REVIEW ARTICLE

The Role of Ultrasound in Obstetric Hemorrhage

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Abstract

Ultrasound assists in the diagnosis and management of obstetric hemorrhage. With improving technology and increasing availability, there has been a decreased morbidity and mortality from obstetric hemorrhage due to ectopic pregnancy, vasa previa and abnormal placentation. There is also theoretic benefit for the use of ultrasound in less common conditions such as uterine varix. The goal of this article is to review the common causes of obstetric hemorrhage; to review the ultrasound findings in these causes; and to discuss the intraoperative use of ultrasound in the treatment of obstetric hemorrhage.

Objectives

- Review common causes of obstetric hemorrhage
- Review the ultrasound findings of these causes
- Discuss the role of ultrasound during procedures for obstetric hemorrhage

Keywords: Obstetric hemorrhage, ultrasound, placenta.

INTRODUCTION

Obstetric hemorrhage is one of the leading causes of maternal mortality (within 42 days of birth) worldwide accounting for 25 to 30% of maternal deaths. Maternal mortality due to hemorrhage in the early antepartum period is attributed mainly to ectopic pregnancies, molar pregnancies and abortions. The rate of death per 100,000 live births from 1974 to 1978 was 2.1 and from 1979 to 1992 decreased to 1.3. It is reasonable to assume that improved diagnosis using such modalities as ultrasound has decreased maternal mortality.[1,2]

Obstetric hemorrhage is a common and often daunting clinical emergency. In the late antepartum obstetric hemorrhage complicates 2 to 5% of all pregnancies with, and abruption accounts for approximately, 18.5% of all cases of obstetric hemorrhage.[3]

Fetal outcome is also affected by obstetric hemorrhage. For example, in maternal hemorrhage resulting in maternal death, a live birth occurs only 56% of the time.

A stillbirth occurs 16% of the time, and 6.3% of women die undelivered.[4]

For aid in ultrasound and clinical diagnosis it is useful to break the causes of obstetric hemorrhage into groups by time in gestation when they occur, such as early and late antepartum and postpartum periods (Table 1).

Table 1: Common causes of obstetric hemorrhage by stage of pregnancy (causes discussed in this article are highlighted)

	Early	*Late*
Antepartum	• Ectopic pregnancy • Molar pregnancy • Abortion (medical or spontaneous)	• Placental abruption • Placenta previa
Postpartum	• Uterine atony • Myomas • Retained products • Invasive placentation • Uterine rupture • Uterine inversion • Coagulopathy • Lacerations of genital tract – Lower and upper	• Infection • Retained products • Subinvolution of placental site • Coagulopathy • Uterine varix

This article will review some of the common causes of obstetric hemorrhage, other than ectopic pregnancy, with emphasis on those causes that can be diagnosed and/or managed with help of ultrasound imaging.

UTERINE ATONY

Uterine atony or the inability for the myometrium to contract after delivery of the placenta is perhaps the most common cause of obstetric hemorrhage.[2] Because 300 to 600 cc/min of blood circulates through a term gravid uterus which is 2 to 17% of the maternal cardiac output, uterine atony is

a clinical emergency and if not treated immediately can lead to death.[5,6] In certain instances, ultrasound can help to predict women at risk for uterine atony such as myomas, retained placental tissue and abnormal placentation.

MYOMAS

Myomas can be recognized with ultrasound in 10.7% off all pregnancy with rates as high as 18% in African American women.[7] There is an increased risk of postpartum hemorrhage regardless of size. Qidwai et al demonstrated that from 1993 to 2003, 15,104 women underwent routine second trimester prenatal ultrasonography, and only 401 (2.7%) women were identified with at least 1 leiomyoma. However, this group of women had an odds ration of 2.57 (95% CI 1.54 to 4.27) risk of obstetric hemorrhage.[8-11]

More rare complications of myomas in pregnancy include spontaneous hemoperitoneums and hypovolemic shock to massive edema of a pedunculated myoma.[12,13]

