Obstetric Ultrasound: Artistry in Practice

John C. Hobbins, MD
Professor of Obstetrics and Gynecology
University of Colorado Health Sciences Center
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Dedication

I have dedicated this book to three people.

My dad was the ideal role model. He possessed incredible talent, intelligence, integrity, and humility. It has been tough to try to match up to someone who was the total package (although I will bet he never realized it). The description "he speaks softly but carries a big stick" fit him perfectly, except he didn't need a big stick since I toed the line (most of the time) simply because I did not wish to displease him.

The word "artistry" in the book title is not there by accident. My dad, my brother, and one of my sons were/are fine artists by trade, but my very rudimentary talent has been limited to drawing stick figure fetuses during counseling sessions. However, everyone in ultrasound is displaying a form of artistry—artistry in obtaining the information and artistry in putting the information into play.

Thank you, dad, for guiding me every day.

Elaine is one of the most remarkable of the thousands of patients I have had the pleasure of meeting over the past 40 years. She participated fully in her own care, and even provided me with snippets from the literature when I was struggling with her diagnosis. Her remarkable courage, determination, and impressive intellect energized me.

Elaine, this book was written for you and others like you whose fetuses have problems that might be helped by some messages contained within.

Last, I am dedicating this book to my wife, Susan. She has provided much of the inspiration for it.

After spending the first part of my career seeking new—and often invasive—ways to find out more about the fetuses, my energies then turned toward finding noninvasive substitutes. While in that mindset, Susan, a nurse midwife, helped me to further understand that in many ways we, as providers, have a tendency to interfere in what is generally a very natural and normal process. Our "ready, shoot, aim" thinking evolved to help patients, but often it can have the opposite effect. She has stimulated me to try to put the "aim" back in its proper place in the diagnostic sequence.

Susan, I deeply appreciate your support and, recently, your patience with me while I spent hours and hours sitting in front of the computer (yours)—often swearing at my inept attempts to complete the simplest tasks—when we could be playing tennis or doing something infinitely more entertaining.

Thank you for adding so much to my life.

Acknowledgments

For an academic department to be successful, it must have an excellent coordinator. Through the years I have been lucky to have had only five perinatal coordinators—all of them world-class. Jane Berg, who, as well as possessing a myriad of organizational talents, also has the ability to tweak everything possible out of the computer. In addition, she reads at least as much of the perinatal literature as our fellows, and has a "Jeopardy-like" ability to remember even obscure papers.

I know this project has not only tested her above skills, but, at times, her patience, and I am deeply indebted.

Thank you, Jane. It would have been very difficult to pull this off without you.

Wayne Persutte and I have worked together for more than 15 years, and I have thoroughly enjoyed every minute of our hundreds of discussions about ultrasound, sports, and politics. He has been responsible for many of the images in this book, which obviously are essential to the messages within it.

Thank you for everything, Wayne.

Helen MacFarlane provided most of the illustrations for this book. Since this was designed to be a "nuts-and-bolts" type of text, we decided to make the illustrations reflect this concept. Rather than "Netter-like" renditions, we resorted to the simplest of diagrams, and Helen did a remarkable job of following that pathway.

Thank you so much, Helen.

A large "thank you" goes to John Queenan, who has provided the forward to this book. Who better to write this than one of the most respected individuals in OB/GYN?

Many years ago I was an intern in a community hospital in Connecticut and John was on the staff there, as well as being a faculty member at Cornell Medical School in New York City. After watching him in action as a clinician, teacher, and leader in the therapy of Rh disease, I decided I wanted to be him. John, you are one of the 4 individuals who influenced me to do what I do, including writing this book.

Foreword

A medical pundit was once asked, "What are the three greatest advances in obstetrics and gynecology of the last decade?" His answer was swift and definitive: "Ultrasound, ultrasound, ultrasound." While all of us could add to the list, there is little doubt of the primacy of sonography in clinical medicine. This modality has made a profound improvement in the delivery of care in numerous ways: detecting congenital anomalies, early fetal life, and ectopic pregnancies; establishing gestational age; and evaluating fetal condition in Rh disease, multiple gestations or intrauterine growth restriction.

