Vasa previa refers to unprotected fetal vessels running through the membranes over the cervix. Until recently, this condition was associated with an exceedingly high perinatal mortality rate attributable to fetal exsanguination when the membranes ruptured. However, ultrasonography has made it possible to diagnose the condition prenatally, allowing cesarean delivery before labor or rupture of the membranes. Several recent studies have indicated excellent outcomes with prenatally diagnosed vasa previa. However, outcomes continue to be dismal when vasa previa is undiagnosed before labor. Risk factors for vasa previa include second-trimester placenta previa and low-lying placentas, velamentous cord insertion, placentas with accessory lobes, in vitro fertilization, and multifetal gestations. Recognition of individuals who are at risk and screening them will greatly decrease the mortality rate from this condition. Because of the relative rarity of vasa previa, there are no randomized controlled trials to guide management. Therefore, recommendations on the diagnosis and management of vasa previa are based largely on cohort studies and expert opinion. This Clinical Expert Series review addresses the epidemiology, pathophysiology, natural history, diagnosis and management of vasa previa, as well as innovative treatments for the condition.

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expert opinion. In this review, we address the epidemiology, pathophysiology, natural history, diagnosis, and management of vasa previa and review innovative treatments for the condition.

**EPIDEMIOLOGY**

**Incidence**

Vasa previa occurs in about 1 in 1,200–1 in 2,500 births. About 15–30% of cases of vasa previa detected in the second trimester will no longer be a vasa previa by the time of delivery. Thus, the incidence at the time of birth will be lower than earlier in pregnancy. Vasa previa is likely underreported. In deliveries with vasa previa, the umbilical cord may be avulsed, and the velamentous insertion may not be recognized. Furthermore, not all placentas are thoroughly examined after birth. Finally, some patients may have cesarean deliveries before labor for other reasons, and the vasa previa may never be recognized. What is clear is that, although vasa previa is relatively rare, it has now become commonplace to diagnose; therefore, it is becoming increasingly common as a cause of antenatal hospitalization. With 3,659,289 births in the United States in 2021 and an estimated incidence of 1 in 2,000 births, it is estimated that vasa previa complicates about 1,830 births annually in the United States. Thus, it is important that all obstetricians are aware of this condition.

**Risk Factors**

Several risk factors for vasa previa have been identified. Early reports indicated that both velamentous cord insertions and second-trimester placenta previa or low-lying placentas were risk factors for vasa previa. Subsequently, several reports and studies have demonstrated that assisted reproductive technologies, especially in vitro fertilization, carry a greatly increased risk for vasa previa, with estimates that about 20% of cases of vasa previa are among pregnancies with some type of assisted reproductive technology. Ruiter et al and Pavalagantharajah et al found in their systematic reviews and meta-analyses that about 80% of cases of vasa previa had risk factors. In these reviews, about 62% of cases of vasa previa at delivery had a second-trimester low-lying placenta or placenta previa. Thus, a second-trimester low-lying placenta or placenta previa is a risk factor for vasa previa at delivery, even if the low-lying placental location resolves in the third trimester. One-half of cases of vasa previa are associated with a velamentous cord insertion; umbilical cord insertion into the lower third of the uterus in the first trimester of pregnancy is also a risk factor. About one-third of cases of vasa previa will be associated with a bilobed placenta or one or more accessory (succenturiate) placental lobes. Multifetal gestations also have an increased risk for vasa previa.

**TYPES OF VASA PREVIA AND PATHOPHYSIOLOGY**

Three types of vasa previa have been described. Type 1, the most common, results from a velamentous cord insertion in which unprotected fetal vessels run over the cervix to insert into the placental edge. Type 2 results from a bilobed or succenturiate lobed placenta with unprotected fetal vessels running between the lobes over the cervix. Type 3 results from aberrant fetal vessels that run from one edge of the placenta through the membranes to another edge of the placenta. Although the exact pathogenesis of vasa previa is unknown, the observation has been made that several cases start off as a placenta previa in the second trimester. It has been proposed that the placenta grows preferentially toward the better-vascularized fundus of the uterus with advancing gestational age, and then the placental tissue overlying the less well-vascularized cervix and lower uterine segment undergoes atrophy, leaving behind exposed fetal vessels.
DEFINITION, CLINICAL PRESENTATION, AND NATURAL HISTORY