RETAINED PRODUCTS

It is important to remember that the clinical history is extremely important when interpreting the ultrasound images of retained products (usually placental), as the sensitivity and positive predictive value of ultrasound can be marginal. Retained products should be considered in instances of persistent bleeding after a spontaneous or induced abortion or a preterm or term delivery. In up to 15% of postpartum uteri, retained products have been observed with ultrasound. When correlated with uterine exploration and curettage, the sensitivity, specificity, positive and negative predictive value of ultrasound in predicting retained products were 44, 92, 58 and 87%, respectively.[14] Echogenic mass seems to be the most common finding immediate postpartum finding in documented retained products (Figure 1), however recent instrumentation can lead to a false positive result, and therefore ultrasound is more reliable prior to instrumentation. The finding with the best negative predictive value was a normal uterine stripe.[14,15]

Succenturiate lobes occur in 10% of placentas, and they are a risk factor for retained placental tissue and obstetric hemorrhage.[16-18] If a succenturiate lobe is not anticipated, what appears to be an intact placenta will lead to the false clinical assumption that the uterus is empty postpartum. On ultrasound, a succenturiate lobe appears a separate placental mass connected to the main placenta by intramembranous vessels (Figure 2). It sometimes look like

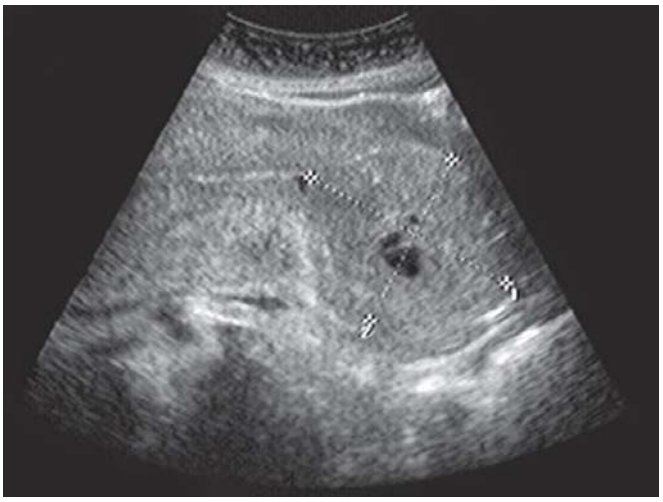

Figure 1: Retained placental tissue after term delivery

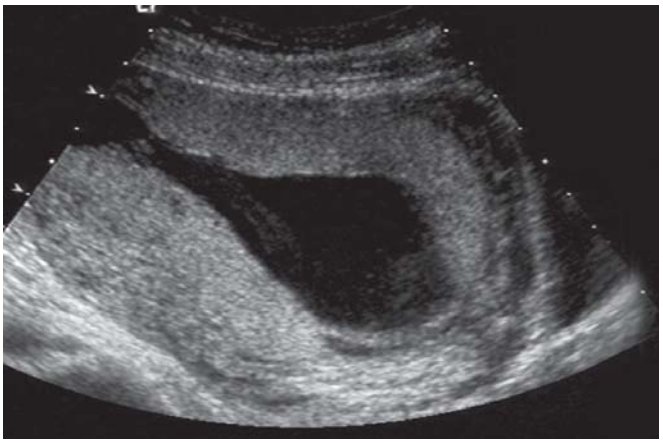

Figure 2: Succenturiate placental lobe

a placental abruption and can be confused with a myometrial contraction or even a placental infarction.[19] Succenturiate lobes have also been associated with artificial reproductive technologies.[18] When a succenturiate lobe is identified it should prompt evaluation for possible vasa previa.[16,18,20-28]

