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Placental Abnormalities

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INTRODUCTION

In the UK, hemorrhage was the major factor in more than 150 maternal deaths between 1985 and 1996[1], and remains one of the main causes of admission of pregnant women to intensive care units[2–4]. In countries with limited resources, the toll from obstetric hemorrhage is greater[5,6] and a significant number of the deaths from hemorrhage are associated with substandard care and/or inadequate obstetric facilities[1,7].

Placental abnormalities are a major contributor to obstetric hemorrhage. Placental abruption and placenta previa are associated with odds ratios for postpartum hemorrhage (PPH) of 13 (99% CI 7.6–12.1) and 12 (99% CI 7.2–23), respectively, representing the highest of any major risk factors identified by the Royal College of Obstetricians and Gynaecologists (RCOG)[8]. Placental abnormalities including morbidly adherent placentas (accreta, increta, percreta) are rare conditions, but increasing in incidence and associated with high risk of catastrophic hemorrhage. In one series, placental abnormalities accounted for 36% of pregnancy-related deaths due to hemorrhage[9].

PLACENTAL ABRUPTION

The Latin term 'abruptio placentae' means 'rending asunder of the placenta', a valid clinical characteristic of most cases implying a sudden accident. The bleeding associated with abruption follows premature separation of a normally sited placenta once fetal viability has been attained. The initial event begins with bleeding into the decidua basalis, usually from the spiral arteries. The exact mechanism of abruption is unclear in many cases, but incomplete trophoblastic invasion, chronic inflammation and subclinical trauma all have been suggested as playing a role[10]. The condition is an increasingly important cause of maternal hemorrhage, with overall incidence increasing from 0.6% to 0.8% worldwide over the past decade[11]. This change may be as a result at least in part to the increase in cesarean section rate in developed countries. According to one large retrospective cohort study from the US, a previous cesarean section confers a 40% increased risk in a subsequent pregnancy[12]. According to the Confidential Enquiry into Maternal Deaths (2011)[13], between 2006 and 2008 two maternal deaths in the UK were ascribed to placental abruption, although in developing countries the overall maternal mortality rate is probably much higher[14].

Incidence and risk factors

Placental abruption occurs in approximately 1 in 200 pregnancies (0.5%)[15], although higher incidences have been reported[16]. The incidence is much higher (4.5%) when placentas are examined routinely, suggesting that small episodes are more common than those diagnosed clinically[17]. Placental abruptions are characteristically revealed (apparent, with external bleeding) or concealed (no external bleeding is present); the former occurs in 65–80% of cases (Figure 1). Concealed abruptions are clinically more dangerous as they often are associated with more severe complications. Risk factors for placental abruption are shown in Table 1.

Domestic violence, maternal stress and depression represent independent risk factors for placental abruption and subsequent hemorrhage[23,24]. These specific aspects of social history should help the process of making care decisions and should not be overlooked in routine antenatal care.

Diagnosis

Unlike placenta previa where ultrasound is the mainstay of diagnosis, diagnosis is usually on clinical grounds in cases of placental abruption (Table 2). The specificity and sensitivity of correlating the clinical and histological diagnoses of placental abruption have been reported as 30% and 100%, respectively[26]. In certain cases, however, ultrasonography may be helpful, for example when a large retroplacental hematoma is present, although this is uncommon even in severe cases. Symptoms and signs will be diagnostic in moderate to severe cases. In the mild forms, however, the diagnosis may not become obvious until after delivery when a retroplacental clot is identified. In clinical practice, a retroplacental clot is identified at later histological examination in 77% of clinically diagnosed cases of placental abruption[26].

Classically, placental abruption presents with vaginal bleeding, abdominal pain, uterine contractions and abdominal tenderness (Table 2). Vaginal bleeding, however, is present in no more than 70–80% of

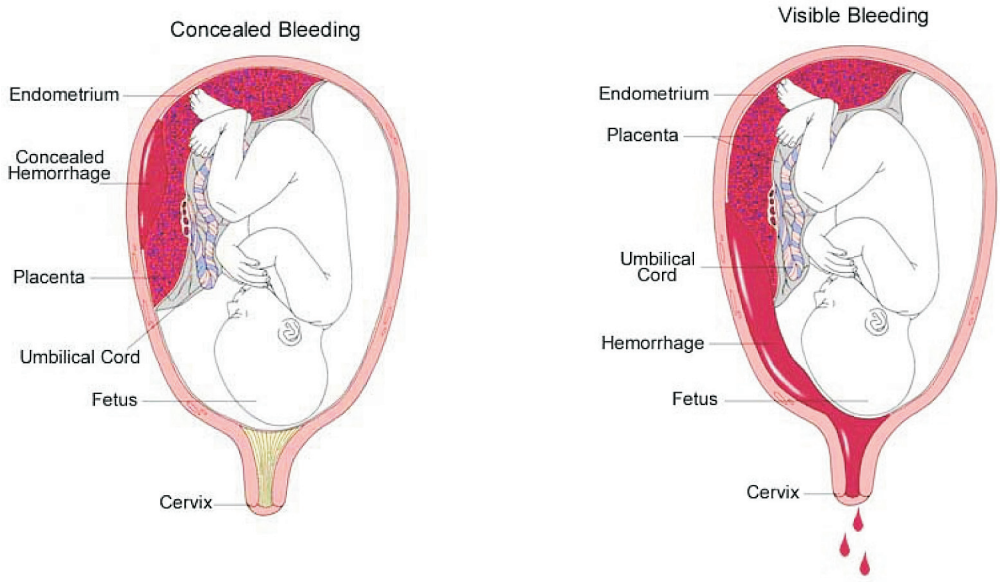

Figure 1 Concealed and revealed (visible) placental abruption

Table 1 Risk factors associated with placental abruption[18–22]