Definition

Until recently, *vasa previa* was defined simply as unprotected fetal vessels running through the membranes over the cervix and under the fetal presenting part. The Society for Maternal-Fetal Medicine (SMFM) guidelines published in 2015 state, “There are no standardized criteria for how close the fetal vessels must be to the internal os to constitute *vasa previa.*” However, recently, some authors have defined *vasa previa* as vessels that lie within 2 cm of the internal cervical os. There is often a misconception that the 2-cm distance is universally accepted and that vaginal delivery is safe when the vessels are greater than 2 cm from the internal os. This distance was extrapolated from the definition of a low-lying placenta in which 2 cm had been found to be a distance from the lower placental edge to the internal os that would permit a safe vaginal delivery. However, there are no data confirming the safety of the 2-cm distance to allow vaginal birth when unprotected vessels run close to the cervix. The wisdom of using a 2-cm distance definition for *vasa previa* has been contested by several authors, and this remains an area of controversy in the clinical management of *vasa previa.*

Extrapolation of data from low-lying placenta to *vasa previa* may be inappropriate. When bleeding results from a low-lying placenta in labor, cesarean delivery can be safely performed. However, if a fetal vessel ruptures, even in labor, the results will likely be catastrophic. One publication reported a perinatal death after rupture of membranes with subsequent bleeding in a patient in whom the vessel distance from the internal os was 2.8 cm on ultrasonography. Given that the cervix dilates to 10 cm, any unprotected vessels running through the membranes within a radius of 5 cm at full dilation could be at potential risk of rupture. Because the consequences of rupture of fetal vessels are catastrophic, we suggest using a radius of 5 cm for defining *vasa previa.* However, this is not a standard definition, and no distance has been shown to be safe or to represent a universally accepted definition for *vasa previa.* Several other authors and guidelines have acknowledged that there is no known “safe” distance and have used differing definitions of distance from the vessels to the internal os to define *vasa previa.*

Finally, it is important to recognize that the relationship between vessels and the internal os of the cervix can be likened to the relationship between a line and a dot. The distance between the two depends on where along the line the measurement is taken. A vessel that appears to be 2 cm from the internal os in a sagittal plane may be much closer laterally. Often this relationship is evaluated only by ultrasonography in a midsagittal plane; therefore, vessels may be closer than assessed and at greater risk for rupture than is appreciated in a single ultrasound image.

Clinical Presentation and Outcomes

In the past, the classic presentation of *vasa previa* was spontaneous rupture of the membranes with vaginal...
bleeding and then an inability to detect fetal heart tones.\textsuperscript{2,8-10} After delivery, the neonate was noted to be pale.\textsuperscript{2} Examination of the placenta showed vessels running through the fetal membranes with rupture of the vessels. Occasionally, and fortuitously, in some cases, pulsations may be felt on digital examination while the membranes are intact.\textsuperscript{2} Recognition of these pulsations may help diagnose (previously undiagnosed) vasa previa and lead to cesarean delivery. In cases undiagnosed prenatally, bleeding after intrapartum rupture of the membranes with fetal heart rate pattern abnormalities such as a sinusoidal fetal heart rate pattern (Fig. 3) or fetal bradycardia is a common presentation.\textsuperscript{2,6}

In recent years, more cases of vasa previa have been diagnosed prenatally, leading to excellent outcomes in those cases.\textsuperscript{1-9,14-17,34-47} A large, international, multicenter cohort study of 155 cases found that, when vasa previa was not diagnosed prenatally, there was a 56% perinatal mortality rate.\textsuperscript{48} Conversely, 97% of neonates survived when vasa previa was diagnosed prenatally.\textsuperscript{48} In a systematic review and meta-analysis, Zhang et al\textsuperscript{49} found that intact survival in vasa previa that was not diagnosed prenatally was only 28.1% compared with 96.7% in cases diagnosed prenatally. The risks of perinatal death and of hypoxic morbidity were 25-fold and 50-fold higher, respectively, in those not diagnosed prenatally compared with those diagnosed prenatally.\textsuperscript{49} Survivors after rupture of vasa previa that is not diagnosed prenatally may have high rates of long-term neurodevelopmental impairment with tremendous economic burden to society, as well as severe psychological damage to parents and families.\textsuperscript{33}

Pregnancies complicated by vasa previa also are at greatly increased risk for preterm delivery with its attendant morbidities.\textsuperscript{37,46,50} A California population-based study of 586 pregnancies complicated by vasa previa found that 63% of patients delivered before 37 weeks of gestation compared with a rate of 10% in pregnancies not complicated by vasa previa; the rate of delivery before 32 weeks of gestation was 5.1% for pregnancies complicated by vasa previa compared with 1.2% for pregnancies not complicated by vasa previa.\textsuperscript{50} In a study of 122 patients with prenatally diagnosed vasa previa from a New York hospital

Fig. 3. Sinusoidal fetal heart rate tracing following rupture of a vasa previa in labor. The upper tracing shows the heart rate when the membranes were intact. The lower tracing occurred after rupture of the membranes in labor, associated with vaginal bleeding. Immediate cesarean delivery was performed and vasa previa confirmed at delivery. The neonate was transfused in the delivery room and did well. Reprinted with permission from Queenan JT. Queenan’s Management of High Risk Pregnancy: An Evidence-Based Approach. John Wiley & Sons; 2012. p. 386.\textsuperscript{111}

In that study, 38 weeks) for patients who had unscheduled deliveries and 35.1 weeks (range 34–38.6 weeks) for patients who had scheduled deliveries.

