 ratio is currently recommended to control massive hemorrhage.16) Moreover, a 1:1:1 ratio of packed red blood cells, fresh frozen plasma, and platelets may be considered based on the current available evidence in trauma resuscitation.17)

Timing of delivery
A scheduled delivery is desirable as it is associated with reduced blood loss.8) O’Brien et al. reported that the most common indication for delivery is antepartum hemorrhage (at all gestational age, 65%; after 35 weeks’ gestation, 93%).15) Accordingly, the timing of delivery should be individualized, depending on each patient’s circumstances. The presence of warning bleeding or short cervix may be ominous signs for an emergent delivery and warrant precipitation delivery. Warshak et al. reported that scheduled cesarean hysterectomy without removal of the placenta at 34–35 weeks of gestation was linked to reduced blood loss without significant increase in neonatal morbidity.11) Robinson et al. reported that a scheduled delivery at 34 weeks of gestation was the preferred gestational age of delivery.19) On the other hand, the maternal benefits of earlier delivery must be balanced against the risks of neonatal prematurity. Although the optimal timing of delivery remains controversial, most women without any bleeding underwent planned delivery at 36 weeks gestation.19,20) The Royal College of Obstetricians and Gynecologists (RCOG) states that a planned delivery at around 36–37 weeks of gestation (with corticosteroid cover) is a reasonable compromise for high-risk cases for having placenta accreta.21)

Anesthetic technique
The choice of anesthetic technique must be made by anesthesiologists. Regional anesthesia is generally safer for both the mother and baby and provides an opportunity for the mother to view and touch her infant. In contrast, general anesthesia is usually preferred in cases with a high likelihood of massive bleeding and coagulopathy. However, not all cases of presumed placenta accreta are authentic. Indeed, false positive results can occur in 18–28%.8,22,23) Moreover, if placenta accreta is successfully managed conservatively, the patient remains hemodynamically stable because of a remarkable reduction in blood loss. Therefore, in our institution, cesarean section is currently performed under spinal anesthesia, and is converted to general anesthesia, if necessary.

Interventional radiology
Interventional radiology can save lives and even preserve the uterus in cases of massive obstetric hemorrhage. Over the last two decades, arterial embolization and balloon catheters occlusion has become widely used to control obstetric hemorrhage due to placenta accreta. Bakri and Linjawi first reported successful pelvic arterial embolization for placenta percreta in 1992.24) Dubois et al. described two cases of placenta percreta treated with balloon occlusion and embolization of the internal iliac arteries in 1997.25) A combination of balloon occlusion in the internal iliac arteries and following embolization is a reasonable stepwise approach to control hemorrhage.26–28) When inflation of the occlusion balloons in the internal iliac arteries does not control hemorrhage, the presence of intra-arterial catheters can offer prompt embolization. Radiological intervention is usually performed in the radiology suite. Today, hybrid operating theatres are gradually being equipped to provide safe, prompt, and effective intervention. Hybrid theatre can save transfer of a patient between the radiology suite and the operation
theater and prevent catheter dislodgement. So, the hybrid theater must be preferable to the standard operation room where available.

**Controversial issues**

**Prophylactic embolization and placement of balloon occlusion catheter**

Amsalem et al.\(^{29}\) and Lo et al.\(^{22}\) reported that the mean blood loss was 900–1,600 ml in planned conservative management with adjuvant prophylactic uterine artery embolization shortly after cesarean section and that no peripartum hysterectomy was needed in either series. In contrast, Soyer et al.\(^{30}\) performed pelvic embolization in emergency cases alone. The success rate was 10 out of 12 cases after one or two embolization sessions. They found that more than half of women with placenta accreta (15/27; 56%) did not require embolization and thus stated that the use of prophylactic embolization should not be warranted. The same can be said of the prophylactic placement of balloon occlusion catheters. The adjunctive intervention may cause maternal morbidity, such as, uterine necrosis, vaginal fistula, arteriovenous malformation, arterial thrombosis, and arterial rupture.\(^{31–38}\) Moreover, catheterization has a potential risk for the baby, including radiation exposure and fetal bradycardia, probably due to subsequent spasm of the uterine artery.\(^{39}\) Thus, the question remains as to whether or not to perform prophylactic embolization or temporary catheter placement for balloon occlusion. If placenta accreta is managed at an institution where a 24-hour interventional radiology service is not provided, prophylactic balloon occlusion and subsequent embolization may be presently acceptable. In our institution, radiology service is available 24 hours a day, and we therefore do not advocate the use of prophylactic embolization in the management of placenta accreta, although we are going to apply prophylactic placement of balloon occlusion catheters.

