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# Placenta Previa, Placenta Accreta, and Vasa Previa

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**Placenta previa, placenta accreta, and vasa previa are important causes of bleeding in the second half of pregnancy and in labor. Risk factors for placenta previa include prior cesarean delivery, pregnancy termination, intrauterine surgery, smoking, multifetal gestation, increasing parity, and maternal age. The diagnostic modality of choice for placenta previa is transvaginal ultrasonography, and women with a complete placenta previa should be delivered by cesarean. Small studies suggest that, when the placenta to cervical os distance is greater than 2 cm, women may safely have a vaginal delivery. Regional anesthesia for cesarean delivery in women with placenta previa is safe. Delivery should take place at an institution with adequate blood banking facilities. The incidence of placenta accreta is rising, primarily because of the rise in cesarean delivery rates. This condition can be associated with massive blood loss at delivery. Prenatal diagnosis by imaging, followed by planning of peripartum management by a multidisciplinary team, may help reduce morbidity and mortality. Women known to have placenta accreta should be delivered by cesarean, and no attempt should be made to separate the placenta at the time of delivery. The majority of women with significant degrees of placenta accreta will require a hysterectomy. Although successful conservative management has been described, there are currently insufficient data to recommend this approach to management routinely. Vasa previa carries a risk of fetal exsanguination and death when the membranes rupture. The condition can be diagnosed prenatally by ultrasound examination. Good outcomes depend on prenatal diagnosis and cesarean delivery before the membranes rupture.**
*(Obstet Gynecol 2006;107:927–41)*

Clinically important causes of bleeding in the second half of pregnancy and in labor include placenta previa, placenta accreta, and vasa previa. These conditions are associated with significant maternal and perinatal mortality and morbidity. This review presents a contemporary evidence-based approach to the management of these conditions.

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ISSN: 0029-7844/06

## STUDY SELECTION

We performed a thorough MEDLINE search using the keywords "placenta previa," "placenta accreta," "placenta percreta," "placenta increta," and "vasa previa." Further articles were identified by cross-referencing. We were particularly interested in articles that dealt with the incidence, clinical implications, diagnosis, and management of these conditions. Only 5 randomized controlled studies dealt with the management of placenta previa. None have specifically addressed the diagnosis or management of placenta accreta or vasa previa. The majority of publications on placenta previa, placenta accreta, and vasa previa are cohort or case-control studies, or case series/reports. Frequently no controls were available; a large proportion of studies were descriptive. Thus, the levels of evidence for most studies are II-2, II-3,

and III. In cases where the literature does not provide convincing evidence for management of these conditions, we have described our experience and techniques.

## PLACENTA PREVIA

### Definition

The term *placenta previa* refers to a placenta that overlies or is proximate to the internal os of the cervix. The placenta normally implants in the upper uterine segment. In placenta previa, the placenta either totally or partially lies within the lower uterine segment. Traditionally, placenta previa has been categorized into 4 types (Fig. 1):

1. *Complete* placenta previa, where the placenta completely covers the internal os.
2. *Partial* placenta previa, where the placenta partially covers the internal os. Thus, this scenario occurs only when the internal os is dilated to some degree.
3. *Marginal* placenta previa, which just reaches the internal os, but does not cover it.
4. *Low-lying* placenta, which extends into the lower uterine segment but does not reach the internal os.

### Clinical Importance

Morbidities associated with placenta previa include antepartum bleeding (relative risk [RR] 9.81, 95% confidence interval [CI] 8.92–10.79), need for hysterectomy (RR 33.26, 95% CI 18.19–60.89), morbid adherence of the placenta, intrapartum hemorrhage (RR 2.48, 95% CI 1.55–3.98), postpartum hemorrhage (RR 1.86, 95% CI 1.46–2.36), blood transfusion (RR 10.05, 95% CI 7.45–13.55), septicemia (RR 5.5, 95% CI 1.31–23.54), and thrombophlebitis (RR 4.85, 95% CI 1.50–15.69).[1] In the United States, maternal mortality occurs in 0.03% of cases of placenta previa.[2] Women with placenta previa may suffer considerable emotional distress because of recurrent bleeding along with hospitalizations that frequently occur in the second half of pregnancy. Placenta previa is also associated with an increase in preterm birth and perinatal mortality and morbidity.[3] Finally, there is a higher rate of congenital malformations among women with placenta previa, although the precise mechanisms for these are unclear.[3]

### Incidence and Risk Factors

Placenta previa complicates approximately 0.3–0.5% of pregnancies.[2] A United States population-based study for the years 1979–1987 found the overall annual incidence of placenta previa to be 4.8 per 1,000 deliveries (0.48%).[2] Several studies have found that risk factors for placenta previa include a history of prior cesarean delivery,[4] termination of pregnancy or uterine surgery,[4,5] smoking,[6] increasing age,[7] multiparity,[7] cocaine,[8] and multiple pregnancy.[9] The likelihood of placenta previa increases in a dose-response fashion with a greater number of prior cesarean deliveries and with greater parity, with relative risks of previa rising from 4.5 (95% CI 3.6–5.5) in women with one prior cesarean delivery to 44.9 (95% CI 13.5–149.5) in women with 4 prior cesarean deliveries, respectively.[7]

### Pathophysiology

It is unclear why some placentas implant in the lower uterine segment rather than in the fundus.[10] It does appear that uterine scarring may predispose to placental implantation in the lower segment. With the progression of pregnancy, more than 90% of these low-lying placentas identified early in pregnancy will appear to move away from the cervix and out of the lower uterine segment. Although the term "placental migration" has been used, most authorities do not believe the placenta moves.[10] Rather, it is felt that the placenta grows preferentially toward a better vascularized fundus (trophotropism), whereas the placenta overlying the less well vascularized cervix may undergo atrophy.[10] In some cases, this atrophy leaves vessels running through the membranes, unsupported by placental tissue or cord (vasa previa).[10] In cases where the atrophy is incomplete, a succenturiate lobe may develop. The apparent movement of the placenta may also be due to the development of the lower uterine segment. Contractions and cervical effacement and dilation that occur in the third trimester cause separation of the placenta, which leads to small amounts of bleeding. This bleeding may stimulate further uterine contractions, which, in turn, stimulates further placental separation and bleeding. Rarely are these initial bleeds a major problem, although they may be a reason for hospitalization. In labor, as the cervix dilates and effaces, there is usually placental separation and unavoidable bleeding.

### Diagnostic Approach

The classic clinical presentation of placenta previa is painless bleeding in the late second trimester or early third trimester. However, some patients with placenta previa will experience painful bleeding, possibly the consequence of uterine contractions or placental separation, whereas others will experience no bleeding at all before labor. Placenta previa may also lead to an unstable lie or malpresentation in late pregnancy.