Maternal risks of vasa previa include bleeding if there is a coexisting low-lying placenta or interventions such as hospitalization and cesarean delivery performed for the diagnosis of vasa previa. There is also often associated maternal anxiety stemming from the diagnosis of vasa previa and the inherent risks to the pregnancy.33

Ultrasound Diagnosis

In 1987, Gianopoulos et al11 first described the prenatal diagnosis of vasa previa with ultrasonography. Subsequently, over the next decade, several case reports of prenatal diagnosis of vasa previa were published.51–57 In 1990, Nelson et al52 described prenatal diagnosis of vasa previa with transvaginal ultrasonography with color Doppler. The advent of prenatal diagnosis made it possible to deliver the patient with vasa previa by cesarean before labor, preventing the previously observed high perinatal mortality rates from rupture of fetal vessels.2 In two separate studies published in 2000 and 2001, Lee et al26 and Catanzarite et al27 reported cohorts of 18 and 10 cases, respectively, of vasa previa diagnosed prenatally using ultrasonography at their centers, with cesarean deliveries and favorable outcomes. Since then, numerous studies from different centers have reported use of ultrasonography in the prenatal diagnosis of vasa previa with good neonatal outcomes.14–17,34,36,37,40–47 A systematic review by Ruiter et al58 found excellent performance of transvaginal ultrasonography with Doppler for the diagnosis of vasa previa with a sensitivity and specificity of 100% and 99%, respectively.

Vasa previa appears on ultrasound imaging as linear or circular hypoechogenic structures overlying or close to the cervix (Fig. 4).1–6,38 Although vasa previa may be suspected or even diagnosed with transabdominal ultrasonography with color Doppler (Fig. 5), the diagnosis is best confirmed with transvaginal ultrasonography with color or power and pulse wave Doppler (Figs. 6 and 7).3–6,38 It is important to note that transvaginal ultrasonography is safe when used for the evaluation of possible vasa previa and is not associated with increased risk of bleeding.3 False-positive results may result from movement artifact, funic presentation of the cord (free loops of cord overlying the cervix), or maternal vessels within the uterus or cervix.3–6,38 Funic presentation can be differentiated from vasa previa because the cord will move with maternal position changes and will not be present on repeated examinations.1,3–6,38 Vessels running transversely over the cervix may be more difficult to recognize because, in the commonly used sagittal view of the cervix, these vessels are seen in cross-section and therefore may appear as circles rather than lines.59

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The presence of vessels should be confirmed with color Doppler (Figs. 5 and 6).1,4–6,26,38 It is important to use pulse wave Doppler to show that the vessel demonstrates a fetal arterial or venous waveform, confirming vasa previa (Fig. 7).1,4–6,38 Because of false-positive results and because approximately 20–30% of cases of vasa previa diagnosed at about 20 weeks of gestation will have resolved by the time of delivery, we recommend a repeat transvaginal ultrasound with Doppler to confirm the diagnosis at 28–32 weeks of gestation.1,3–7,15,16,38 Transvaginal ultrasonography at that gestational age may, however, be limited because the fetal head may be well applied to the cervix, compressing the fetal vessels and making visualization of these vessels difficult, leading to the false belief that there is no vasa previa.50 For this reason, we recommend attempting to mobilize the fetal head away from the cervix with manual pressure. It is important to note that the pressure of the examiner’s hand on the suprapubic area itself may compress fetal vessels, leading to false-negative results.51 Therefore, in previously diagnosed vasa previa, we recommend a meticulous and cautious examination at 28–32 weeks of gestation while being attentive to the limitations of ultrasonography at this gestational age. The entire
region over the cervix must be well visualized before vasa previa can be excluded. False-negative results may also occur as a result of a lack of suspicion, an inexperienced examiner, inadequately sensitive Doppler settings, higher maternal weight, and suboptimal imaging characteristics. Although ultrasonography performs well in diagnosing vasa previa, in some cases, vasa previa may be missed even in the hands of the most experienced practitioners.\(^1,5\)

Three-dimensional ultrasonography has been used in diagnosis of vasa previa.\(^2,28,62,63\) This technique has the benefit of being able to accurately map out the precise relationship between the vessels and the internal os of the cervix in multiple planes.\(^2,28,63\) Although magnetic resonance imaging has been used to evaluate vasa previa, it does not have any advantages over ultrasonography alone.\(^64,65\) It is also expensive and not readily available, and there is less experience in using it for evaluation of vasa previa. For these reasons, routine use of magnetic resonance imaging for the detection of vasa previa is not recommended.