**Optimal balloon location**

There are conflicting reports regarding balloon occlusion in the internal iliac arteries. Some studies reported that balloon occlusion in the internal iliac arteries reduced intraoperative blood loss,\(^{26,40–42}\) but others showed no benefit with the approach.\(^{31,43–45}\) As Clark et al. reported that ligation of the hypogastric arteries failed to control obstetric hemorrhage in more than half of the examined cases,\(^{46}\) balloon occlusion in the internal iliac arteries seems less effective due to the extensive network of collateral vessels. So, balloon inflation in the common iliac artery has been gradually used for patients with placenta accreta since Shih et al.'s\(^{47,48}\) first report. This can overcome collateral flow from the external iliac and femoral arteries and is attributed to significant reductions of intraoperative blood loss. The more proximal the site that the balloon occludes, the more blood reduction can be expected from the procedure. Indeed, previous reports demonstrate that balloon occlusion of the infrarenal aorta seems a feasible and promising method for the management of placenta percreta, which is characterized by a high risk of catastrophic bleeding.\(^{59–53}\) However, limited data are available, and further investigation is warranted to clarify the risks and benefits of this technique.

**Strategies for the management of placenta accreta**

The following three main strategies involving cesarean section are advocated in the management of placenta accreta (Table 1). The first strategy is to extirpate both the uterus and the placenta,\(^{23}\) which is termed a cesarean hysterectomy. The second strategy is to preserve the uterus but extirpate the placenta. This approach contains forced placental removal or local resection of the myometrium that is invaded by the placenta (e.g., a one-step surgical approach).\(^{45,54–58}\) This strategy is conservative in terms of uterine preservation, but can be an invasive approach in a clinical setting. We therefore do not use the term, “conservative,” in this context although some authors may have used it before. An alternative to the two permissible strategies is the preservation of both the uterus and the placenta.\(^{59–71}\) Conservative management includes leaving the placenta in situ, partly or entirely without forced placental removal, awaiting either spontaneous resorption or expulsion. Delayed hysterectomy,\(^{72–74}\) manual removal of the placenta,\(^{22,23,75,76}\) or hysteroscopic resection of retained placenta\(^{77–79}\) have been also proposed by some investigators, but we do not describe these planned interventions as conservative approaches in this paper.

**Cesarean hysterectomy**

The hysterectomy has long been conventional treatment for placenta accreta. Cesarean hysterectomy can cause significant blood loss and surgical complications, despite aggressive multidisciplinary perioperative management.\(^{15,23,80,81}\) Grace et al. reported that half of the woman suffered from surgical complications, mostly from bladder injury.\(^{23}\) Elller et al. reported that a key component in cesarean hysterectomy was whether an attempt was made to remove the placenta.\(^{3}\) The main disadvantages of this strategy are loss of fertility, unnecessary hysterectomy for false-positive cases, and potential severe and high morbidity, especially in the case of placenta percreta.
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**Table 1. Risks and benefits of competing strategies for management of placenta accreta**