VASA PREVIA

Vasa previa is defined as fetal vessels traversing the fetal membranes free of placental tissue in the lower uterine segment near the internal cervical os. Vasa previa occurs in approximately 1:3000 births. There is a high fetal mortality (22 to 100%) associated with vasa previa resulting in vessel rupture and fetal exsanguination.[29-31] The advent of transvaginal imaging and doppler technologies have improved the diagnosis of vasa previa and thereby decreased but not eliminated the high morbidity and mortality. Doppler

waveform can be crucial in identifying fetal vessel waveforms. One of the pitfalls of diagnosing a vasa previa is differentiating between a free-floating loop of umbilical cord. It is important to document that the suspect fetal vessels do not move with fetal position change and that they persist on subsequent exams and are not surrounded by amniotic fluid. Succenturiate lobes, low-lying placentas, bilobate placentas and velamentous cord insertion are risk factors. These risks should prompt mapping of the placental cord insertion and the use of transvaginal doppler mapping if a vasa previa is suspected.[20-26,29,30,32]

PLACENTA PREVIA AND LOW-LYING PLACENTA

Placenta previa occurs in approximately 0.5% all pregnancies but is seen in 4% ultrasound done in the second trimester.[33, 34] Approximately, 85% of previas diagnosed in the second trimester "resolve" by the time of delivery probably due to the expansion of the lower uterine segment increasing the distance from the placental edge to the internal os. Placental infarction has also been attributed to the resolution of placenta previas. Risk factors for placenta previa include age, parity, previous cesarean, smoking, and prior abortion. Ultrasound was first used to diagnose placenta previa in 1966.[35] Transabdominal imaging has a 2 to 7% false-positive and 2 to 8% false-negative and transvaginal imaging has a false positive and false-negative rate of approximately 1 to 2%.[36-41] Transperineal and transrectal ultrasonography have also been used successfully in diagnosing placental previa.[36, 42, 43] When imaging the placental edge it is important to have the endocervical stripe visualized and if possible some amniotic fluid for contrast between the internal cervical os and the presenting fetal part. An overdistended maternal bladder or a contraction in the lower uterine segment can leave to false positive findings.

Placenta previas have been categorized into both clinical and ultrasonographic classifications. The terms of marginal versus partial were a traditionally clinical diagnosis used at the time of a "double set up" manual exam after cervical dilation while in labor. This terminology has changed with the refinement of ultrasound. If the leading edge of the placenta in relation to the internal os >2 cm this is not a previa. If the placenta covers the os it is termed a complete previa. A "low-lying" should be described in terms of centimeters from the internal os because of the varied clinical outcomes. For example, most recent studies suggest that if the distance to the os is < 1 cm treat, then the pregnancy should be treated as a previa with a planned cesarean delivery. At 1 to 2 cm from the internal os there is a more debatable risk of cesarean secondary to hemorrhage which is anywhere from 23.5 to 90%.[33,44,45] Other studies have shown no correlation between clinical outcome and placental edge to internal cervical os distance.[46]

PLACENTA ACCRETA

Placenta accreta, increta and percreta represent a spectrum of invasive placentations that do not respect the myometrial border. These types of invasive placentations are associated with a maternal mortality quoted as high as 7 to 15% and a transfusion rate as high as 90%. Depth of invasion has an important influence on maternal morbidity and clinical management. Accreta occurs in 78% of cases and is defined as placental invasion through the Stratum Basalis of the endometrium and approximating the myometrium. Increta occurs in 17% of cases and is defined as placental invasion into the myometrium. Percreta occurs in 5% of cases and is defined as placental invasion through the myometrium and into or past the serosa.