**Screening**

Because vasa previa, when undiagnosed, carries such a high mortality rate and the condition can be diagnosed reliably with prenatal ultrasonography, it seems logical that routine screening would be performed.\(^34,38,66,67\) However, the subject of routine screening for vasa previa has been one of much debate.\(^1,7,34,38,66–74\) There are two approaches to screening: routine screening of all pregnancies and targeted screening, which is screening of patients with risk factors, given that about four-fifths of patients with vasa previa have risk factors.\(^1,3–7,38,66–74\)

Routine screening may be achieved through always attempting to identify the placental cord insertion and with a color Doppler sweep of the region over the cervix at the time of the fetal anatomy survey.\(^7,38,42,46,67\) A study by Nomiyama et al demonstrated that routine ultrasound examination for placental cord insertion was accurate and achievable in less than 1 minute in 95% of examinations. Another study by Sepulveda et al confirmed that routine evaluation of placental cord insertion is feasible as a part of the second-trimester anatomy scan.

In the United States, 2014 consensus guidelines from the SMFM, the American College of Obstetricians and Gynecologists, and the American Institute of Ultrasound in Medicine recommend routine examination of the placental cord insertion at 32 weeks of gestation in patients who have a second-trimester low-lying placenta or placenta previa (especially when the low-lying placenta or placenta

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**Fig. 5.** Transabdominal ultrasonogram with color Doppler of the lower uterine segment showing a fetal vessel overlying the cervix (cx), confirming a diagnosis of vasa previa. h, fetal head; b, bladder.


**Fig. 6.** Transvaginal ultrasonogram with color Doppler showing a fetal vessel overlying the cervix (cx). h, fetal head.


**Fig. 7.** Transvaginal ultrasonogram with color and pulse wave Doppler showing a fetal arterial waveform confirming the vasa previa. h, fetal head; cx, cervix.

previa has resolved by the third trimester).77–79 We recommend following this protocol, which results in screening of all patients. This strategy will be highly effective in detecting most cases of vasa previa prenatally, which is likely to lead to a decrease in perinatal deaths from undiagnosed vasa previa. However, the UK National Screening Committee continues to recommend not screening for vasa previa.67,71,79,80 A recent modeling study from the United Kingdom has suggested that targeted screening of all patients with second-trimester placenta previas or low-lying placentas will detect about 60% of cases of vasa previa without leading to increased cost or modification of current protocols.80 A recent opinion argued that vasa previa is more common than several conditions routinely screened for in pregnancy and, given the high detection rate of ultrasound screening and the dramatic difference in outcomes in prenatally diagnosed cases, advocated that there should be routine screening for vasa previa.67

**MANAGEMENT**

**Bed Rest and Activity Restriction**

Bed rest is not recommended for patients with vasa previa because it has no benefits and has potential risks, including thromboembolism.81 Although there are no data indicating that sexual intercourse is harmful in patients with vasa previa, bleeding after intercourse is likely to lead to significant alarm, hospitalization, and even iatrogenic delivery. For these reasons, it would be prudent to suggest pelvic rest. Similarly, although there is no evidence of harm from high-impact activities, it is reasonable to avoid such activities.

**Antenatal Fetal Surveillance**

Because any type of velamentous cord insertion is associated with an increased risk of fetal growth restriction, we recommend ultrasound examinations to evaluate fetal growth every 4 weeks starting at 24 weeks of gestation. We do not routinely perform fetal monitoring with nonstress tests or biophysical profiles before 32 weeks of gestation. When patients are admitted antenatally, they are likely to be monitored with fetal heart rate tracings daily.42 In addition, these patients frequently are monitored with biophysical profiles at least weekly. Although there is a theoretical risk of compression of the exposed fetal vessels by the fetal presenting part that may lead to fetal heart rate abnormalities, our experience with hospitalized patients is that this is extremely rare. We suggest that patients with vasa previa who are managed as outpatients have biophysical profiles or nonstress tests weekly after 32 weeks of gestation.

**Cervical Length Measurements**

Transvaginal ultrasound cervical length measurements have been shown to be correlated inversely to risk for preterm birth and preterm rupture of the membranes, and for this reason, some have advocated using cervical length measurements to assess risk for rupture of the fetal vessels in vasa previa.7,14,82–85 Transvaginal ultrasound cervical length evaluation may play a role in helping to triage patients to inpatient or outpatient management and may assist in planning timing of delivery.7,14,84,85 In a study by Zhang et al,14 the 15 patients with vasa previa who had elective cesarean deliveries at 34 weeks of gestation had normal cervical lengths above the fifth centile. Conversely, all five patients with vasa previa who required emergency cesarean delivery because of labor or rupture of the membranes had cervical lengths below the fifth centile.14 We suggest performing transvaginal ultrasound examinations for cervical length on patients with vasa previa every 2–4 weeks from 28 weeks of gestation until delivery. In our practice, a cervical length of less than 2.5 cm on transvaginal ultrasonography is a criterion for which we consider inpatient management. However, there are no available data demonstrating the efficacy of monitoring cervical lengths for the reduction of the need for emergency or unplanned deliveries in patients with vasa previa, and it may be of questionable utility, especially in patients who are already admitted to the hospital for monitoring.