<table>
<thead>
<tr>
<th>Uterus/placenta</th>
<th>Cesarean (periapartum) hysterectomy</th>
<th>e.g., One-step surgical or triple-P procedure</th>
<th>Conservative management</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extirpated/extirpated</td>
<td>High/High</td>
<td>Moderate</td>
<td></td>
</tr>
<tr>
<td>Preseved/extirpated</td>
<td>High/High</td>
<td>Low</td>
<td></td>
</tr>
<tr>
<td>Preserved/preserved</td>
<td>Can happen/No</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Risk of intraoperaive massive hemorrhage</td>
<td>High</td>
<td>High</td>
<td>Moderate</td>
</tr>
<tr>
<td>Risk of adjacent organ damage</td>
<td>High</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Unnecessary hysterectomy for false-positive cases</td>
<td>Can happen</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Fertility</td>
<td>Lost</td>
<td>Preserved</td>
<td>Preserved</td>
</tr>
<tr>
<td>Close, long-term follow-up monitoring</td>
<td>Not needed</td>
<td>Not needed</td>
<td>Needed</td>
</tr>
<tr>
<td>Risk of delayed hemorrhage, infection, and coagulopathy</td>
<td>No</td>
<td>No</td>
<td>Moderate</td>
</tr>
<tr>
<td>Need for delayed surgical or radiological interventions</td>
<td>No</td>
<td>No</td>
<td>Can happen</td>
</tr>
</tbody>
</table>

**Uterine preservation and placenta extirpation**

A forced manual removal of the placenta usually causes massive hemorrhage, and seems counter to uterine preservation. However, this approach may be feasible for those who desire to retain their future fertility, if the suspected adherent placental areas are small or superficial by preoperative examination. Obviously, this approach should be offered only where appropriate resources and facilities are available. There is a high probability of massive hemorrhage that requires interventional radiology, such as, balloon occlusion of the infrarenal aorta or common iliac arteries, intrauterine balloon tamponade, oversewing the placenta bed, myometrial excision, or uterine compression sutures. The alternative option is local removal of the placenta with the invaded uterine wall and the adjacent organ en bloc, which is known as a one-step surgical, or triple-P, procedure. Clausen et al. reported that, although accuracy of data was limited due to small sample size, local resection for placenta percreta was associated with fewer complications within 24 hours postoperatively compared with cesarean hysterectomy or conservative management. On the other hand, local resection has a potential risk of uterine rupture in subsequent pregnancies, and either one-step surgery or the triple-P procedure is likely to require a highly experienced surgical team. The strategy is desirable to prevent unnecessary hysterectomy, but the main disadvantage is the potential for catastrophic hemorrhage.

**Conservative management**

A conservative treatment of placenta accreta was first described in English literature in 1948. Recently, this approach has been frequently attempted in Europe and the Unites States, because conservative management is superior to the other two strategies in avoiding severe peripartum hemorrhage and adjacent organ damage as well as preserving fertility. The key prerequisites to success are meticulous advance preparations with appropriate resources and facilities. It is absolutely imperative that the peripartum bleeding is under control and the patient is in a hemodynamically stable condition. Therefore, conservative management often requires adjunctive procedures, including interventional radiology, intrauterine balloon tamponade, and uterine compression suture. Sentilhes et al. reported a retrospective multicenter study of conservative management of placenta accreta in 25 French university hospitals. The authors showed that conservative treatment was successful for 131 of 167 women (78.4%). In total, pelvic arterial embolization was performed in 34.1% of cases for primary postpartum hemorrhage; 18 (10.8%) required primary hysterectomy. Another 18 had delayed hysterectomy (range: 9–105 days) due to secondary postpartum hemorrhage, sepsis, uterine necrosis, vesicouterine fistula, arteriovenous malformation, and maternal request. Thus, women with placenta accreta should be properly counseled that conservative management has potential risks for unpredictable secondary postpartum hemorrhage and infection that require delayed hysterectomy, and that...
close, follow-up monitoring is necessary.