Prenatal diagnosis of invasive implantation can reduce maternal morbidity and mortality.[47-51] Ultrasound is typically 89 to 93% sensitive in detecting placenta accreta in high-risk women.[52,53] Common ultrasound findings are a disrupted placenta-myometrial interface, myometrial thickness < 1 mm, cystic lacunae and hypervascularity of bladder and uterine serosa (Figure 3), prominent subplacental venous complex; loss of subplacental doppler signals, and a tissue mass outside the uterus.[47,53,54] Ultrasound is still considered the first line imaging modality to detect placenta accreta. However, MRI is increasing in popularity as expertise with MRI in obstetrics is increasing. At this time

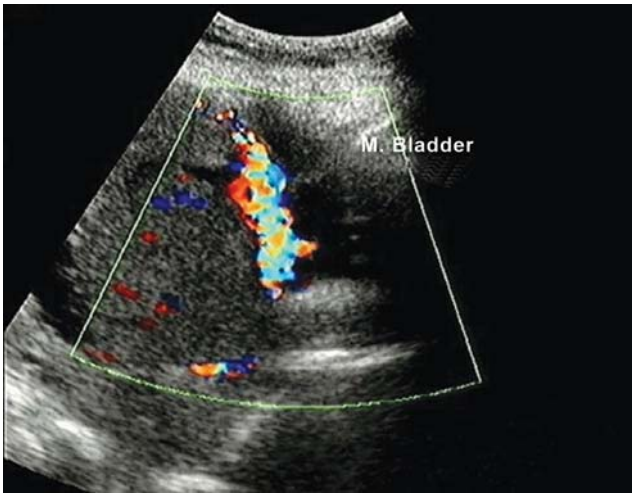

Figure 3: Doppler used to visualize hypervascularity with bladder wall invasion by a placenta percreta

there is no clear cut evidence that supports the use of MRI over ultrasound in the diagnosis of placenta accreta.[51,52,54,55] Personal experience suggests that MRI may have some benefit in diagnosing and describing suspected posterior accretas or lateral percretas.

Use of MRI has been helpful in some hands. MRI's accuracy rate varies from 38 to 97%. This may be due to the varied experience of the radiologist interpreting the images. Typically, MRI's best detection rate is for posterior increta and percretas.

PLACENTAL ABRUPTION

Clinically evident placental abruption occurs in approximately 0.6 to 1.7% of all pregnancies and occurs most commonly at the placental edge.[56-60] Although, ultrasound is a useful tool in detecting placental abruptions and predicting clinical outcome, ultrasound should not to be relied on in basing clinical decisions. Hemorrhage due to placental abruption may cause significant clinical impact without any retroplacental clot visualized by transabdominal or transplacental ultrasound. Detection of a retroplacental clot is variable and has been estimated at any where from 11 to 80%.[60-67] The positive predictive value of ultrasound to diagnose abruption is much higher than the relatively poor predictive value of ultrasound, 88% and 53% respectively.[63] The ability to detect placental abruption with ultrasound depends on the location, size and the age of the abruption. Nyberg and associates described the ultrasonographic appearance of acute and chronic abruptions in a retrospective cohort of 57 cases. Although, abruption may just appears as a heterogeneous and thickened placenta, they found that