**Hospitalization**

Because of the potential for sudden rupture of the fetal vessels, hospitalization has been suggested for patients with a prenatal diagnosis of vasa previa.1,4–6,15,16,42,46,73 The rationale for admission is that, if the membranes were to rupture, there would be proximity to an operating room where an emergency cesarean delivery could save the newborn. Conversely, if the patient were to be at home when the vessels ruptured, there would be a high likelihood of fetal death before the patient would be able to get to the hospital to have a cesarean delivery. Thus, many authors have recommended hospitalization of patients with vasa previa at about 32 weeks of gestation, and others have suggested that admission be offered as early as 28 weeks of gestation.1,4–6

However, routine antenatal hospitalization for vasa previa has been the subject of much controversy.1,4–6 The SMFM guidelines state, “Quality data
to support routine inpatient management are lacking and that decisions for hospitalization should be individualized based on patient characteristics and risk factors.\textsuperscript{71} Hospitalization has several downsides and potential risks, including venous thromboembolism, nosocomial infections, iatrogenic intervention such as preterm delivery, disruption to relationships and family life, depression, anxiety, stress, and loss of income.\textsuperscript{81} In addition, inpatients typically undergo cardiotocography once to twice daily. This monitoring may pick up asymptomatic contractions, leading to iatrogenic preterm delivery.

Fishel Bartal et al\textsuperscript{86} reviewed outcomes for 109 women with prenatally diagnosed vasa previa, of whom 75 (68.8\%) were managed as inpatients, with elective hospitalization at 34 weeks of gestation, and 34 (31.2\%) were managed as outpatients. It is important to note that there were no perinatal deaths attributable to vasa previa in either group. Ten women in the outpatient group (29.4\%) were admitted to the hospital before their scheduled cesarean delivery dates. Women in the inpatient group delivered earlier (36.0 weeks vs 36.4 weeks; \(P=.01\)). However, women in the inpatient group were less likely to have urgent cesarean delivery (26/75 [34.6\%] in the inpatient group vs 20/34 [58.8\%] in the outpatient group, \(P<.001\)). The most common reason for urgent cesarean delivery in the inpatient group was premature contractions (17/26 patients [65.4\%]). In the outpatient group, the most common reasons for urgent cesarean delivery were preterm prelabor rupture of the membranes (8/20 patients [40\%]), vaginal bleeding (7/20 patients [35\%]), and nonreassuring fetal status (5/20 patients, [25\%]).\textsuperscript{86}

Other studies have similarly found that inpatients were more likely to deliver preterm than those not admitted antenatally, whereas outpatients were more likely to have unscheduled deliveries, with no increased perinatal mortality in those managed as outpatients.\textsuperscript{37,87} The most common reason for urgent delivery in the hospitalized patients is premature contractions, whereas those managed as outpatients rarely have urgent delivery for this reason.\textsuperscript{37,87} These data suggest that hospitalization leads to a higher rate of preterm delivery attributable to asymptomatic contractions detected on routine monitoring. Although those managed as inpatients are likely to receive routine antenatal steroids on admission, the majority received their steroids several weeks before delivery, indicating that steroid timing is typically not optimized for those managed as inpatients.\textsuperscript{37,87}

There are currently no data demonstrating improved outcomes or a benefit of hospitalization in patients with prenatally diagnosed vasa previa compared with those managed as outpatients. If hospitalization is recommended, it must be at a center that can perform an urgent cesarean delivery at all hours. It has become clear that the majority of the perinatal risk occurs with the onset of labor.\textsuperscript{7} Thus, it is reasonable to manage patients with vasa previa as outpatients if they do not have risk factors for preterm birth such as prior early preterm birth, shortened cervixes on transvaginal ultrasonography, bleeding, rupture of the membranes, or regular painful contractions. Ideally, patients with vasa previa who are managed as outpatients should have easy access to a hospital. We recommend that each individual with prenatally diagnosed vasa previa should be counseled on the options of inpatient compared with outpatient management and have risk assessment performed, and then the mode of management should be determined with shared decision making.