Risk factor	*Relative risk*
Increased age and parity	1.3–1.5
Pre-eclampsia	2.1–4.0
Chronic hypertension	1.8–3.0
Preterm rupture of membranes	2.4–4.9
Multifetal gestation	2.1
Hydramnios	2.0
Cigarette smoking	1.4–1.9
Thrombophilias	3–7
Cocaine use	NA
Prior abruption	10–25
Uterine leiomyomas	NA
Trauma	NA
Early vaginal bleeding	1.6–3.1
Autoimmune thyroid disorders	1.51–2.7

NA, Not available

Table 2 Clinical picture of placental abruption[25]

Symptom/sign	*Frequency (%)*
Vaginal bleeding	78
Uterine tenderness or back pain	66
Fetal distress	60
Preterm labor	22
High-frequency contractions	17
Hypertonus	17
Dead fetus	15

Table 3 Grading of placental abruption[29]

Grade	*Description*
0	Asymptomatic abruption with a small retroplacental clot (<150 ml)
1	Vaginal bleeding (150–500 ml); uterine tetany and tenderness may be present; no signs of maternal shock or fetal distress
2	Vaginal bleeding; no signs of maternal shock; signs of fetal distress present
3	Vaginal bleeding; marked uterine tetany yielding a board-like consistency on palpation; persistent abdominal pain, with maternal shock and fetal demise; coagulopathy may be evident in 30% of cases

cases[27]. If it occurs after the 36th week of gestation (50% of cases), it is characteristically dark and non-clotting, especially in severe cases. Because labor most commonly precipitates placental separation[28], nearly 50% of patients with placental abruption are in established labor. In cases where labor has also commenced, uterine contractions may be difficult to distinguish from the abdominal pain of abruption. Where this distinction is possible, the contractions are characteristically very frequent often with a rate of more than five in 10 minutes[25].

Sher and Statland[29] divided placental abruption into four grades of severity upon which management can be based. These are shown in Table 3. The absence of abdominal pain does not exclude placental abruption, especially where the placenta is located posteriorly. This is evidenced by the so called 'unsuspected or silent abruption' referred to by Notelovitz *et al.*[30] and the higher histological incidence of placental abruption found by Fox[17]. The presence of pain is probably indicative of extravasation of blood into the myometrium. In severe cases (grade 3) (Table 3) the pain is sharp, severe and sudden in onset. Some patients may, in addition, present with nausea, anxiety, thirst, restlessness and a feeling of faintness, whereas others characteristically complain of absent or reduced fetal movements.

When blood loss has been significant, some patients will present with signs of shock, tachycardia being more important than hypotension in this context. The presence of hypertension, on the other hand, may mask true hypovolemia, whereas an increasing abdominal girth or a rising fundal height heightens suspicion of significant concealed hemorrhage. Typically, the uterus is 'woody hard' in severe cases and the fetus is difficult, if not impossible, to palpate. In such instances, a continuous fetal heart rate monitor or real-time ultrasonography is essential to identify the fetal heart beat. The fetus may be 'distressed' and

display heart rate abnormalities (grade 1–2) or may be dead (grade 3)[31]. In severe cases complicated by disseminated intravascular coagulation (DIC; often late presentations), clotting is absent in the vaginal blood loss, which is dark colored. The incidence of coagulopathy is variable but significant (35–38%)[32,33], occurring mainly in the severe forms.

A vaginal examination reveals blood clots in the vagina, although serous fluid from a retroplacental clot may be confused with liquor. The cervix may be dilating, as 50% of cases are in labor and if the membranes are ruptured, blood stained liquor is commonly seen. Ultrasound scan can exclude coincident placenta previa, which is present in 10% of cases. When the retroplacental clot is large, it appears on ultrasonography as hyperechogenic or isoechogenic compared to the placenta. On occasion, such findings are misinterpreted as a thick placenta[34]. In contrast, a resolving retroplacental clot, often found earlier in the pregnancy and of a self-limited nature, appears hyperechogenic within 1 week and sonolucent within 2 weeks. Though the accuracy of ultrasound as a diagnostic tool is less than ideal, it is useful in monitoring those cases managed conservatively. The size of the hematoma, its location, changes over time and fetal growth are all parameters routinely monitored by ultrasound scan. A Kleihauer-Betke test has previously been used to help in the diagnosis but is of limited value in guiding management[35,36].

Management

Management depends on the severity of the abruption, the state of the fetus and the gestational age of the pregnancy. Management can be divided into general and specific measures.

General management is similar to that for any patient presenting with bleeding. The specific measures include immediate delivery, expectant management and management of complications.

Immediate delivery

Immediate delivery depends on the severity of abruption and whether the fetus is alive or dead.

When the fetus is alive (80% of cases), the decision on how best to achieve delivery is not easy. It is compounded by the fact that the outlook for the fetus is poor, not only in terms of immediate survival, but also because studies have shown that as many as 15.4% of live born infants do not survive[37]. Accepting these facts, delivering by cesarean section when the fetus is alive has been shown in non-randomized controlled trials to have a better outcome than vaginal delivery which would necessitate a delay and further extension of the retroplacental hematoma 52% versus 16%[38] and 20% versus 15%[31], respectively. Indecision and unnecessary delays in performing immediate abdominal delivery are responsible for most poor results associated with cesarean section for abruption in the last quarter of pregnancy[28]. Indecision is particular reprehensible in all cases where the fetus is alive, especially if there is evidence of fetal distress. The presence of DIC adds considerable risk to the mother whose morbidity and mortality could be increased by surgery, but DIC is considered by most authorities to be rare with a living fetus[14]. Once the decision is made to deliver and the fetus is alive, the degree of abruption and the state of the fetus must be taken into consideration. When the abruption is severe, cesarean section must be performed promptly once initial maternal resuscitative measures have been undertaken, as most post-admission fetal deaths occur if more than 2 hours have elapsed after admission.