Dr. Hobbins begins this book by presenting a systematic review of the fetal physical exam. In chapter 12 he starts to define the role of sonography in many clinical problems and ends with practical uses of this technology in a changing world. He closes with vintage Hobbins, expounding on various hot topics. The appendix contains his selection of useful clinical tables.

Over the last half decade as the deputy editor of *Obstetrics and Gynecology* I have been immersed in evidence-based scientific manuscripts. While advancing medical knowledge, there is a loss of author's experience and advice in such manuscripts. Enter John C. Hobbins, MD, one of the outstanding teachers and researchers from the onset of clinical sonography, three decades ago. From the start, Dr. Hobbins' skills at scanning were artistry in practice. To me, reading this book is like following Pablo Picasso, Dr. Hobbin's favorite artist, on a personal tour of his gallery. How refreshing to read the thoughts and advice of a world-class expert. In undertaking this project Dr. Hobbins has crafted the book to serve both patients and the medical profession. I believe it fully achieves his mission.

John T. Queenan, MD
Professor of Obstetrics and Gynecology
and Chair Emeritus
Georgetown University Medical Center
Deputy Editor, *Obstetrics and Gynecology*
August 2007

Preface

During the 35 years that I have been immersed in the practice of perinatal medicine, it has been possible to chronicle intimately the evolving role of ultrasound. At first, it was used to answer a few basic questions regarding gestational age, fetal and placental position, and to rule out multiple gestations. Now the modality can unroof the innermost secrets of the fetus through two-dimensional and three-dimensional imagery and Doppler waveform analysis.

In 1977, one of the first books dedicated to ultrasound was written by Fred Winsberg and me. The second edition was coauthored with Richard Berkowitz, one of the great thinkers in the field. Both times, we had difficulty in filling up these thin books with enough information to make them worth selling. At that time, most practitioners were using a "contact scanner" that required the operator to move a small transducer attached to an articulated arm across patient's abdomen in order to create a composite image from data stored during the sweep. The first machine we used at Yale was a surprisingly small unit made by Picker that was donated by a grateful patient of the chairman at that time, C. Lee Buxton, who felt that there might a future for ultrasound in obstetrics and gynecology (after hearing a lecture by the father of obstetrical ultrasound, Ian Donald). Also, his interest was kindled further by Dr Ernest Kohorn, a British transplant in the department who had spent time with Professor Donald.

In 1975, Jim Binns, a young representative from a fledgling company, ADR, stopped by with a small real-time machine that could almost fit in a suitcase. The real-time images springing from this machine had the same wow effect on us that the four-dimensional real-time images from today's machines have on patients, and we instantly *had* to own it. This we accomplished with a check for $20,000. A few years later, this simple linear array technology morphed into the complicated, expensive, and often cumbersome units of today that, fortunately, produce exquisite images. In just a decade, the price of these machines has gone from that of a Mazda Miata to a Lamborghini, and, while during the time it took to reduce the size of a computer to something you can enclose in your hand, many of today's ultrasound machines, which ironically depend heavily on microchip technology, are so heavy that I live in fear that I might accidentally run one over my foot. In addition, because the new machines incorporate many new features to substantially improve the images, some keyboards now look like the instrument panels of a jumbo jet. Also, although companies are constantly striving to make their keyboard the most user-friendly feature ever fashioned, no keyboard is the same—something that is very frustrating to a dyslexic multiple machine-user like me.

What is the point of this stroll down memory lane (which generally produces the same gag reflex as telling a young resident that we used to work every other night)? It is to point out that, while all this was going on, ultrasound has evolved from something that would answer a few clinical questions to a now indispensable tool that plays a major role in every pregnancy. Just like the history of ultrasound technology, which has taken many tangents, the clinical pathway of ultrasound has not always followed a straight-line. However, until the next technological advance sets off a new set of challenges, most of the clinical kinks have been ironed out to a point where a book can now be written to lay out the state of contemporary knowledge in obstetrical ultrasound.