**Steroids for Fetal Lung Maturation**

The American College of Obstetricians and Gynecologists recommends administration of steroids to patients at risk of preterm delivery within the next 7 days, up to a gestational age of 36 6/7 weeks, because the optimal timing of steroids is within 7 days of birth, with most benefit occurring at least 48 hours after steroid administration.\textsuperscript{88–90} In patients with vasa previa who are admitted to the hospital, steroids are frequently administered at the time of admission,\textsuperscript{3–6} with some guidelines suggesting steroid administration as early as 28 weeks of gestation.\textsuperscript{1,5,6} However, the overwhelming majority of these patients do not deliver within 7 days of steroid administration; in a large cohort of 122 patients with prenatally diagnosed vasa previa, fewer than 50\% received steroids within 7 days of delivery.\textsuperscript{37} Golic et al\textsuperscript{91} found that none of their patients with vasa previa diagnosed prenatally delivered before 34 weeks of gestation and argued against routine steroid administration. There is now an increasing body of evidence, albeit controversial, that suggests that steroids not administered within 7 days of delivery may have long-term detrimental effects to the infant or child.\textsuperscript{92} For these reasons, we suggest not routinely administering steroids in asymptomatic patients with vasa previa but rather performing a risk assessment and administering steroids within 7 days of anticipated delivery.

**Monitoring for Contractions and Administration of Tocolytics**

Contractions occur in a significant proportion of pregnant individuals in the third trimester. Often,
these contractions are asymptomatic and are detected on the cardiotocograph, not infrequently leading to concern and interventions, including iatrogenic preterm cesarean delivery. Monitoring for contractions is a poor way of predicting preterm delivery in asymptomatic women. For this reason, and because of the high likelihood of iatrogenic intervention, we do not recommend routine monitoring for contractions in asymptomatic women with vasa previa.

**Evaluation of Bleeding in Pregnancy**

Patients with vasa previa may experience vaginal bleeding in the second and third trimesters. For the most part, the reason is that many patients with vasa previa have a coexisting low-lying placenta. Bleeding creates a diagnostic and therapeutic dilemma; it is difficult to determine whether the bleeding is arising from rupture of the fetal vessels or from another (maternal) source such as a low-lying placenta or cervical lesions. In the past, it was commonplace to perform a bedside Apt test to determine whether the vaginal blood was of fetal or maternal origin. However, because of regulations on bedside tests in the United States, these tests are unlikely to be available. Furthermore, these tests have limited sensitivity, and results may not be available in a timely manner. For this reason, when bleeding occurs between 24 and 34 weeks of gestation, we recommend continuous monitoring with strong consideration of urgent cesarean delivery should significant fetal heart rate abnormalities (bradycardia, recurrent late decelerations, sinusoidal fetal heart rate tracing) occur. After 34 weeks of gestation, we recommend proceeding with cesarean delivery if bleeding occurs.

**DElIVERY**

There is consensus that any unprotected vessels within 2 cm of the internal os meet the definition of vasa previa and requires cesarean delivery. As described, we recommend that, if there are any unprotected vessels between a 2-cm and 5-cm radius of the internal os, the patient should be counseled thoroughly about the potential risks of rupture and given the option of cesarean delivery. If vaginal delivery is attempted when unprotected fetal vessels lie between 2 and 5 cm of the internal os, we recommend that the patient should be monitored continuously during labor and should deliver in a center with the ability to perform an immediate cesarean delivery if the vessels should rupture and with adequate neonatal care facilities. In addition, the neonatologists should be informed and be prepared for a possible transfusion in the delivery room. In patients in whom there is complete resolution of a vasa previa (fetal vessels greater than 5 cm from the internal os), we recommend routine labor care with continuous monitoring.

**Management of Undiagnosed Vasa Previa in Labor**

Unfortunately, in cases of vasa previa not diagnosed prenantly, the most common presentation will occur during labor, when the membranes rupture and there are associated vaginal bleeding and fetal heart rate abnormalities—typically bradycardia, late decelerations, or a sinusoidal fetal heart rate pattern (Fig. 3). Prompt recognition of these signs is essential, and immediate cesarean delivery is indicated. The neonatal team should be called urgently to the operating room, and there should be preparation for immediate volume replacement and transfusion. Aggressive resuscitation of the neonate in the delivery room may be lifesaving. However, even with aggressive management, there remains a significant risk of hypovolemic and hypoxemic injury to the neonate, with an attendant risk of neurodevelopmental impairment.

**Timing of Delivery**

Timing of delivery with prenatally diagnosed vasa previa involves carefully balancing the risks of vessel rupture with possible fetal exsanguination against those of prematurity. The majority of the risk occurs in labor or when the membranes rupture; therefore, cesarean delivery should occur before labor or rupture of the membranes. However, recommendations for specific delivery timing are based on limited data and rely on expert opinion. The SMFM recommends delivery between 34 and 37 weeks of gestation.