In contrast, when the abruption is mild to moderate (i.e. grade 1 or 2), the mode of delivery should be determined by the condition of the baby, its presentation and the state of the cervix. In the presence of abnormal fetal heart rate patterns, immediate operative abdominal delivery is the option of choice. However, if the decision is to deliver vaginally, continuous fetal monitoring must be available to enable early identification of abnormal fetal heart rate patterns. Golditch and Boyce[39], Lunan[40] and Okonufua and Olatubosun[38] have all shown that the perinatal mortality is higher with vaginal delivery in the absence of electronic fetal monitoring. Although there is a place for prostaglandins in cervical ripening in women with mild abruption, the danger of inducing tetanic contractions must always be borne in mind. Where amniotomy is feasible, this often (but by no means always) hastens delivery; when it is not possible, Syntocinon® can be used while maintaining vigilance for hyperstimulation.

Where the fetus is dead (20% of cases), placental detachment is usually greater than 50%, and approximately 30% of patients manifest coagulopathy. Vaginal delivery should be the goal after maternal resuscitation, recognizing that the average blood loss is often more than 2500 ml. Under such circumstances, at least 4 units of blood should be cross-matched and transfusion commenced with packed red blood cells regardless of the initial vital signs, as the initial hematocrit or hemoglobin levels may be normal due to hemoconcentration. Once resuscitation has been established, subsequent hypotension and tachycardia are likely to supervene.

Unless there is an obstetric contraindication to vaginal delivery or hemorrhage is so brisk that it cannot be safely managed with vigorous blood transfusion, every attempt should be made to deliver such patients vaginally without jeopardizing maternal health. Once resuscitation has been initiated, fetal membranes should be ruptured (amniotomy) to hasten the onset of labor. Rupture of the membranes may provide the additional benefit of reducing the thromboplastins entering the maternal circulation through a reduction in intrauterine pressure, but this remains to be proven[14]. Amniotomy is effective in most cases, but augmentation with Syntocinon may be needed if no rhythmic uterine contractions are superimposed on the background uterine hypertonus. The rigidity of the uterus or the presence of a high intrauterine pressure

should not deter the use of Syntocinon. The benefits of achieving a vaginal delivery override the risks of using Syntocinon, but careful monitoring is essential because uterine rupture may follow vigorous stimulation and the pain from the abruption may be confused with that of the rupture. There is no evidence that the use of Syntocinon is associated with enhanced passage of thromboplastin into the maternal circulation thereby either initiating or enhancing maternal consumptive coagulopathy[41]. Maternal outcome is mainly dependent on the diligence with fluid and blood replacement rather than on the interval to delivery[42]. Where the cervix is unfavorable and maternal health is not in danger, prostaglandins may be used to induce delivery.

Expectant management

This is recommended when neither the fetus nor the mother are at risk. Unfortunately, the lack of signs of fetal compromise on monitoring does not guarantee absence of deterioration in the fetal condition. In general, however, pregnancy is prolonged with expectant management in the hope of improving fetal maturity and therefore survival.

Such an approach is ideal for pregnancies that are less than 37 completed weeks of gestation; however, as neonatal survival is virtually guaranteed at more than 34–35 weeks' gestation, there is no place in persisting with such an approach for pregnancies more than 34 weeks where fetal monitoring cannot reliably predict outcome. Expectant management is recommended for patients whose vaginal bleeding is slight, abdominal pain is mild and usually localized, and who are cardiovascularly stable. Once a decision has been made on conservative management, the fetal condition must be monitored closely as it may change very rapidly.

Expectant management can take place in the community or in the hospital; no evidence suggests that admission is associated with a better outcome. However, when patient education as well as access to hospital is poor, admission may provide a safer option. Unfortunately, it is perhaps in such communities that admission may be rejected because it is expensive or causes significant family disruptions.

During expectant management, fetal growth should be monitored by regular ultrasound scan, as fetal growth restriction is common. The timing of delivery depends on further vaginal bleeding, fetal condition, gestational age and available neonatal care facilities. If bleeding episodes are recurrent, induction at 37–38 weeks is advisable provided there is no fetal compromise. Where the initial episode is small and self-limiting and there are no acute features (e.g. abnormal cardiotocography or a biophysical profile score <6) or chronic fetal compromise (growth restriction, oligohydramnios or abnormal umbilical artery Doppler recording) available evidence does not support induction of labor. Despite this lack of evidence, it is common practice to advocate induction of labor at term using the speculative argument that some undetected damage might have occurred to the integrity and function of the placenta and, in the face of such uncertainty, delivery at term confers more advantages.

In a small proportion of cases, mild abruption may coexist with labor. Whether abruption provoked labor, or vice versa, is difficult to establish. The use of tocolytics in such patients is controversial, as their use in the presence of placental abruption is regarded by many as contraindicated, since they may worsen this process[43]. Sholl[44], however, stated that a trial of tocolytics in the presence of mild placental abruption and labor may successfully prolong pregnancy without jeopardizing the mother and fetus. One retrospective case series reported on 131 cases of placental abruption where tocolysis had been administered to 73% of patients with no additional increase in maternal or fetal morbidity or mortality[45]. At present, there is insufficient evidence to truly guide expectant management of placental abruption; decisions regarding treatment should be made on a case by case basis.

Management of complications of placental abruption

Complications of placental abruption include:

(1) *Maternal shock* This may be disproportionate to the revealed blood loss. The type and nature of the resuscitation should therefore be determined by the clinical state of the patient. In most cases of shock, DIC requires exclusion, as its presence requires additional measures to replace coagulation factors.

(2) *DIC* Treatment is aimed at volume replacement and correction of coagulation factor deficits and is best accomplished in consultation with a hematologist. Monitoring of renal function is essential, as acute tubular necrosis is a recognized complication. Heparin has no role in the modern management of consumptive coagulopathy. The presence of coagulopathy *per se* is not an indication for cesarean delivery but rather a strong contraindication. Also, the presence of an unfavorable cervix is not an indication for cesarean delivery, unless the condition of the mother necessitates prompt delivery. Abdominal and uterine incisions can bleed excessively when coagulation defects persist.