The majority of cases of placenta previa are

diagnosed during routine sonography in asymptomatic women, usually during the second trimester. Although transabdominal sonography is frequently used for placental location, this technique lacks some precision in diagnosing placenta previa.[11,12] Numerous studies have demonstrated the accuracy of transvaginal sonography for the diagnosis of placenta previa, uniformly finding that transvaginal sonography is superior to transabdominal sonography for this indication (Fig. 2).[11,12] False-positive and -negative rates for the diagnosis of placenta previa using transabdominal sonography range from 2% to 25%.[11] A study by Smith and colleagues[11] of 131 women believed to have a placenta previa by transabdominal sonography found that anatomic landmarks crucial for accurate diagnosis were poorly recognized in 50% of cases. In 26% of the cases of suspected placenta previa, the initial diagnosis was changed after transvaginal sonography because it was incorrect.

The superiority of transvaginal sonography over transabdominal sonography can be attributed to several factors:

1. The transabdominal approach requires bladder filling, which results in approximation of the anterior and posterior walls of the lower uterine segment, with the result that a normally situated placenta may falsely appear to be a previa.

2. Vaginal probes are closer to the region of interest, and typically of higher frequency, and therefore obtain higher resolution images than transabdominal probes.

3. The internal cervical os and the lower placental edge frequently cannot be imaged adequately by the transabdominal approach. The position of the internal os is assumed rather than actually seen.

4. The fetal head may obscure views of the lower placental edge when using the transabdominal approach, and a posterior placenta previa may not be adequately imaged.

The improved accuracy of transvaginal sonography over transabdominal sonography means that fewer false-positive diagnoses are made; thus, the rate of placenta previa is significantly lower when using transvaginal sonography than when using transabdominal sonography.[11,13] Lauria and colleagues,[13] performing routine transvaginal sonography, found an incidence of placenta previa of only 1.1% at 15–20 weeks, considerably lower than the second trimester placenta previa incidence of 15–20% reported by previous investigators using transabdominal sonography.[14] Numerous studies have demonstrated the safety of transvaginal sonography for the diagnosis of placenta previa.[12,15] Importantly, this imaging technique does not lead to an increase in bleeding.[15] This is for 2 main reasons: 1) the vaginal probe is introduced at an angle that places it against the anterior fornix and anterior lip of the cervix, unlike a digital examination, where articulation of the hand allows introduction of the examining finger through the cervix (Fig. 3);[15] 2) the optimal distance for visualization of the cervix is 2–3 cm away from the cervix, so the probe is generally not advanced sufficiently to make contact with the placenta.[15] Nonetheless, the examination should be performed by personnel experienced in transvaginal sonography, and the transvaginal probe should always be inserted carefully, with the examiner looking at the monitor to avoid putting the probe in the cervix.

Translabial sonography has been suggested as an alternative to transvaginal sonography and has been shown to be superior to transabdominal sonography for placental location.[16] However, because transvaginal sonography is accurate, safe, and well tolerated, it should be the imaging modality of choice.

Several studies have demonstrated that the majority of placentas that are in the lower uterine segment in the second trimester will no longer be in the region of the cervix by the time of delivery (Table 1).[13,17–21] Persistence to term can be predicted based on whether or not the placenta overlaps the internal os in the second trimester, and to what extent.[13,17–21] The later in pregnancy that placenta previa is diagnosed, the higher the likelihood of persistence to delivery.[22] Women who at 20 weeks have a low-lying placenta that does not overlie the internal os will not have a placenta previa at term and need no further sonographic examinations for placental location. However, the presence of a low-lying placenta in the second trimester is a risk factor for developing a vasa previa, and therefore, in these cases, a sonogram should be performed later in pregnancy to exclude that condition.

## Management

In the past, suspected placenta previa was managed by vaginal examination and immediate cesarean delivery if placenta previa was confirmed. It was believed that the first bleed (usually occurring in the early third trimester) would lead to maternal death. However, MacAfee[23] showed that, in the absence of interference, this almost never happened, and that the high perinatal mortality from placenta previa was primarily due to prematurity, which could be reduced considerably by conservative expectant management and delivery as close to term as possible.

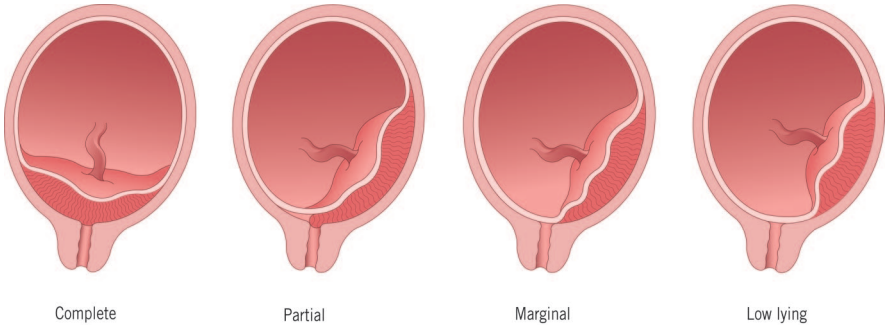


**Fig. 1.** Types of placenta previa. Illustration: John Yanson.

*Oyelese. Placenta Previa, Accreta, and Vasa Previa. Obstet Gynecol 2006.*

Women who present with bleeding in the second half of pregnancy should have a sonographic examination (preferably by the transvaginal approach) for placental location *prior* to any attempt to perform a digital examination. Digital vaginal examination with a placenta previa may provoke catastrophic hemorrhage and should not be performed.

It is reasonable to hospitalize women with placenta previa while they are having an acute bleeding episode or uterine contractions. One to two wide-bore intravenous cannulas should be inserted and blood taken for a full blood count and type and screen. In the absence of massive bleeding or other complications, coagulation studies are not helpful. The blood bank must be capable of making available at least 4 units of compatible packed red blood cells and coagulation factors at short notice. Rh immune globulin should be administered to Rh-negative women. A Kleihauer-Bettke test for quantification of fetal-maternal transfusion should also be performed in Rh-negative women because the mother may require increased doses of Rh immune globulin.