Early reports of prenatal diagnosis were accompanied by recommendations for cesarean delivery at about 37 weeks of gestation. In a study of 155 patients with vasa previa that compared outcomes between survivors and nonsurvivors, the mean gestational age at delivery of nonsurvivors was 37.6 ± 3 weeks compared with 35.6 ± 2.6 weeks in survivors. On the basis of this study, 35–36 weeks of gestation was suggested by the authors as an optimal age for delivery. However, as experience has increased, it has become obvious that neonates born after a prenatal diagnosis of vasa previa have high rates of neonatal complications attributable to early delivery. A decision analysis by Robinson and Grobman recommended scheduled cesarean delivery at 34 weeks of gestation as the preferred strategy. In a single-center study of 59 patients with vasa previa, 40

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delivered before 36 weeks of gestation and 19 delivered at or after 36 weeks; there were improved neonatal outcomes in those who delivered at or after 36 weeks with no increase in adverse outcomes. In addition, a recent international systematic review and meta-analysis of aggregate data by Mitchell et al found that 36–37 weeks appeared to be the gestational age at which scheduled cesarean delivery was associated with the best outcomes in asymptomatic patients with prenatally diagnosed vasa previa without an increase in adverse outcomes.

It is important to note that many of the recommendations for early delivery at 34 weeks of gestation were made before the recognition of the adverse effects of late preterm deliveries. On the basis of what is now known, we recommend delivery at 36–37 weeks of gestation in asymptomatic patients without risk factors. However, timing of delivery should be individualized in patients with risk factors such as history of preterm delivery, preterm labor in the current pregnancy, short cervix, or multifetal gestations. We do not recommend amniocentesis for demonstration of lung maturity before delivery.

Surgical Techniques for Delivery
Patients with prenatally diagnosed vasa previa should deliver by scheduled cesarean before labor or rupture of the membranes. A lower-segment transverse uterine incision is appropriate in most cases; a diagnosis of vasa previa alone is not an indication for classic cesarean delivery. At cesarean delivery, if care is not taken, fetal vessels may be transected, leading to fetal anemia, hypovolemia, and need for neonatal transfusions. The exposed fetal vessels frequently run in the membranes in the anterior aspect of the uterus, are often in the path of the uterine incision, and will be easily transected if care is not taken. Some have advocated preoperative ultrasound mapping of the fetal vessels. However, this can be difficult, and the person who performs the ultrasonogram is frequently not the person who performs the surgery, making this of questionable value. For this reason, we suggest making the lower-segment transverse uterine incision carefully in the midline, avoiding incising the membranes, and then extending the uterine incision laterally bluntly to expose the amniotic sac and the intact vessels. The incision can then be made in the membranes, avoiding these vessels. Alternatively, it has been proposed to deliver the neonate en caul with intact membranes and rupture the membranes after the neonate is delivered (Fig. 8).

We suggest that after delivery in all cases of prenatally diagnosed vasa previa or those suspected during labor, the placenta be thoroughly examined and photographed and the description of the placenta be documented in the medical record. Photography of the gross placental specimen after delivery may be the only way to clearly document the diagnosis. Included in the description should be whether there were velamentous vessels and what type (arteries or veins), the presence of accessory lobes, and whether any vessels appeared ruptured. In addition, we recommend that the placentas be sent to pathology.

TWIN PREGNANCIES
Few studies have specifically addressed vasa previa in twins. Because of the increased risk for preterm birth in twins, regardless of chorionicity, and therefore higher risk of rupture of membranes or vessels and of fetal death, more vigilance is required than in singleton gestations, and hospitalization may need to be offered more readily. A large cohort study of prenatally diagnosed vasa previa found that twin gestations were nearly three times as likely to require unscheduled delivery as singleton gestations (73.3% vs 25.2%, \( P < .001 \)). In monochorionic twins specifically, death of one twin often leads to hypoxic or hypovolemic brain injury to the surviving twin. Thus, in monochorionic twins, it is preferable to err on the side of caution to prevent the death of a twin. In vaginal delivery of twins (monochorionic or dichorionic), after delivery of the presenting twin, the amniotic sac of the second twin may descend over the cervix; if there is a velamentous insertion of that twin, that may become a vasa previa at cesarean delivery. The neonate’s head is being delivered, still covered in the membranes, and large fetal vessels can be seen running through the membranes over the head.

Fig. 8. Vasa previa at cesarean delivery. The neonate’s head is being delivered, still covered in the membranes, and large fetal vessels can be seen running through the membranes over the head.
previa.104 For this reason, caution and close monitoring are recommended in vaginal delivery of a second twin who has a velamentous cord insertion.