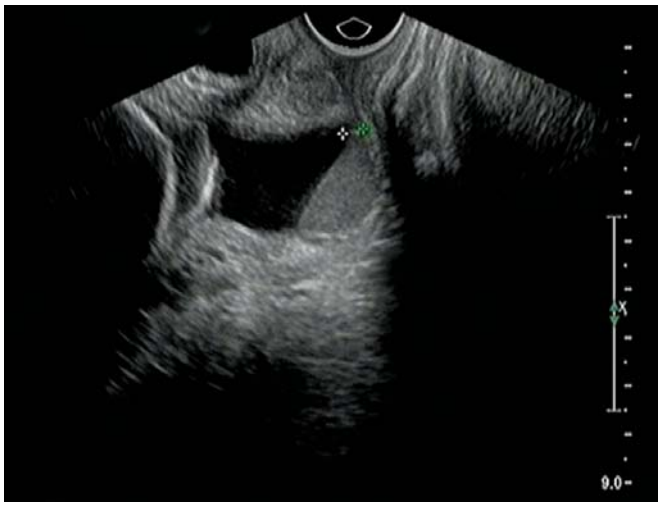

Figure 4: Hyperechoic blood collection near the internal os

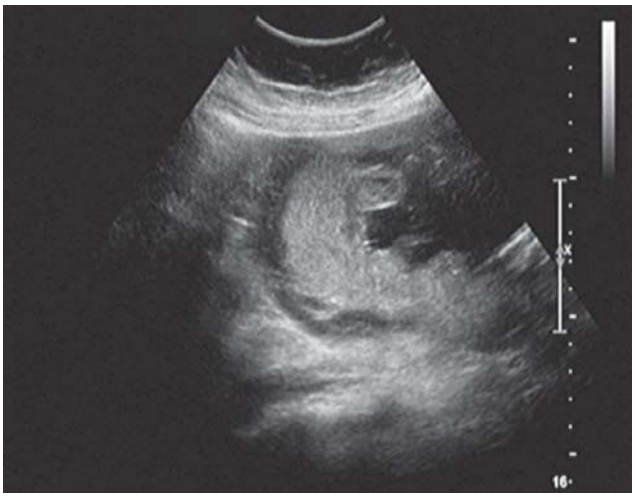

Figure 5: Retroplacental hypoechoic clot

in the acute phase the abruption was typically hyperechoic (0 to 48 hours duration) (Figure 4) or isoechoic (3 to 7 days duration) in relation to the placenta. After one week duration the abruption was hypoechoic (Figure 5) and after 2 weeks the abruption was typically sonolucent.[64] The volume (> 60 ml) and location (retroplacental) of the abruption and percent (30 to 40%) of the placental surface involved in the abruption has also been found to negatively correlate with fetal mortality and morbidity such as intrauterine growth restriction.[68]

UTERINE RUPTURE

The diagnosis of uterine rupture is primarily clinical.[69] It is often based on historical risk factors, abdominal pain, and a change in fetal station, uterine bleeding, and fetal intolerance of labor. However, ultrasound can be useful as a supportive tool. It can be used to visualize a hemoperitoneum, check for fetal location, visualization of a prior uterine scar with absence of myometrium and possibly a bulging amniotic sac.[70-75] Ultrasound has also been used to predict women at risk for uterine rupture or dehiscence after prior cesarean birth with varying degrees of success.[76-78] On average the average full lower uterine segment (LUS) thickness (defined as the shortest distance between the urinary bladder wall-myometrium interface and the myometrium/chorioamniotic membrane-amniotic fluid interface) in women with a prior cesarean delivery is 1.8 to 2.8 mm.[76,78] Cheung and associates demonstrated that a sonographic LUS thickness of 1.5 mm had a sensitivity of 88.9%, a specificity of 59.5%, a positive predictive value of 32.0%, and a negative

predictive value of 96.2% in predicting a paper-thin or dehisced LUS.[78] Bujold and associates demonstrated that only full LUS thickness (OR, 4.66; 95% confidence interval, 1.04-20.91) *vs* just the myometrial thickness were predictive of uterine rupture. In this study a short interdelivery interval (<18 months) and a single layer closure were also associated with uterine rupture and dehiscence.[76] Transvaginal measurements of the lower uterine segment thickness have been found to be superior.[79]

MOLAR PREGNANCY

Molar pregnancy is a potential cause of obstetric hemorrhage in the first and/or early second trimester. It occurs approximately 1:1000 pregnancies. Rarely a molar pregnancy can coexist with a live pregnancy, and this occurs in 1:20,000-100,000 pregnancies (Figure 6). Clinical symptoms associated with molar pregnancies include hyperemesis, thyrotoxicosis and hypertension.[80-85] Clinical signs include bleeding, uterine enlargement and theca-lutein cysts. Vesicles may be observed being passed from the vagina.