Small studies have suggested a benefit of tocolytic therapy for women with placenta previa who are having contractions.[24,25] Contractions may lead to

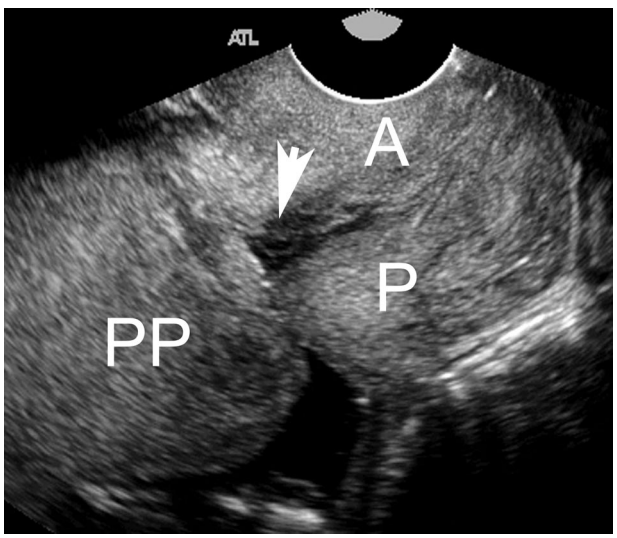


**Fig. 2.** Transvaginal sonogram of a complete placenta previa *(PP)*. Note that both the placenta and the internal cervical os *(arrow)* are clearly depicted. *A,* anterior lip of cervix; *P,* posterior lip of cervix. The placenta just overlaps the internal os. One can see how this could become a partial placenta previa covering just the anterior lip of the cervix if cervical dilation were to occur.

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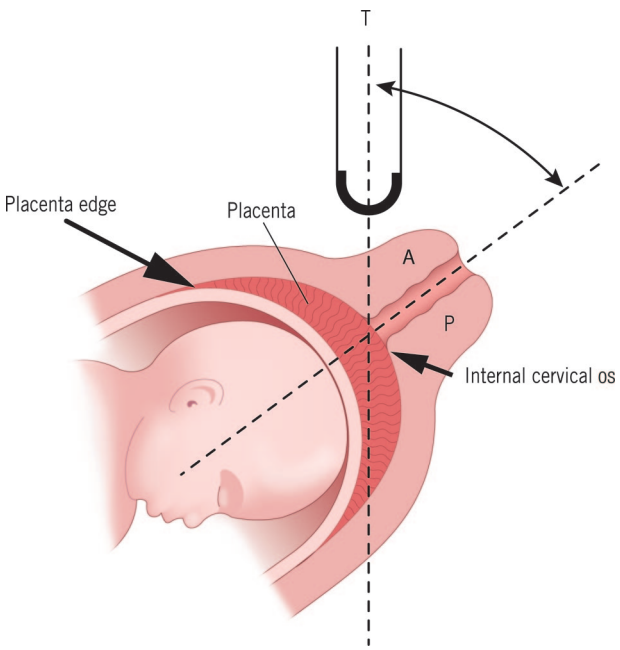


**Fig. 3.** Diagram demonstrating the technique for transvaginal sonography of placenta previa. *T,* transvaginal transducer; *A,* anterior lip of cervix; *P,* posterior lip of cervix. Complete placenta previa is shown completely covering the internal os *(arrow)*. The transvaginal transducer lies within the vagina, about 2 cm from the anterior lip of the cervix. The angle between the transducer and the cervical canal is 35 degrees, demonstrating why the probe does not enter the cervix. Illustration: John Yanson.

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**Table 1. Studies of Second Trimester Transvaginal Sonography in the Prediction of Placenta Previa at Delivery**

| Author | Gestational Age at Sonogram (wk) | Number of Women | Incidence of Placenta Previa at First- or Second-Trimester Sonography [n (%)] | Incidence at Delivery [n (%)] |
|---|---|---|---|---|
| Becker[17] | 20–23 | 8,650 | 99 (1.1) | 28 (0.32) |
| Taipale[21] | 18–23 | 3,969 | 57 (1.5) | 5 (0.14) |
| Hill[19] | 9–13 | 1,252 | 77 (6.2) | 4 (0.31) |
| Mustafa[20] | 20–24 | 203 | 8 (3.9) | 4 (1.9) |
| Lauria[13] | 15–20 | 2,910 | 36 (1.2) | 5 (0.17) |
| Rosati[18] | 10–16 | 2,158 | 105 (4.9) | 8 (0.37) |

cervical effacement and changes in the lower uterine segment, provoking bleeding which, in turn, stimulates contractions, creating a vicious cycle. Sharma and colleagues[24] carried out a small randomized study using the β-adrenergic ritodrine and found a significant prolongation in pregnancy and higher birth weights in women treated with ritodrine when compared with women treated with placebo. Similarly, Besinger and colleagues,[25] in a retrospective study, found that use of intravenous magnesium sulfate and/or oral or subcutaneous terbutaline in women with symptomatic placenta previa was associated with greater prolongation of pregnancy and higher birth weight than in women who were not treated with tocolytics. Thus, cautious use of tocolytics in women with placenta previa who are having contractions, when both mother and fetus are stable, appears reasonable.

Steroids should be administered in women between 24 and 34 weeks of gestation, generally at the time of admission for bleeding, to promote fetal lung maturation. The patient and her family should have a neonatology consultation so that the management of the infant after birth may be discussed. In women who have a history of cesarean delivery or uterine surgery, detailed sonography should be performed to exclude placenta accreta. Because prematurity is the main cause of perinatal mortality associated with placenta previa, it is desirable to prolong gestation as long as safely possible. Therefore, before 32 weeks of gestation, moderate-to-severe bleeding when there is no maternal or fetal compromise may be managed aggressively with blood transfusions, rather than resorting to delivery.[26] When the patient has had no further bleeding for 48 hours, she may be considered for discharge as long as there are appropriate home conditions to allow outpatient management. Specifically, the patient should have access to a telephone, have a responsible adult and transportation available at all times, and must live within reasonable distance of a hospital. She should return to the hospital immediately if she experiences bleeding or contractions. Although there are no data to support the efficacy of avoidance of intercourse and excessive activity, common sense suggests that these should be avoided. Similarly, bedrest is often advised, but there is no evidence that demonstrates that this practice is beneficial.

## Outpatient Versus Inpatient Management

Whether women with placenta previa should be managed as inpatients or outpatients has been a matter of controversy. A few retrospective studies have addressed this issue and have found no difference in outcomes, whether patients were managed in hospital or at home, and found that outpatient management may be associated with lower costs.[27,28] These studies concluded that outpatient management of selected women with placenta previa was safe. However, in another retrospective study, D'Angelo and Irwin[29] found an increase in perinatal mortality, lower gestational age at delivery, increased neonatal hospitalization duration, and neonatal morbidity among women who were managed as outpatients when compared with those managed expectantly as inpatients. In one of the few prospective randomized studies dealing with placenta previa, Wing et al[30] randomized 53 women with placenta previa at gestational ages between 24 and 36 weeks, who had been initially stabilized in hospital, to inpatient or outpatient management and found no significant difference in outcomes. Thus, women who are stable and asymptomatic, and who are reliable and have quick access to hospital, may be considered for outpatient management.

## Cerclage

Arias[31] randomized 25 women who were admitted to hospital with symptomatic placenta previa at 24–30 weeks gestation to cerclage or no cerclage and found a higher mean birth weight and gestational age at delivery and fewer neonatal complications in the cerclage group. Women with cerclage had lower hospitalization costs and fewer bleeding episodes.