(3) *Ischemic necrosis of the distal organs (e.g. kidneys and brain)* This requires adequate fluid replacement and vigilance for the integrity of such organs (see Chapter on classification of near misses by Barrett).

(4) *PPH (secondary to DIC or Couvelaire uterus)* Treatment is with uterotonic drugs and other methods of managing PPH.

(5) *Isoimmunization* The administration of anti-D needs to be within 72 hours of delivery, but the quantity administered should be determined by a Kleihauers-Betke test.

PLACENTA PREVIA

Placenta previa is defined as a partial or completely sited placenta in the lower uterine segment after fetal viability (20 weeks in developed countries and 24–28 in developing countries). Four grades of placenta previa are recognized (Figure 2):

- *Grade I* Placenta in the lower segment but its edge does not reach the internal os
- *Grade II* Lower placental edge reaches the os but does not cover it
- *Grade III* Placenta covers the os and is asymmetrical
- *Grade IV* Placenta symmetrically covers the os.

Although this is the most commonly used classification/grading system in textbooks, it is important to recognize others that reflect the ultrasound definition of the placental site. The RCOG classifies placenta previa in clinical terms as major or minor. When the placenta lies over the internal os, it is considered a major previa; in contrast, it is considered a minor placenta previa when the placenta lies within the lower segment, but does not cover the os.

Incidence and risk factors

The overall incidence is variable but approximates to 1 in 300 deliveries (0.3%)[15,46]. Risk factors include:

(1) *Maternal age* Placenta previa is more common with advanced maternal age, but this may be a reflection of increased parity rather than age. In general, the doubling in incidence from 0.3% to 0.7% over a 10-year period is attributed to a shift to an older obstetric population[47].

(2) *Parity* Women of higher parity have a higher incidence[48].

(3) *Multifetal gestation* This is thought to be secondary to an increase in the surface area occupied by the placental mass[49].

(4) *Prior cesarean section delivery* The incidence increases with the number of previous cesarean deliveries[50,51]. A single cesarean section increases the risk by 0.65%, two by 1.5%, three by 2.2% and four or more by 10%. In addition, a previous cesarean section in association with placenta previa increases the risk of cesarean hysterectomy almost 4-fold[47].

(5) *Smoking* Doubles the risk of placenta previa[49,52]. This may be attributed to placental hypertrophy secondary to carbon monoxide hypoxemia[52].

(6) *Fetal anomalies* Patients with placenta previa have 12 times the usual risk of having a recurrent previa in subsequent pregnancies. For unclear reasons, fetal anomalies are increased with placenta previa even after controlling for maternal age[46]. It is also uncertain whether an association with intrauterine fetal growth restriction is present[53,54].

Diagnosis

Diagnosis is made either by clinical presentation or by imaging.

Clinical presentation

The most characteristic feature of placenta previa is painless vaginal bleeding, commonly recurrent and unprovoked and typically not appearing until after the end of the second trimester. The first episode is usually self-limiting and is rarely so profuse as to prove fatal. However, the earlier in pregnancy the first presentation of bleeding occurs, the more likely is the subsequent need for early intervention. 'Fetal distress' is unusual unless the hemorrhage is severe enough to cause maternal shock.

Abdominal palpation is not diagnostic but where the presenting part is free (unengaged) in late pregnancy or the lie is abnormal/unstable, placenta previa should be suspected. Sometimes, especially with minor degrees of placenta previa, bleeding might not appear until the onset of labor. This may mimic abruption clinically. In women who present with bleeding in the latter half of pregnancy, the possibility of placenta previa should always be considered, but the diagnosis can seldom be made solely on clinical grounds. Nonetheless, such presentations may provoke reimaging to check the placental site.

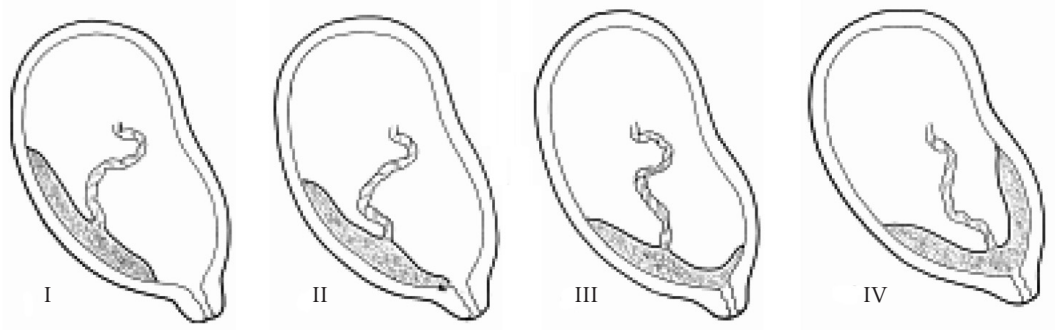

Figure 2 Grades of placenta previa. I, Encroaching on the lower segment; II, reaching the internal os; III, asymmetrically covering the internal os; IV, symmetrically covering the internal os

There is no role for digital examination in the diagnosis of placenta previa unless in the operating theater as part of a double set-up with adequate preparation for proceeding to cesarean section. Fortunately, this is now an uncommon (and costly) practice, especially where imaging (see below) should be easily available and reliable.

Imaging

The most commonly used method for placental localization in modern obstetrics is ultrasound scan (Figure 3). Because it is safe, accurate and non-invasive, it is the method of choice for making the diagnosis, although the gestational age at which the diagnosis is made significantly influences its accuracy. The earlier the scan is performed, the more likely is the placenta found in the lower pole of the uterus. Consequently, it is not recommended that ultrasound be carried out at 20–22 weeks for the purpose of placental localization alone, but that the position should be noted during the routine anomaly scan if it is carried out at this time.