**Intrapartum**

Ideally, cesarean section is performed in a hybrid operating room suite with a multidisciplinary team. Dorsal lithotomy positioning can allow direct evaluation of intraoperative vaginal bleeding and uterine balloon placement, if necessary. A ureteral stent, which may contribute to reduction of ureteral injury, is placed after induction of anesthesia. The placement of prophylactic occlusion balloon catheters in aorta or common iliac arteries may be preferred to control intraoperative hemorrhage. When the abdomen is entered, the pelvis should be carefully inspected. Intraoperative sonography is useful to determine the site of uterine incision, which should be made away from the placental edge. After delivering the baby, no attempt should be made to remove the placenta forcibly. If massive hemorrhage occurs due to partial separation of the placenta, the spontaneously separated part is trimmed off and adjunctive intervention, such as, interventional radiology, intrauterine balloon tamponade, and uterine compression suture should be immediately conducted for the initial control of the hemorrhage. If these interventions are inadequate to control the bleeding, the decision to proceed to hysterectomy must be made without delay.

While some authors do not use uterotonics to avoid placental disruption, oxytocin is routinely used to enhance uterine contraction and to reduce uterine bleeding in our institution. Moreover, gentle traction on the umbilical cord may be feasible, especially in cases of equivocal findings of placenta accreta, because the attempt can avoid unnecessary complications and close, long-term surveillance, which are inherent with conservative management in case of false-positive placenta accreta. On the other hand, placenta accreta is sometimes accidentally encountered due to failure of routine ultrasound to diagnose it (i.e., false-negative cases). In such cases, when the patient remains hemodynamically stable, leaving the placenta in situ should be considered over forced manual removal and the patient referred to a tertiary center.

**Postoperative management**

**Interventions to remove the placenta in the postpartum period**

Close surveillance is recommended for patients in conservative management. The potential risks include: delayed massive hemorrhage, infection, sepsis, coagulopathy, persistent bleeding, and pelvic pain. Thus, despite absence of any complications, some reports advocate planned prophylactic delayed intervention, such as, abdominal or laparoscopic hysterectomy, or manual removal of the placenta. However, such interventions can cause unanticipated massive bleeding or damage to adjacent organs, such as, the bladder or ureters. Moreover, a large retrospective study showed that spontaneous placental resorption was observed in 75% of the cases (87/116) managed by watchful waiting. Indeed, a number of case reports and short case series support this evidence. So, interventions of in situ placenta may not be required for the patient without complications, especially for placenta accreta with adjacent organ involvement. We therefore advocate expectant, rather than active, conservative management as far as circumstances permit. Duration of spontaneous placental regression is observed at a median of 13.5 weeks (range: 4–60 weeks) after delivery. Although pelvic embolization may promote placental resorption, this tendency was not observed in our experience. Further studies are needed to draw definite conclusions. Delayed hemorrhage and sepsis are two of the most common causes that require surgical or radiological interventions.

**Delayed hemorrhage**

Sudden massive delayed hemorrhage can occur, even after a couple of months after delivery. Delayed hemorrhage can be treated with uterine artery embolization or conservative surgical management. Nevertheless, delayed hemorrhage is the leading cause of delayed hysterectomy. However, it remains unclear how long women, who are managed conservatively, should be considered at high risk for delayed hemorrhage. It seems plausible that there is a potential risk of hemorrhage as long as placental perfusion persists. A color Doppler ultrasound study showed that placental blood flow disappeared 8.9 ± 1.7 weeks postpartum. Another study also demonstrated spontaneous cessation of placental perfusion 9–13 weeks postoperatively. The potential alternative to evaluate a potential risk of hemorrhage may be the pulsatility index of uterine arteries and serum human chorionic gonadotropin (hCG). Serum hCG levels were significantly correlated with dynamic MRI-based placental vascular volume, and placental blood flow disappeared on follow-up ultrasonography, almost coincident with a fall in hCG to undetectable levels. So, color Doppler ultrasonography and serum hCG measurements may be useful in monitoring patients to evaluate potential risk of delayed hemorrhage. Should the removal of the remaining tissue be scheduled, the timing must be after cessation of placental blood flow and hCG levels become undetectable.