There are two different types of molar pregnancies, complete and partial, with different ultrasound findings and varied clinical courses.[86, 87] Complete moles are diploid (paternal origin). 90% of partial moles are triploid. Diandric partial moles (two sets of paternal chromosomes) usually have a thicker placenta and the digynic partial moles (two sets of maternal chromosomes) appear to have a more normal placenta and often do not develop vesicles until later in the first trimester.

The classic finding is hydropic vesicles often described as a "snow storm" appearance and more common in the complete molar pregnancies. Other supportive findings on ultrasound include an echogenic placental mass, theca-lutein cysts and the absence of a gestational sac with an increasing placental mass and rising hCG levels. When a fetus exists in partial molar pregnancies they are often incomplete or severely growth retarded.[88-94] Because molar pregnancies change appearance with time as the hydropic vesicles become more obvious, ultrasound becomes less sensitive the earlier it is performed in pregnancy.[95] Overall sensitivity of transvaginal ultrasound in diagnosing molar pregnancy is 50 to 86% with the increased sensitivity for complete molar pregnancy of approximately 80% *vs* for partial molar pregnancy of approximately 30%.[94, 96, 97] Doppler has also been used with some limited success in determining which postpartum women will progress to have gestational trophoblastic neoplastic disease.[98, 99]

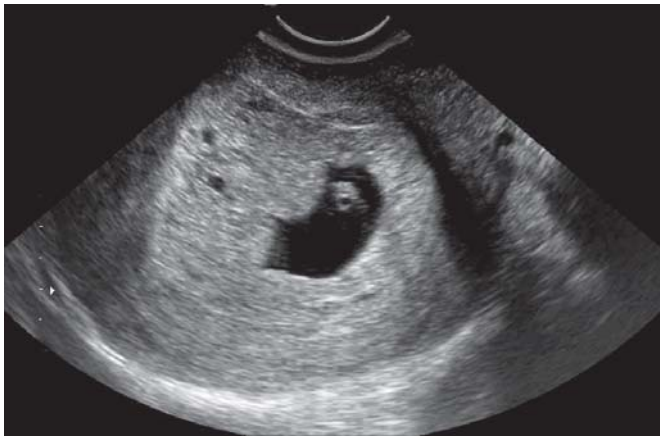

Figure 6: An incomplete mole with embryonic tissue

UTERINE VARIX

A rare but clinically challenging cause of delayed postpartum hemorrhage is the uterine varix or arterio-venous malformation (AVM). Typically these lesions occur after a cesarean or postpartum curettage, and they present as recurrent heavy vaginal bleeding that does not respond to medical therapy.[100-105] Ultrasound with color and duplex doppler technology can be essential in the diagnosis of this rare disorder. Pseudoaneurysms, often demonstrate a blood-filled cystic structure with swirling arterial flow. AVMs often demonstrate intense vascular tangle on color Doppler and low-resistance and high-velocity arterial flow on duplex doppler. AVMs combined with a pseudoaneurysm demonstrate the findings of both AVMs and pseudo-aneurysms.[104]

CONCLUSION

Ultrasound has been used since 1966 to help diagnose causes of obstetric hemorrhage.[35] Although ectopic pregnancy is one of the most common clinical problems resulting in obstetric hemorrhage, there are many other diagnoses that contribute to the overall maternal morbidity and mortality due to obstetric hemorrhage. In this article we have reviewed some common and rare causes of obstetric hemorrhage that can be diagnosed and managed with ultrasound. In some instances such as previa sensitivity can be as high as 98% and in others as low as 30% (partial molar pregnancy), but in all instances ultrasound has the potential to reduce morbidity and improve outcome. When the problem of obstetric hemorrhage presents to the clinician in any trimester or in the postpartum period, a thorough transvaginal and

transabdominal ultrasound exam with Doppler technology should be undertaken with the knowledge of ultrasound's strengths and limitations. Often recurrent ultrasound exams may be required to secure a diagnosis as in vasa previa, molar pregnancy, myomas and uterine wall thickness.

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