About 28% of placentas in women scanned transabdominally before 24 weeks are 'low', but by 24 weeks this figure drops to 18%; only 3% are low lying by term[55]. Conversely, a false negative scan for a low placenta is found in as many as 7% of cases at 20 weeks[56]. Such results are commoner when the placenta is posterior, the bladder is over filled, the fetal head obscures the placental margin or the operator fails to scan the lateral uterine wall[57]. A low-lying placenta is more common in early pregnancy, because the lower segment does not exist. This apparent 'placental migration' is due to enlargement of the upper segment and formation of the lower segment, with many apparently low-lying placentas being found to be above the lower segment. Comeau *et al.*[58] and Ruparelia and Chapman[59] have shown that the more advanced is the pregnancy, the more accurate is a scan diagnosis of placenta previa.

Transvaginal ultrasound is not only more accurate in diagnosing placenta previa but also is more precise in defining the relationship of the lower edge of the placenta to the internal os. The safety of transvaginal scanning in the context of managing low-lying placentas has been shown in multiple observational trials, and the use of such scanning allowed reclassification of a considerable number of suspected low-lying placentas[60]. When the distance between the lower edge of the placenta and the internal cervical os is actually measured, the persistence of a low-lying placenta is higher at a later gestation. Taipale *et al.*[61], for example, observed that if a placenta overlapped the internal os by at least 25 mm at 18–23 weeks, the positive predictive value for previa at the time of delivery was 40%, with a sensitivity of 80%. In a similar type of study, Becker *et al.*[62] found that when the lower edge overlapped the os by at least 25 mm at 20–23 weeks, a vaginal delivery was not possible at all at term (i.e. it had a 100% positive predictive value).

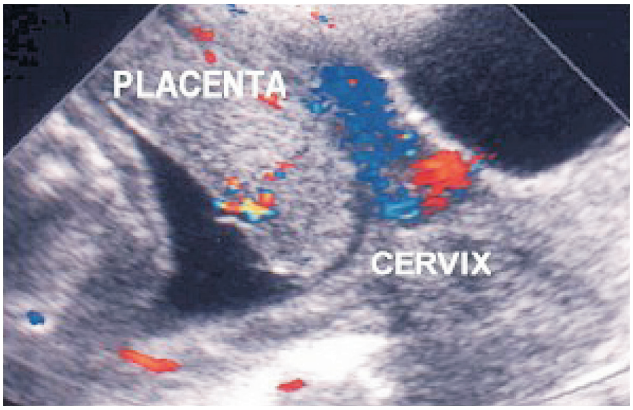

Figure 3 Transabdominal ultrasound scan with superimposed color Doppler signal showing an anterior placenta previa

Although the practice of localizing the placenta at the time of the routine anomaly scan at 19–21 weeks will continue, its limitations should be recognized and, wherever possible, transvaginal ultrasound scans should be offered to improve the accuracy of localization as well as to measure the distance from the os to the placental edge in order to help define the degree of 'low-lying'. Dashe *et al.*[63] observed that persistence of placental previa diagnosed at 20–23 weeks occurred in 34% of cases at delivery, while 73% of those with a low placenta, but not covering the os present at 32–35 weeks persisted at delivery. In view of this observation, the latest consensus guidance from the Royal College of Obstetrician and Gynaecologists[8] suggests that in a woman with minor previa who has an unscarred uterus diagnosed transvaginally at 20–24 weeks and who is asymptomatic, further imaging may safely be left until 36 weeks. This policy aims to avoid the financial and psychological cost to the patient and medical staff of repeated imaging late in pregnancy. The situation is altered, however, for women in whom the transvaginal ultrasound at 20–24 weeks has shown a placenta that covers the internal os. In these patients, the likelihood of a placenta previa diagnosed at 32 weeks persisting until term is 90%[62]. Accordingly, these women should have repeated scanning in order to allow appropriate planning for delivery. Repeated scanning should also occur earlier in patients who have had a previous cesarean section (in whom the risk of a low-lying placenta persisting until term has been estimated at approximately 50%).

The third major criterion that must be met in order to allow rescanning to be delayed safely until 36 weeks is that there should be no episodes of bleeding. Women with a low-lying placenta who are experiencing small self-limiting episodes of bleeding should be managed on a case-by-case basis, in the absence of any high quality evidence to guide clinical practice. Transperineal sonography has been used by some investigators[64], allowing visualization of the internal os in all cases and carryng a positive predictive value of 90% and a negative predictive value of 100% for placenta previa.

Magnetic resonance imaging (MRI) also has been used to visualize placental abnormalities including

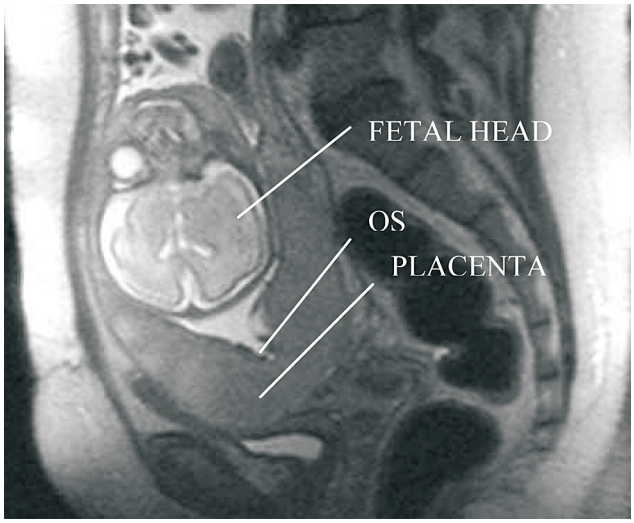

Figure 4 MRI of a grade IV placenta previa (completely covering the internal os)

placenta previa (Figure 4). This has the advantage of being objective and reproducible, thus minimizing operator error. However, due to its cost and logistic limitations, it is unlikely that it will replace ultrasonography for routine evaluation[65,66].