However, in a later study, Cobo and colleagues[32] randomized 39 women with placenta previa at 24–30 weeks to cerclage or no cerclage and found no statistically significant differences in gestational age at delivery, prolongation of pregnancy, or in amount of blood lost between the 2 groups. In view of the lack of convincing data to support cerclage in these women, cerclage should not be performed for treatment of placenta previa.

## Mode of Delivery

There is consensus that a placenta previa that totally or partially overlies the internal cervical os requires delivery by cesarean. However, the mode of delivery when the placenta lies in proximity to the internal os is more controversial. Three small retrospective studies using transvaginal or translabial sonography have evaluated the role of ultrasonography in determining the optimal mode of delivery for women whose placentas were in proximity to the internal cervical os.[33–35] All 3 studies found that women in whom the distance between the lower placental edge and the internal cervical os was greater than 2 cm could safely have a vaginal delivery. Conversely, among women with a placenta-internal os distance less than 2 cm, the overwhelming majority required cesarean delivery, usually for bleeding. However, in none of these studies were the clinicians blinded to the results of the scan, and this may have influenced obstetric management. Furthermore, these studies had relatively small numbers. Nonetheless, the studies suggest that women with placenta previa should have a transvaginal sonogram in the late third trimester, and that those with a placental edge to internal os distance of less than 2 cm should be delivered by cesarean. It has been our experience that women with a placenta-internal os distance of less than 2 cm who undergo a trial of labor almost invariably experience significant bleeding during labor, necessitating cesarean delivery. Consequently, it is now our practice to deliver these women by elective cesarean. Women whose placentas are 2 cm or more from the os undergo a normal labor. It is important though to realize that, in women with a placenta that extends into the noncontractile lower uterine segment who have a vaginal delivery, there is potential for postpartum hemorrhage.

When there is an anterior placenta previa, there is a considerable likelihood of incising through the placenta during delivery. This could lead to significant maternal and fetal blood loss and also to difficulty with delivery, but this rarely constitutes a significant problem. Alternative strategies have been proposed and used to avoid incision into the placenta. These include use of a fundal vertical uterine incision, especially in women who have no desire for further childbearing.[36] This may especially be useful when there is a complete placenta previa with a fetal transverse lie with the fetal back down. Sonography before surgery for placental location enables the surgeon to plan the most appropriate incision.[36] Generally, we perform a lower segment transverse uterine incision, incising the placenta when it is unavoidable. The infant is delivered as rapidly as possible, and the cord is clamped immediately to avoid hemorrhage from fetal vessels.

## Timing of Delivery

As gestational age advances, there is an increased risk of significant bleeding, necessitating delivery. It is preferable to perform a cesarean delivery for placenta previa under controlled scheduled conditions rather than as an emergency. Therefore, in a stable patient, it is reasonable to perform a cesarean delivery at 36–37 weeks of gestation, after documentation of fetal lung maturity by amniocentesis. If the amniocentesis does not demonstrate lung maturity, we deliver the women by elective cesarean at 38 weeks, without repeating the amniocentesis, if they remain stable, or earlier if bleeding occurs or the patient goes into labor.

## Anesthesia for Delivery

In the past, it was generally recommended that cesarean deliveries for placenta previa be performed under general anesthetic.[37] It was believed that this allowed more controlled surgery. At least 2 studies, including a prospective randomized trial, have found that cesarean deliveries for placenta previa performed under general anesthetic were associated with significantly greater estimated blood loss and greater requirements for blood transfusion than those performed under regional anesthesia,[38,39] possibly due to increased uterine relaxation associated with general anesthetic. Otherwise, there was no difference in the incidence of intraoperative or anesthesia complications between regional and general anesthesia. A survey of anesthesiologists in the United Kingdom found a wide variety of opinions regarding whether general or regional anesthesia should be used for cesarean for placenta previa. However, anesthesiologists who did more obstetric anesthesia were more likely to employ regional anesthesia.[40] Another U.K. survey found that, 60% of the time, anesthesiologists used regional anesthesia for cesarean for placenta previa.[37] At our institution, we generally perform cesarean deliveries for placenta previa under regional anesthesia.

## PLACENTA ACCRETA

### Definition

Placenta accreta refers to a placenta that is abnormally adherent to the uterus (Fig. 4). When the placenta invades the myometrium, the term *placenta increta* is used, whereas *placenta percreta* refers to a placenta that has invaded through the myometrium and serosa, sometimes into adjacent organs, such as the bladder. The term *placenta accreta* is often used interchangeably as a general term to describe all of these conditions.

### Clinical Significance

Placenta accreta may lead to massive obstetric hemorrhage, resulting in such complications as disseminated intravascular coagulopathy, need for hysterectomy, surgical injury to the ureters, bladder, and other viscera, adult respiratory distress syndrome, renal failure, and even death.[41,42] The average blood loss at delivery in women with placenta accreta is 3,000–5,000 mL.[41] Indeed, in several centers, placenta accreta has become the leading reason for cesarean hysterectomy.[43] Rarely, placenta accreta may lead to spontaneous uterine rupture in the second or third trimester, resulting in intraperitoneal hemorrhage, a life-threatening emergency.[44] Minor degrees of placenta accreta may occur, which may lead to slightly heavier postpartum bleeding, but may not require the aggressive management that is often employed with more extensive placenta accreta.

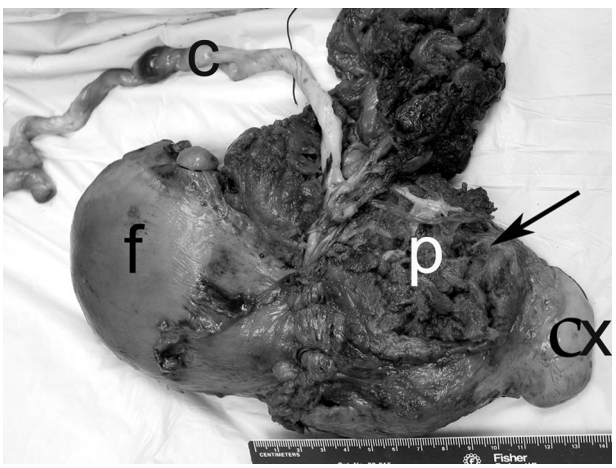


**Fig. 4.** Hysterectomy specimen demonstrating placenta accreta. This placenta accreta was diagnosed prenatally. The placenta *(p)* has invaded the myometrium *(arrow)* and after hysterectomy could not be separated from the uterus. There were no planes of demarcation between placenta and myometrium. *cx,* cervix; *f,* uterine fundus; *c,* umbilical cord.