INNOVATIVE THERAPIES UNDER INVESTIGATION

Fetoscopic Laser Ablation

Fetoscopic laser ablation of the unprotected fetal vessels has been proposed as a potential in utero treatment for vasa previa.105–109 Proposed benefits include avoiding hospitalization and allowing a vaginal delivery at term, circumventing the late preterm cesarean delivery that is typically performed for vasa previa.105 This therapy can only be performed in type 2 and 3 vasa previa.

Quintero et al106 were the first to publish a report describing fetoscopic laser ablation of vasa previa in 2007. In the earliest reports, procedures were uncomplicated and performed between 22 and 33 weeks of gestation.106 However, although neonatal outcomes were good, preterm delivery frequently occurred after rupture of membranes.106 Johnston et al108 in 2014 first reported a case of successful vaginal delivery at term after fetoscopic laser ablation for vasa previa. Subsequently, Chmait et al109 reported their experience with successfully performing laser ablation in 10 patients, again with no periopeative complications. Nine patients were managed as outpatients after the procedure. In 2010, this team changed their protocol to performing the laser ablation at 31 weeks of gestation or later to minimize the risk for neonatal morbidity if preterm delivery were to result from a complication of the procedure.109 In the five patients with singleton pregnancies who underwent laser ablation after the protocol change, the mean gestational age at surgery was 32.5±0.8 weeks and the mean gestational age at delivery was 38.1±1.4 weeks.109 Vaginal delivery occurred in all cases, with a mean birth weight of 2,965±596 g and no neonatal intensive care unit admissions.109 Thus, as experience with fetoscopic laser ablation of vasa previa has grown, the results suggest that the objectives of avoiding hospitalization, prolonging gestation, and allowing vaginal delivery without any increase in adverse outcomes may be met and that laser ablation, especially when performed at approximately 32 weeks of gestation, may have promise in the management of selected cases of vasa previa.106,109 However, the numbers treated with this procedure remain small, and more data are needed to confirm the safety of fetoscopic laser ablation for vasa previa.

Fetoscopic laser ablation at the advanced gestational age of 32 weeks may be technically difficult. Furthermore, the procedure has potential risks, including rupture of the membranes, preterm delivery, infection, and abruption, as well as fetal exsanguination, which may lead to fetal loss. In addition, ablating vessels leads to some loss of varying amounts of placenta, and the effects of this placental loss on the short-term and long-term development of the fetus and infant are unknown. For these reasons, laser ablation of vasa previa, although promising, should be considered experimental and of questionable benefit and should be performed only under an IRB-approved research protocol and only by experts with extensive experience with operative fetoscopy. Thorough patient counseling and informed consent are essential if laser ablation for vasa previa is performed.

KNOWLEDGE GAPS

Although our knowledge about vasa previa has increased over the past 20 years, significant knowledge gaps remain. The actual prevalence of vasa previa remains elusive, as does the true mortality rate from undiagnosed vasa previa. Furthermore, significant questions remain about the optimal management of the condition, including the distance of vessels from the os at which a vaginal delivery may be considered. The rarity of vasa previa and the potential catastrophic consequences of the condition make it difficult to study; it is unlikely that adequately powered randomized controlled trials will ever be conducted. Therefore, expert opinion may help guide the diagnosis and management of vasa previa. There is currently a Delphi study by international vasa previa experts underway with the aim of arriving at consensus in the diagnosis and management of the condition. Further studies are being carried out to assess the role of fetoscopic laser ablation for selected cases of vasa previa. Finally, a registry of cases of vasa previa with management strategies and outcomes may help improve our knowledge of this condition.

CONCLUSION

Vasa previa, although a relatively rare condition, carries a high risk for perinatal death and other adverse outcomes when not diagnosed prenatally. Poor perinatal outcomes resulting from vasa previa are almost entirely avoidable. In few other conditions does prenatal diagnosis make such a difference between survival and death.7,48,49,67 Although reduction of stillbirth is an important health care objective, few causes of stillbirth are as preventable as a ruptured vasa previa.7 It is
Therefore important that all those caring for pregnant individuals, particularly those who perform ultrasonography in pregnancy, are aware of this condition. Our opinion is that, in all pregnancies, at the time of the second-trimester anatomy scan, the placental cord insertion should be identified when possible and a Doppler sweep of the region over the cervix should be performed.\(^5\) In addition, a transvaginal ultrasonogram with Doppler should be performed at 32 weeks of gestation in cases of second-trimester placenta previa or low-lying placenta.\(^5\) At present, only prenatal diagnosis and cesarean delivery before rupture of the membranes or labor have been shown to improve outcomes. Although other interventions such as routine hospitalization have been recommended by some, we suggest that decisions regarding care be individualized and based on shared decision making. Recognition of the significance of this condition and prenatal screening will ensure good outcomes in most cases of vasa previa.

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