Management

Asymptomatic patients (where the diagnosis is made on ultrasound scan) are managed expectantly, often in a similar way to those with mild symptoms that are non-threatening to either the mother or fetus.

Those with symptoms can be divided into four categories depending on maternal condition, severity of hemorrhage, gestational age and the neonatal facilities available in the unit. These categories are:

(1) Pregnancy <37 weeks' gestation and with no threat to the mother;

(2) Pregnancy >37 weeks with no threat to the mother;

(3) Severe life-threatening and continuing hemorrhage;

(4) Hemorrhage associated with uterine contractions.

The management of the third and fourth categories is immediate delivery by cesarean section. Where there is non-life threatening hemorrhage after 37 weeks' gestation, a planned delivery is advisable. This decision must, however, be made with the recognition that such a hemorrhage could very rapidly become life threatening. For category 1, the best approach is expectant management, although this must not be at the detriment of maternal life.

Expectant management

Perinatal mortality in placenta previa is directly related to gestational age at delivery[67–70]. Macafee[68] and Johnson *et al.*[70] introduced expectant management of placenta previa with the aim of achieving maximum fetal maturity possible, while minimizing the risks to both mother and fetus, the overall objective being to reduce perinatal mortality while at the same time reducing maternal mortality. This concept was based on the assumption that most episodes of bleeding are usually small, self-limited and are not fatal to the fetus or mother in the absence of provoking trauma (e.g. intercourse, vaginal examination) or labor, and that a relatively high proportion of cases, particularly those presenting early with lesser degrees of previa, may resolve to permit vaginal delivery.

Recent work shows that the incidence of resolving placenta previa, in the absence of a previously scarred uterus, is higher than previously described. Improvements in perinatal mortality attributed mainly to prolongation of pregnancy following expectant management have been recorded[44,71]. In those who are to be managed expectantly on an inpatient basis, the RCOG[8] recommends that thromboprophylaxis be instituted in the form of good hydration and compression hosiery, but that anticoagulation may be considered on an individual basis in high risk patients.

Although most experts advocate immediate delivery in the presence of severe hemorrhage (heavy vaginal bleeding producing maternal hypovolemia), heavy bleeding is not, however, considered a contraindication to expectant management[72]. An aggressive approach involving admission and repeated transfusions improves perinatal morbidity and mortality, especially when the bleeding occurs very early in pregnancy. In one study, where approximately 20% of the women lost over 500 ml of blood, half were successfully managed expectantly with a mean gain in gestation of 16.8 days[73]. Crenshaw *et al.*[69], on the other hand, managed only 43–46% of patients successfully with an aggressive expectant approach, whereas Cotton *et al.*[67], also with an aggressive approach, successfully managed 66% of women expectantly.

During expectant management, preterm labor remains a problem. Brenner *et al.*[74] found that 40% of women with placenta previa developed prelabor rupture of membranes, went into spontaneous labor or developed other problems that resulted in delivery before 37 weeks' gestation. Inhibiting contractions in those with preterm labor would seem logical, but some authors regard antepartum hemorrhage as a contraindication to the use of tocolytics[42]. In the presence of vaginal bleeding and uterine contractions, placental abruption, widely regarded as a contraindication to tocolysis, cannot be excluded. In addition, placental abruption is said to coexist with placenta previa in 10% of cases, and tocolytics cause maternal tachycardia and palpitations, two important features that could be confused with hypovolemia. Sampson *et al.*[75] advocate the use of tocolytics in cases of placenta previa and uterine contractions occurring after 21 weeks and demonstrated a reduction in perinatal mortality from 126 to 41 per 1000. The largest available trial shows at least no excess morbidity or mortality from tocolysis used in tertiary centers in the third trimester[44].

High perinatal mortality is directly related to the total amount of blood lost before delivery; thus light blood loss is not associated with significantly high perinatal mortality. Liberal use of blood transfusion reportedly nullifies this effect[67]. Although in theory there is no limit to the number of blood transfusions a patient can have, praticality and patient wishes, along with cost considerations, dictate otherwise. To optimize oxygen supply to the fetus and protect the mother against anticipated future blood loss, transfusion therapy should maintain a hemoglobin of at least 10 g/dl or a hematocrit of 30%.

Despite the use of expectant management, 20% of women with placenta previa are delivered earlier than 32 weeks, accounting for 73% of perinatal deaths[67]. These deaths remain a major problem. Neonatal mortality and morbidity are reduced by maternal corticosteroid administration.

Although Macafee[68] in his regimen proposes that the patient remains as an inpatient in a fully equipped and fully staffed maternity hospital from the time of initial diagnosis to delivery, a policy of permitting some women to return home has been advocated as part of expectant management, but this remains controversial[76]. Cotton *et al.*[67] reported no difference in the perinatal and maternal mortality rates in those sent home and those managed in hospitals, whereas D'Angelo and Irwin[77] suggested that keeping the mother in hospital until delivery was justified on the grounds that neonatal mortality and morbidity, and cost of later treatment were reduced. Kaunitz *et al.*[78] in a review of 355 maternities managed at home, however, reported one intrapartum death from placenta previa. In a review of 15,930 deliveries in Edinburgh, Love and Wallace[72] concluded that while clinical outcomes were highly variable and cannot be predicted from antenatal events, the majority of cases with or without bleeding irrespective of the degree of previa could be managed on an outpatient basis.