*Oyelese. Placenta Previa, Accreta, and Vasa Previa. Obstet Gynecol 2006.*

### Incidence and Risk Factors

Miller and colleagues,[45] reviewing 155,670 deliveries at their hospital between 1985 and 1994, found that 62 (one in 2,510) were complicated by placenta accreta. The incidence of placenta accreta is increasing, primarily as a consequence of rising cesarean delivery rates. A recent study by Wu and colleagues[46] looking at placenta accreta over a 20-year period (1982–2002) found an incidence of 1 in 533 pregnancies at their institution. Placenta accreta occurs most frequently in women with one or more prior cesarean deliveries who have a placenta previa in the current pregnancy. Clarke and colleagues[47] found that, in the presence of a placenta previa, the risk of having placenta accreta increased from 24% in women with one prior cesarean delivery to 67% in women with 3 or more prior cesareans.

It has been proposed that the abnormality of the placental-uterine interface in women with placenta accreta will lead to leakage of fetal alpha-fetoprotein into the maternal circulation, resulting in elevated levels of maternal serum alpha-fetoprotein (MSAFP).[48] Kupferminc and colleagues,[49] reviewing 44 cases of women who had cesarean hysterectomies, found that 9 of the 20 (45%) with placenta accreta had elevated MSAFP levels (between 2.7 and 40.3 multiples of the median [MoMs]), whereas the controls all had MSAFP levels within normal limits (< 2.0 MoMs). Similarly, Zelop and colleagues[48] found elevated second-trimester MSAFP levels (between 2.3 and 5.5 MoMs) in 45% of 11 women with placenta accreta, whereas none of the controls who had placenta previa without accreta had MSAFP elevations. Although these studies are small, they suggest that women with elevated MSAFP levels with no other obvious cause should be considered at increased risk of placenta accreta.

### Pathophysiology

Placenta accreta is thought to be due to an absence or deficiency of Nitabuch's layer or the spongiosus layer of the decidua.[10] Benirschke and Kaufmann[10] suggest that this is the consequence of failure of reconstitution of the endometrium/decidua basalis after repair of a cesarean incision. Histology usually shows that the trophoblast has invaded the myometrium without intervening decidua.[10] This becomes a problem at delivery when the placenta does not separate and massive bleeding ensues (Fig. 5).

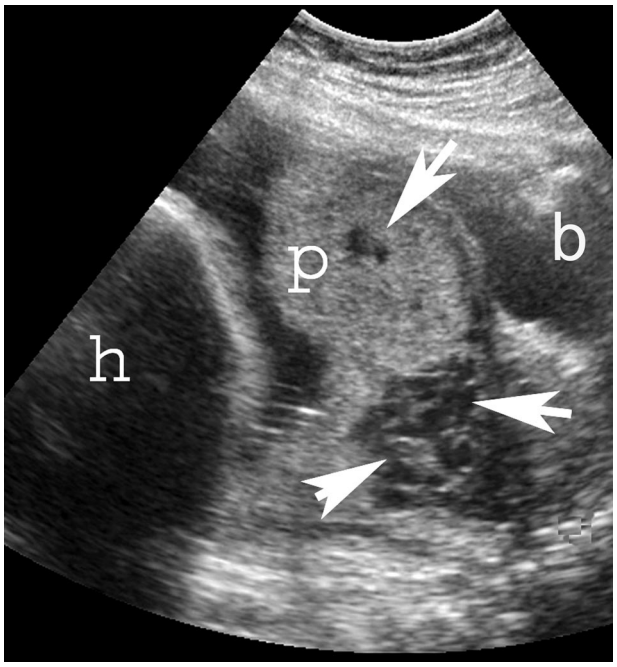


**Fig. 5.** Grayscale sonogram of placenta percreta. Note the prominent placental lacunae *(arrows)* giving the lower uterine segment a "moth-eaten" appearance. The diagnosis was confirmed at delivery. *p,* placenta; *h,* fetal head; *b,* bladder.

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## Diagnostic Approach

It is important to make the diagnosis of placenta accreta prenatally because this allows effective management planning to minimize morbidity. This diagnosis is usually made by ultrasonography or magnetic resonance imaging (MRI). Placenta accreta should be suspected in women who have both a placenta previa and a history of cesarean delivery or other uterine surgery.[41,50] Vigilance is particularly indicated when the placenta is anterior and overlies the cesarean scar.

## Ultrasonography

Several studies have documented the efficacy of sonography in the diagnosis of placenta accreta.[50–52] Comstock,[50] in a recent review, described the sonographic features suggestive of placenta accreta. These include irregularly shaped placental lacunae (vascular spaces) within the placenta, thinning of the myometrium overlying the placenta, loss of the retroplacental "clear space," protrusion of the placenta into the bladder, increased vascularity of the uterine serosa-bladder interface, and, on Doppler ultrasonography, turbulent blood flow through the lacunae (Figs. 5, 6).[51] In a previous study, Comstock and colleagues[51] had found, at 15–20 weeks of gestation, that the presence of lacunae in the placenta was the most predictive sonographic sign of placenta accreta, with a sensitivity of 79% and a positive predictive value of 92%. These lacunae may give the placenta a "moth-eaten" or "Swiss cheese" appearance (Fig. 5). The risk of placenta accreta increases with an increased number of lacunae.[52] Obliteration of the retroplacental "clear space," which is the finding most commonly thought to be associated with placenta accreta, had only a 57% sensitivity and a false-positive rate of 48.4%.[51] After 20 weeks of gestation, the sensitivity of these findings increased, with values of 93% and 80% for lacunae and obliteration of the retroplacental clear space, respectively.[51] The investigators found that a sonographic appearance of apparent bulging into the bladder may occur in cases of placenta accreta without increta or percreta.[50] Thus, this finding may not reliably differentiate between cases in which the placenta has invaded the bladder and cases in which it has not.[50]

Power and color Doppler are often used for the diagnosis of placenta accreta, demonstrating turbulent flow through placental lacunae (Fig. 6).[53] However, in the majority of cases, this imaging modality does not significantly improve the diagnosis over that achieved by grayscale sonography alone. Thus, in the majority of clinical situations, Doppler should not be the primary technique used to diagnose placenta accreta.

A retrospective review of images of first-trimester sonograms of cases of placenta accreta found that, in all the cases, the gestational sac was in the lower uterine segment and that the gestational sac was abnormally close to the uterine scar, suggesting attachment to the scar.[54] This finding in the first trimester, therefore, in women with a prior cesarean delivery, should lead to a suspicion of placenta accreta.