There is no standard treatment method that has proved useful in reducing placental blood flow and preventing delayed hemorrhage. Intriguingly, the timing of a fall...
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in hCG to undetectable levels did not differ much in cases treated conservatively, despite differences in the initial placental volume or approach used to control hemorrhage (e.g., with or without arterial embolization). Consequently, we do not perform uterine artery embolization to facilitate depletion of placental blood supply, though Soyer et al. reported that decreased placental vascularity was accelerated via embolization and El-Messidi et al. attempted a repeat elective uterine artery embolization to reduce the ongoing risk of bleeding. Instead, we use oral methylergometrine maleate (0.75 mg per day) until the disappearance of placental flow to enhance uterine contraction and, hopefully, promote elimination of blood perfusion into the retained placenta. However, there is no evidence to suggest its efficacy of uterotonic agents for prevention of delayed hemorrhage.

Infection and coagulopathy
A considerable number of patients frequently suffer infections accompanied by high fever, which is commonly treated with antibiotics. As for patients complicated with sepsis resistant to antibiotics therapy, removal of the retained placenta is mandatory. The approach varies from laparotomy to a vaginal approach. Some have succeeded in preserving the uterus, while others were obligated to perform hysterectomy. We often use metronidazole vaginal suppositories for infection prophylaxis.

Disseminated intravascular coagulopathy (DIC) is a rare, but life-threatening complication. Although sepsis or severe infection is a common cause of DIC, in situ placenta itself can also induce DIC. The mechanism is largely unknown, and this complication also necessitates removal of the retained placenta.

Monitoring
There is at present no consensus on the optimal method of surveillance. In our practice, the patient is followed up regularly with ultrasound scans and laboratory tests, including complete blood count, C-reactive protein, hCG, and coagulation screening tests (PT, aPTT, fibrinogen). The follow-up is set initially at weekly intervals, then at biweekly to monthly intervals, after the cessation of placental vascularity is observed through color Doppler ultrasound. The follow-up continues until the resorption or expulsion of the placenta is observed and the menstrual cycle resumes.

Methotrexate
Methotrexate has long been used as adjuvant therapy for conservative management. However, methotrexate acts only on cells that are actively dividing, and trophoblast cells rarely proliferate in late pregnancy and after delivery of the baby. A case of maternal death was reported, probably due to aplasia and nephrotoxicity secondary to intraumbilical administration of methotrexate. Thus, the use of methotrexate is no longer recommended.

Subsequent pregnancy
Successful conservative treatment for placenta accreta can allow subsequent pregnancies. Several case reports and short case series have reported successful pregnancies after conservative management. Moreover, the retrospective national multicenter study showed that, of the 27 women who wished for a baby, 24 women had 34 pregnancies. Of 34, 21 deliveries resulted in healthy babies. On the other hand, conservative management can pose an inevitable risk. Not surprisingly, there are several reports of recurrent placenta accreta, and the rate is as high as 28.6% in the largest retrospective study. Thus, the patient and her family should be informed about the high probability of recurrence in future pregnancies.

Summary
Suspected placenta accreta is one of the most ominous obstetric conditions, leading to serious morbidity and even mortality. The decision on whether to opt for conservative management should be based on the degree of invasion, patient’s desire for future fertility, and the resources and facilities available for management of placenta accreta. Intriguingly, the recruitment of a prospective clinical trial titled, “Clinical Situations at High Risk of Placenta Accreta/Percreta: Impact of Diagnostic Methods and Management on Maternal Morbidity” has been active since 2013 in France. Although we would expect that conservative management benefits both women who desire fertility preservation and those with placenta percreta, we need to wait for the results. Further studies are warranted to clarify the optimal strategies for the management of placenta accreta.

Conflict of interest
The authors have no financial disclosures or conflicts of interest.

References


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