Interpretation of this evidence has led to a recommendation by the RCOG that major placenta previa should be managed on a inpatient basis from 34 weeks completed gestation onwards[63]. However, continuous hospitalization is costly and is associated with psychological morbidity among the women and their families. In developing countries, inpatient care may be unavailable and/or unaffordable. However, the advantages of such a program include easy access to resuscitation and prompt delivery as well as ensuring bed rest (which anecdotally has been thought to decrease the occurrence of hemorrhage) and limitation of activities. Evidence demonstrating a benefit from hospitalization at 34 weeks is lacking, with only one small randomized control trial available to guide decision making[79]. With improvement in transportation facilities and ambulance services in developed countries, highly motivated women who clearly understand the necessity of restriction of activity, have the constant presence of a companion and are within, for example, 15–30 min of the hospital perhaps may be monitored at home during the third trimester. This dictum will only apply to cases of grade I–III placenta previa or asymptomatic grade IV placental previa. The most recent RCOG Green-top guidelines[8] advocate that home management is most appropriate within a research context. In all cases of expectant management, regardless of location, local hematology services should be involved in the planning stages and rapid availability of blood products ensured.

Method of delivery

A diagnosis of placenta previa often precedes delivery by cesarean section, but this outcome is not inevitable, especially where the previa is a minor degree. For minor degrees of placenta previa (grade I or II anterior) and an engaged fetal head, pregnancy may continue beyond 37–38 weeks with anticipated vaginal delivery. In such patients, amniotomy followed by Syntocinon can be considered.

On the other hand, patients with a major placenta previa (grade II posterior, grade III–IV), should be delivered by elective or emergency cesarean section. The former is ideal since emergency delivery has a negative effect on perinatal mortality and morbidity, independent of gestational age. Perhaps it is related to the necessity of performing the operation in the absence of a fully prepared staff, a common occurrence during night, weekend and holiday shifts. Of interest, Cotton *et al.*[67] found that 27.7% of babies born as emergencies had anemia compared to 2.9% delivered electively. Perhaps this difference is also related to staffing differences or the hope that things will clear up by the morning, but this opinion is speculative.

Cesarean section for placenta previa poses several problems. It should ideally never be performed by an inexperienced obstetrician. The RCOG recommends that such operations are performed by consultants. Although general was preferred to regional anesthesia in the past, it is now acceptable practice to use the latter especially as Frederiksen *et al.*[80] demonstrated not only its safety but also a reduction in intrapartum blood loss compared to that with general anesthesia.

Procedure

The anesthetic requirements for a cesarean section in the context of placenta previa are a matter of debate, and often depend on the experience of the anesthetist and the available resources. Indeed, an increasing number of anesthetists either offer or strongly suggest that regional anesthesia is preferable for these patients[65,66]. A large retrospective study of operative deliveries for placenta previa, with outcomes stratified by type of anesthetic, demonstrated that the requirements for transfusion were higher in the general compared with the regional anesthesia groups[81]. This may be because epidurals, by lowering blood pressure, critically reduce uterine and placenta perfusion. Where the patient's condition is stable and there is no active bleeding, epidural or spinal anesthesia should not be regarded as contraindicated provided an experienced

anesthetist is available. It is no longer considered acceptable for the same physician to administer the anesthetic, position the patient, and subsequently perform the operation as was so often the case only a few decades ago.

The uterine incision should be a transverse lower segment incision (if possible), provided there is a lower segment. Where the lower segment is non-existent or is very vascular, some obstetricians advocate a classical or a De Lee's incision. Scott[82], however, believes that such incisions are rarely justified because of their consequences and long-term disadvantages. When difficulties are encountered with transverse lower segment incisions, these may be converted to inverted T, J or U shaped incisions.

Where the placenta is anterior, two approaches are available after incising the uterus, going through the placenta or defining its edge and going through the membranes above or below the placenta. The former approach requires speed and may result in significant fetal blood loss[83]. The latter approach, however, may be associated with undue delay in the delivery of the fetus, more troublesome bleeding from a partially separated placenta and therefore fetal blood loss and anoxia. Myerscough[83] advises against cutting or tearing through the placenta because of the inevitable fetal blood loss that will occur as fetal vessels are torn. Because the lower segment is less muscular, contraction and retraction which result in the occlusion of the sinuses of the placental bed is inadequate, and intraoperative hemorrhage is therefore not uncommon[84]. Where hemostasis is difficult to achieve, bleeding sinuses could be oversewn with atraumatic sutures[82]. If this is unsuccessful, packing the uterus is possible, but the major disadvantage of this technique is that by leaving the pack *in situ* during closure of the uterus the bleeding may continue but remain concealed for some time as the pack is soaking through. The use of balloons with a tamponading effect on the bleeding placenta bed or intramyometrial injection of prostaglandin $F_{2\alpha}$ has been shown to be useful in such cases[83] (see Section 8 for information on balloons). Bleeding can also be stabilized with use of the B-Lynch brace suture (see Chapter 51). Where facilities are available, uterine artery embolization has been used with excellent results (see Chapter 49). The difficulty with this is planning to ensure that the facilities and the interventional radiologist are available in the interventional radiology suite when needed. When the bleeding remains uncontrollable, ligation of the internal iliac artery or even hysterectomy may be necessary as the last resort (see Chapter 55).

PLACENTA ACCRETA, INCRETA AND PERCRETA

This is a group of pathologically invasive placentations of varying severity. Such morbid adherence occurs when the implantation site is lacking a sufficient decidua. Consequently, the physiological cleavage plane through the decidual spongy layer is missing. This leads to one or more cotyledons being firmly anchored to the decidua basalis and to or through the myometrium (see also Chapter 28–30).

The term placenta accreta is used to describe any placental implantation that is adherent firmly to the uterine wall. Placental villi are anchored to the myometrium due to defective decidualization. If villi invade the myometrium, the condition is called placenta increta. If the invasion goes as deep as reaching the serosal surface, this is called placenta percreta.

Although uncommon, such placental aberrations are associated with a significantly higher maternal morbidity and sometimes mortality, primarily due to the risk of torrential hemorrhage, uterine perforation, infection and the associated surgical difficulties and complications[85].

Incidence

Morbidly adherent placentation occurs in about 1 in 2500 term (0.04%) pregnancies. A marked increase in incidence has been noted over the past 50 years, probably secondary to rising cesarean section delivery rates, with the risk of accreta increasing dramatically with the number of previous sections[86].