## Magnetic Resonance Imaging

Several articles have described the use of MRI in the diagnosis of placenta accreta.[55–57] Most were retrospective, limited to a few cases, and lacked pathologic correlation.[56] Although most studies have suggested reasonable diagnostic accuracy of MRI for placenta accreta, it appears that MRI is no more sensitive than ultrasonography for diagnosing placenta accreta.[50,57] Ultrasonography is readily available in most centers, whereas MRI is costly and relatively inaccessible. Therefore, at the present time, sonography is the primary imaging modality for diagnosing accreta. However, when there is a posterior placenta accreta, ultrasonography may be less than adequate, and MRI

may be superior to ultrasonography for this specific indication.[50,57]

## Therapeutic Approach

It is generally accepted that placenta accreta is ideally treated by total abdominal hysterectomy. In addition, there is almost universal consensus that the placenta should be left in place; attempts to detach the placenta frequently result in massive hemorrhage. However, the physician should be aware that focal placenta accreta may exist that may not require such aggressive therapy. It is better to perform surgery for placenta accreta under elective, controlled conditions rather than as an emergency without adequate preparation. Therefore, scheduled delivery at 36–37 weeks of gestation, after documentation of fetal lung maturity by amniocentesis, seems reasonable. If amniocentesis fails to document fetal lung maturity, the patient, if stable, should be delivered by cesarean by 38 weeks, or earlier, if she bleeds or goes into labor. A study comparing emergency with elective peripartum hysterectomy found that women in the emergency hysterectomy group had greater intraoperative blood loss, were more likely to have intraoperative hypotension, and were more likely to receive blood transfusions than women who had elective obstetric hysterectomies.[58]

Prevention of complications ideally requires a multidisciplinary team approach. The patient should be counseled preoperatively about the need for hysterectomy and the likely requirement for transfusion of blood and blood products.[59] Although scheduled delivery should be the goal, contingency plans should be made for possible emergent delivery if necessary. It is important that delivery be performed by an experienced obstetric surgeon, with other surgical specialties such as urology and gynecological oncology readily available if required. It is not unusual for the lower uterine segment to be markedly enlarged and vascular, with distortion of normal anatomy and tissue planes. Preoperative cystoscopy with placement of ureteric stents may help prevent urinary tract injury. At our center, we usually insert a 3-way Foley catheter in the bladder via the urethra, allowing simultaneous irrigation and drainage of the bladder during the surgery. In instances where tissue plane identification is difficult because of adhesions or the invasive placenta, we have the option of distending the bladder to aid in its identification and then emptying it to avoid injury while we proceed with surgery. Use of a vertical skin incision facilitates adequate exposure. Generally, a vertical incision in the uterus allows delivery of the infant while avoiding the placenta. There should be no attempt to detach the placenta from the uterine wall. The edges of the uterine incision should be oversewn for hemostasis, after which a total abdominal hysterectomy should be performed. Although some have advocated supracervical hysterectomy, in the majority of cases the lower uterine segment is involved in the morbid adhesion and therefore needs to be removed.

It is important to minimize blood loss and ensure that the blood lost is replaced promptly and adequately.[59] Because of the large volumes of blood that are typically lost, as well as the replacement with packed red blood cells, these patients are at risk of disseminated intravascular coagulopathy. Thus, coagulation factors should be replaced liberally, adequately, and quickly. Donor-directed blood transfusions and use of a blood cell saver may reduce the need for transfusion with blood from another donor.[59] Some centers use acute normovolemic hemodilution to reduce the need for blood.[41] The role of experienced anesthesiology personnel who are skilled in obstetric anesthesia cannot be overemphasized, and they should be involved in preoperative assessment of the patient.[59] Regional anesthesia has been shown to be safe in the management of placenta accreta.

## Balloon Catheter Occlusion and Embolization

Balloon catheter occlusion or embolization of the pelvic vessels decreases blood flow to the uterus and potentially leads to reduced blood loss and makes it possible to perform surgery under easier, more controlled circumstances, with less profuse hemorrhage.[60–62] Two different approaches have been described. In one approach, several investigators preoperatively place occlusive balloon catheters in the internal iliac arteries. These catheters are inflated after delivery of the fetus, allowing surgery under controlled circumstances, and are deflated after the surgery. In the other major approach, catheters with or without balloons are placed preoperatively in the internal iliac arteries, and embolization of the vessels is performed after delivery of the fetus and before hysterectomy. These studies are for the most part retrospective and limited by small numbers. Levine and colleagues[62] did not find that pelvic vessel embolization improved surgical outcomes when compared with women who did not have embolization. Kidney et al[61] reported 5 cases of placenta accreta where prophylactic hypogastric artery balloon catheter embolization was performed after the cesarean delivery and before hysterectomy. These authors suggested

that embolization was both effective and safe, but there was no comparison group. A study by Alvarez and colleagues[60] found that elective embolization resulted in improved outcomes when compared with embolizations done emergently. At our center, the patient has occlusive balloon catheters placed in the anterior branch of the internal iliac arteries before surgery. After delivery of the infant, the balloons are inflated and embolization is performed before hysterectomy.

### Management Without Hysterectomy

Hysterectomy removes any prospect of future fertility and is associated with considerable morbidity and potential mortality, including that of surgical injury, given the distorted tissue planes and the need to operate in what is sometimes a blood-filled field. To minimize these complications and preserve fertility, recently there has been some interest in attempting to conserve the uterus and avoid hysterectomy.[63–66] Generally, in these cases, the placenta is left in situ, with no attempt at removal. Adjunctive procedures include embolization of the internal iliac vessels, treatment with methotrexate, resection of the affected segment of the uterus, use of uterine compression sutures, and oversewing of the placental bed.[63–66] A problem with several of these reports is that varying criteria are used for the diagnosis of placenta accreta, and in most cases, there was no pathologic confirmation of the diagnosis.[56,65] Thus, it is possible that some cases did not have a placenta accreta. A further problem is that, in several cases, the patients developed severe hemorrhage necessitating either emergency surgical intervention or embolization.[64,67] It is preferable to deal with massive hemorrhage in a controlled setting with all resources available, rather than to have to deal with it as an emergency at an unpredictable time. Conservative management also carries the risk of intrauterine infection, which could potentially be life threatening.

Nevertheless, conservative management may have a limited role in carefully selected patients who desire future fertility. It has been suggested that delayed surgery leads to a less vascular surgical field and may have potential benefits when there is bladder involvement.[42] Women offered conservative management should be counseled extensively that the outcomes are unpredictable and that there is a significant risk of serious complications including death. It is possible that, in the future, conservative management will assume a more important role in the management of placenta accreta. However, at the present time, this option cannot be recommended as a mainstay of therapy. Further studies are required to identify women who may be ideal candidates for conservative management and to define the risks associated with this approach.

### Methotrexate Therapy

Methotrexate, a folate antagonist, has been proposed as a conservative treatment for placenta accreta.[63] Methotrexate acts primarily against rapidly dividing cells and therefore is effective against proliferating trophoblast. However, more recently, others have argued that, after delivery of the fetus, the placenta is no longer dividing and therefore methotrexate is of no value. Mussalli and colleagues[68] reported 3 cases of suspected placenta accreta managed conservatively with methotrexate therapy. In 2 of the 3 cases, uterine conservation was possible. However, the use of methotrexate did not prevent delayed hemorrhage. At least 2 reports have documented failed conservative treatment of placenta accreta with methotrexate.[64,67] No large studies have compared methotrexate with no methotrexate in the treatment of placenta accreta. Therefore, at the present time, there are no convincing data for or against the use of methotrexate for accreta.

### Bladder Involvement

The bladder is the most frequently involved extrauterine organ when there is a placenta percreta. Bladder involvement is associated with significant morbidity.[69–72] Washecka and Behling[73] carried out a meta-analysis of 54 reported cases of placenta percreta with bladder involvement. They found that predelivery hematuria was only present in 17 cases (31%). Although cystoscopy was performed in 12 of these patients, in no case did it help in making the diagnosis. In 33% of the cases, the diagnosis was made prenatally by ultrasonography or MRI. The maternal morbidity was high, with 39 urologic complications. These included laceration of the bladder (26%), urinary fistula (13%), gross hematuria (9%), ureteral transaction (6%), and small capacity bladder (4%). Partial cystectomy was necessary in 24 cases (44%). There were 3 maternal deaths (5.6%) and 14 fetal deaths (25.9%).

Management of the patient with bladder involvement requires careful perioperative planning and should involve a urogynecologist, a urologist, and/or a gynecological oncologist. Preoperative cystoscopy and placement of ureteric stents may aid in identification of the ureters, leading to a reduced risk of damage or injury to these structures. Involvement of the bladder may require resection of the bladder and, occasionally, of the




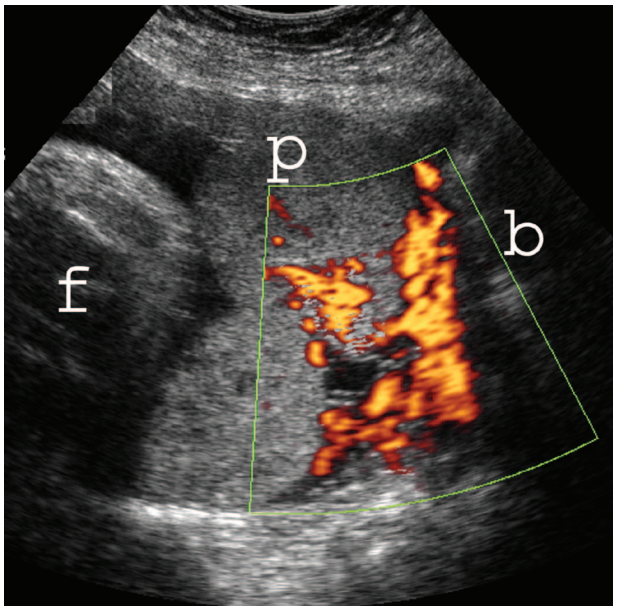


**Fig. 6.** Color Doppler of placenta percreta (same patient as in Fig. 5). Note the vascularity of the bladder wall *(b)*. At surgery, the bladder wall was involved. *p,* placenta; *f,* fetus.

*Oyelese. Placenta Previa, Accreta, and Vasa Previa. Obstet Gynecol 2006.*

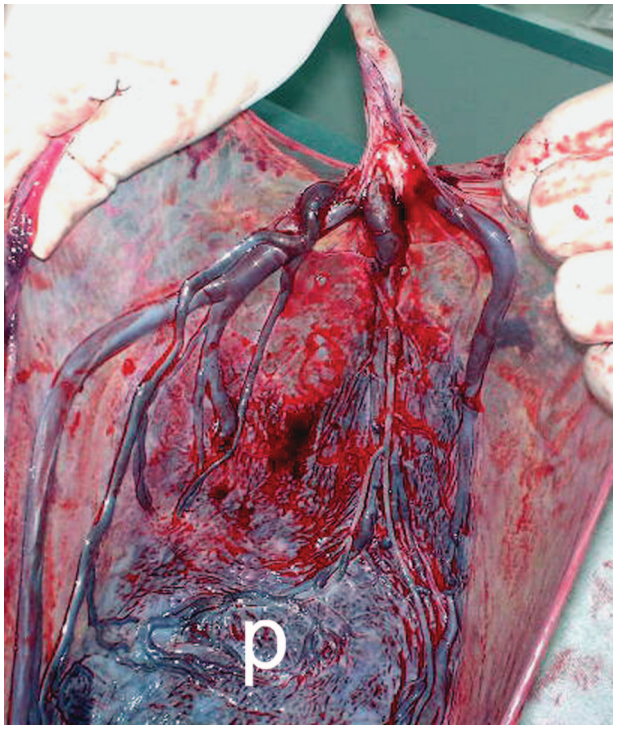


**Fig. 7.** Placenta after delivery showing vasa previa. Vessels are seen running unprotected through the membranes. *p,* placenta

*Oyelese. Placenta Previa, Accreta, and Vasa Previa. Obstet Gynecol 2006.*

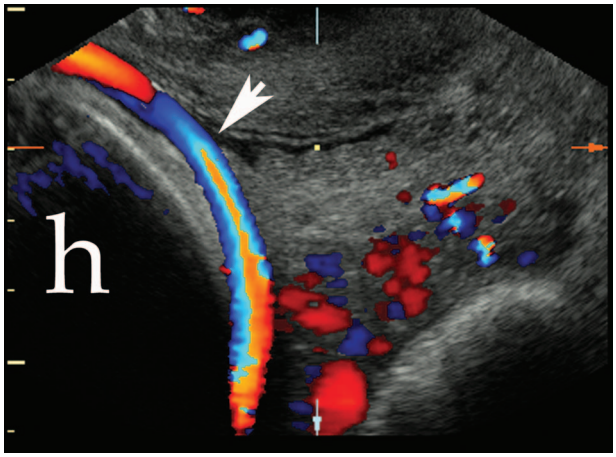


**Fig. 8.** Vasa previa. Transvaginal ultrasonography with color Doppler showing the fetal vessels running over internal os of the cervix *(arrow). h,* fetal head.

*Oyelese. Placenta Previa, Accreta, and Vasa Previa. Obstet Gynecol 2006.*

ureters. Intentional cystotomy may be helpful in identifying the extent of involvement and location of the ureters (Bakri YN, Sundin T. Cystotomy for placenta previa percreta with bladder invasion [letter]. Urology 1992;40:580).