Risk factors include implantation over the lower uterine segment overlying a previous surgical scar or excessive uterine curettage resulting in Asherman's syndrome. Placenta previa is identified in 30% of cases, and 25% of the women would have had a previous cesarean delivery. Nearly a quarter have previously undergone curettage and another quarter are grand multigravida (six or more)[87].

Diagnosis

Recent advances in ultrasound technology enhance diagnosis in patients at high risk – i.e. those with a low-lying placenta on early ultrasound scan, or who have had at least one previous cesarean section – as well as among those not considered to be at risk. When ultrasound is used in combination with MRI, the diagnosis of accreta/percreta can be made with reasonable accuracy with regard to the existence and extent of placental invasion[88–90]. In patients without previous uterine surgery, however, the diagnosis may not be made until after delivery. Some patients may present with vague features which include a raised maternal serum α-fetoprotein[91] and bleeding before delivery, although this is usually a consequence of placenta previa. Uterine rupture may occur antenatally due to myometrial invasion by chorionic villi at the site of a cesarean section scar[92].

Using ultrasound color Doppler flow mapping improves the diagnostic sensitivity. The two most sensitive criteria are: (1) a distance less than 1 mm between the uterine serosal bladder interface and the retroplacental vessels; and (2) the presence of large intraplacental lakes[93]. Preliminary work suggests that the application of three-dimensional color power Doppler ultrasound complements other techniques for antenatal imaging. The additional benefit of MRI

scanning in cases where insufficient anatomical information is obtained from Doppler scanning is a matter of debate, but in the absence of harm demonstrated by this screening modality, many authorities recommend the additional use of MRI imaging. At least one study demonstrated that depth of placental invasion may be more accurately determined from MRI[89]. The main MRI features of placenta accreta include uterine bulging, heterogeneous signal intensity within the placenta, and dark intraplacental bands on T2-weighted imaging[88].

Management

In most cases, problems arise after delivery of the baby. Most of the complications of morbid adherence are related to the problems of delivery or failure to deliver the placenta as anticipated. Management must therefore aim to minimize these complications.

Hemorrhage is the most common complication and this is associated with attempts to detach the placenta from the uterus. Delay in recourse to hysterectomy in attempts to conserve future reproductive potential is a major factor in maternal mortality and morbidity from placenta accreta. Clinicians are understandably reluctant to perform a peripartum hysterectomy until other options have been considered and exhausted, but this should not delay the life-saving intervention of arresting bleeding. A decision to perform a peripartum hysterectomy should ideally be made by two obstetric consultants. In cases where the placental anomaly is identified predelivery, this must be taken into account in the planning stages, and the woman counseled appropriately. Recent research has focused on the value of embolization of the internal iliac or uterine vessels in units where interventional radiology is readily available[63]. Radiological interventions are unlikely to be helpful in the emergency situation of unanticipated hemorrhage, but in cases where the management has been planned prenatally, the value of prophylactic catheterization of the vessels has been studied. Current evidence of benefit is equivocal, and pending further evaluation, the optimal management is to avoid catheterization as a prophylactic measure. Sometimes, the percreta type might even invade the bladder base, further complicating the surgical procedure required and making the control of hemorrhage very difficult. It is agreed by most authorities that delivery in placenta accreta is optimal at 36–37 weeks, with corticosteroid therapy to the mother for fetal lung maturity.

In cases of extensive placenta accreta (involving most of the placental surface), bleeding might be very limited until attempts at manual removal are made. At times, traction on the cord may lead to uterine inversion. Manual removal is usually not successful as the plane of cleavage between the uterus and the placenta cannot be developed. The safest treatment is usually hysterectomy.

Attempts at uterine conservation include piecemeal removal of as much placental tissue as possible followed by packing of the uterine cavity, but this approach has been reported to carry an unacceptably high mortality rate of 25%[87]. Another option to conserve the uterus is to leave the entire placenta *in situ* if there is no bleeding. For women wishing to preserve their fertility, where the placenta has not separated, a review of reported cases revealed that among women whose placentas were left *in situ*, hysterectomy was avoided in 80%[94]. This is now thought to be the optimal strategy when the placenta is not separated[95]. In cases where the placenta partially separates despite morbidly adherent sections, adherent parts should be left *in situ* to minimize the risk of severe bleeding. Hysterectomy or *alternative* removal strategies can then be attempted electively at a later date. Kayem describes a case where spontaneous resorption of the placenta occurred over 6 months following uterine artery embolization[96]. Another group described a similar approach, but their patient was treated by methotrexate. The placenta spontaneously delivered after 4 weeks[97,98]. Chapters 28–30 provide further discussion on this topic as does Chapter 31 on one-step conservative therapy.

RARE TYPES OF PLACENTAL ABNORMALITIES: SHAPE

Some anatomical variations in placental shape can lead to serious PPH. These include bipartite placentas, succenturiate lobes and placenta membranacea.

Bipartite placenta

This occurs when the placenta is occasionally separated into two lobes, and the division is incomplete with vessels of fetal origin extending from one lobe to the other before ending in the umbilical cord. Its incidence is about 1 in 350 deliveries[99].

Succenturiate lobe

In this abnormality, one or more small accessory lobes develop in the membranes at a distance from the main placenta. The succenturiate lobe is usually linked to the main placenta by vascular connections of fetal origin. The process can be considered a small version of the lobate placenta. The accessory lobe may be retained in the uterus after delivery, causing serious hemorrhage. Its incidence has been reported to be as high as 5%[100].

Placenta membranacea

This type of placenta develops as a thin membrane-like structure with the whole of the fetal membranes covering the functioning villi. The diagnosis can be made with ultrasound scan. This abnormality can lead to serious hemorrhage as an association with placenta previa or accreta. One variation is the 'ring-shaped' or 'horse-shoe' placenta where the process is not involving the whole placenta, but only a central part. This might occur in about 1 in 6000 deliveries[100].

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