## VASA PREVIA

### Definition

Vasa previa refers to fetal vessels running through the membranes over the cervix and under the fetal presenting part, unprotected by placenta or umbilical cord.[74] The condition usually results either from a velamentous insertion of the cord into the membranes rather than the placenta (Fig. 7) or from vessels running between lobes of a placenta with one or more accessory lobes.[74,75]

### Clinical Importance

Vasa previa is a condition which, undiagnosed, is associated with a perinatal mortality of approximately 60%.[76] The condition is important because, when the membranes rupture, spontaneously or artificially, the fetal vessels running through the membranes have a high risk of concomitant rupture, frequently resulting in fetal exsanguination and death.[74,77] Because the fetal blood volume is only about 80–100 mL/kg, loss of even small amounts of blood could prove disastrous to the fetus. Pressure on the unprotected vessels by the presenting part could lead to fetal asphyxia and death.

## Incidence and Risk Factors

The estimated incidence of vasa previa is approximately 1 in 2,500 deliveries.[74] Risk factors for the condition include a second-trimester low-lying placenta (even if the "low-lying" placenta or placenta previa resolves in the third trimester),[78] pregnancies in which the placenta has accessory lobes, multiple pregnancies, and pregnancies resulting from in vitro fertilization.[79]

## Pathophysiology

The pathophysiology of vasa previa was discussed earlier under the pathophysiology of placenta previa.

## Diagnostic Approach

Vasa previa is most commonly diagnosed when rupture of the membranes is accompanied by vaginal bleeding and fetal distress or death. The diagnosis is often confirmed only when the placenta is inspected after delivery. Consequently, until recently, most obstetricians have been resigned to the belief that the death of a fetus from a ruptured vasa previa is unavoidable. Very rarely (and fortuitously), vasa previa may be diagnosed during a digital cervical examination when the examiner's fingers palpate fetal vessels running through the membranes. Use of an amnioscope in this situation may allow direct visualization of the vessels. When bleeding occurs in pregnancy or during labor, a test to determine the presence of fetal blood cells in the vaginal blood, such as the Apt test or Kleihauer-Bettke test, may aid in the diagnosis of vasa previa.[74] However, when acute bleeding occurs from a ruptured vasa previa, emergent delivery is frequently indicated, and there may be no time to test for fetal blood cells. Whenever bleeding accompanies rupture of the membranes in labor, especially if there are associated fetal heart rate decelerations, fetal bradycardia, or a sinusoidal fetal heart rate pattern, the obstetrician should have a high index of suspicion for a ruptured vasa previa.[80,81] In these situations, most frequently, immediate delivery by cesarean is indicated. Even when the neonate has lost considerable blood, immediate transfusion may be lifesaving.[82]

Numerous reports and studies have demonstrated that vasa previa can be diagnosed prenatally with ultrasonography.[75,83] The grayscale sonographic appearance of vasa previa is of linear echolucent structures overlying the cervix.[83] When color or power Doppler is used, flow can be demonstrated through these vessels, and pulsed Doppler will demonstrate a fetal umbilical arterial or venous waveform (Fig. 8). It is important to differentiate a vasa previa from a funic presentation. In the latter, the vessels will move when the patient changes position, especially when the patient is placed in the Trendelenburg position. Conversely, the vessels do not move when there is a vasa previa. The majority of prenatally diagnosed cases of vasa previa are detected incidentally in women who have transvaginal sonography for evaluation of low-lying placentas. However, studies have demonstrated that the majority of cases of vasa previa in asymptomatic women can be diagnosed prenatally through a policy of routinely evaluating the placental cord insertion when an ultrasound examination is performed and considering vaginal sonography with color Doppler if the placental cord insertion cannot be identified or if there is a low-lying placenta or a suspected succenturiate placental lobe.[75,83,84]

At least 4 studies have prospectively evaluated the use of ultrasonography in routine screening for vasa previa in large populations.[75,83–85] These studies found that sonographic identification of placental cord insertion was accurate and sensitive and added little or no extra time to the duration of the obstetric sonographic examination. In all the prenatally diagnosed cases, the neonatal survival of infants without congenital malformations was 100%.

## Therapeutic Approach

Good outcomes with vasa previa depend on prenatal diagnosis and delivery by cesarean before rupture of the membranes. We previously carried out a multicenter retrospective study of 155 cases of vasa previa, evaluating the impact of prenatal diagnosis on outcomes of pregnancies complicated by vasa previa.[76] In 61 of these cases, the diagnosis was made prenatally. We determined that, in the absence of prenatal diagnosis, the perinatal mortality was 56%, whereas 97% of fetuses survived when the diagnosis was made prenatally.[76] Among survivors, when the diagnosis was not made prenatally, the median 1- and 5-minute Apgar scores were only 1 and 4, respectively, compared with 8 and 9, respectively, when the condition was diagnosed prenatally.[76] Two thirds of women had a low-lying placenta in the second trimester, whereas, by the time of delivery, only one third of these (20%) had a low-lying placenta. In one third of cases, the placenta was bi-lobed. The main predictors of survival were prenatal diagnosis and gestational age at delivery.

Consideration should be given to hospitalization at about 30–32 weeks and administration of corticosteroids to promote fetal lung maturation. Hospitalization allows proximity to the operating room for

emergent cesarean delivery if the membranes rupture. Approximately 10% of women will rupture their membranes before the onset of labor, so this risk is significant. However, in selected asymptomatic patients, there may be a role for outpatient management, especially if the patient has no signs of labor or uterine activity and has a long-closed cervix on transvaginal sonography. Delivery should occur at an institution where there are adequate facilities for neonatal resuscitation that might include emergent blood transfusions. It is preferable that, before surgery, the surgeon is aware of the position of the fetal vessels and plans the incision to avoid lacerating these vessels. We have previously described the use of 3-dimensional ultrasonography with power Doppler angiography to map out the fetal vessels and thereby make the optimal uterine incision.[86,87] It is desirable to deliver the fetus en caul, with intact membranes, avoiding incising the membranes.

A gestational age of between 35 and 36 weeks is the optimal age for cesarean delivery in women with vasa previa, with a reasonable tradeoff between prematurity with the risk of respiratory distress syndrome and that of rupture of the membranes with the risk of fetal exsanguination and death.[76] Although amniocentesis is generally recommended before elective cesarean delivery before 39 weeks in most conditions, in vasa previa, if the membranes rupture, the risks of fetal death or adverse outcome are so severe that we feel it is justifiable to deliver these women by 36 weeks without amniocentesis documentation of lung maturity

We can think of no other condition in which prenatal diagnosis and appropriate perinatal management makes such a dramatic impact on the difference between survival and death for an otherwise healthy infant. Thus, especially because it adds little in terms of time to the routine obstetric sonogram, it is our opinion that screening for vasa previa should be routine.

## CONCLUSION

Achieving optimal outcomes with placenta previa, placenta accreta, and vasa previa depends on prenatal diagnosis and appropriate management at the time of delivery. Advances in ultrasonography have made it possible to diagnose all 3 conditions with reasonable accuracy, which allows appropriate management planning. Women with these conditions should be considered at high risk and should be delivered at institutions with skilled personnel, adequate blood transfusion facilities, and good neonatal resources.

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