Other than a cursory mention of the past in this introduction, the only historical inserts will be used to dispel a few earlier misconceptions or to do away with some misguided rituals that have crept into ultrasound practice over the past two decades.

In contrast to our first books, the challenge now is to sift through the myriad of available clinical information and to cram selectively the most useful nuggets into this text. The format will be simple, but different than other standard textbooks. While avoiding "text book speak," I will be working backward from a topic by focusing on a specific condition or an initial finding noted during a basic examination and exploring how ultrasound can be used optimally to attain the clinician's goal of arriving upon a diagnosis and activating a plan of management. While attempting to be succinct, I have avoided including voluminous reference sections after each chapter, and have tried to be judiciously selective by citing mostly those papers whose data I have used in the text.

The goal is to inform—but with a heavy dusting of opinion.

John C. Hobbins, MD
February 2007

1 Early pregnancy loss

Most perinatologists deal more frequently with patients during the second portion of the first trimester, and I am no exception. For that reason, while drafting this chapter I needed help with the topics of early pregnancy milestones and the common problem of early first trimester embryonic/fetal loss. After a brief search, I came up with a gem in the form of syllabus material accompanying a superb lecture by Dr Steven Goldstein, given at an ultrasound course. This will be sprinkled throughout this chapter.

Early pregnancy can be divided up into three segments: the pre-embryonic period (conception to 5 menstrual weeks); the embryonic period, during which time organogenesis is the major activity (4–9 menstrual weeks); and the early developmental period, during which time the fetus simply grows while adding to the building blocks formed earlier (10–12 weeks). Not surprisingly, the third segment has been called the fetal period.

Ultrasound milestones

First, it must be stipulated that there is a major difference between when a certain finding *can* appear and when it *should* be present, the latter having more importance in early pregnancy failure. Also, one can identify structures much earlier with transvaginal ultrasound, which has a separate timetable. Frankly, up until the eleventh week, there is little reason to view a first trimester pregnancy with transabdominal ultrasound (TAU) other than as an initial quick scouting venture.

The first ultrasound sign of pregnancy is a gestational sac that is generally oblong and has a thick "rind" (Figure 1.1a). The sac should have a double ring, representing the decidua capsularis and the decidua parietalis, and should be seen when the beta human chorionic gonadotropin (hCG) is between 1000 and 2000 mIU/mL. Once seen, the sac diameter should grow by an average of 1 mm a day, and the mean sac diameter (MSD) can be used as a gauge against which to assess other findings [1]. Beware of the pseudosac, which does not have a double ring and is seen in association with ectopic pregnancy (Figure 1.1b).

The yolk sac is the second structure to be visible by ultrasound (Figure 1.2). It can be seen when the MSD is 5 mm, but it *should* be seen by the time the MSD is 8 mm [2]. It plays a crucial role in the development of the fetus—providing nourishment and producing the stem cells that develop into red blood cells, white blood cells, and platelets. In effect, the yolk sac provides the immunological potential for the fetus until about 7 menstrual weeks, when those functions are taken over by the fetal liver. From then on the functionless yolk sac becomes a circular structure without a core, after which it finally disappears by 12 menstrual weeks.

After about 8 weeks, the yolk sac has little diagnostic value and, although some studies have suggested that a macro yolk sac (more than 6 mm) is an ominous sign, our own observations have not borne this out. We have noted a "filled in" yolk sac (Figure 1.3) to be sometimes associated with fetal demise, but in these cases the embryo/fetus provides the ultimate information.

One can see an embryo by 5 menstrual weeks and a way to determine gestational age is to add 42 days to the crown–rump length (CRL) measurement in millimeters. The embryo should increase its CRL by 1 mm/d. Not seeing an embryo when the MSD has reached 6 mm is indicative of a pregnancy loss [3]. Also, the size of the embryo, relative to the MSD, is important. For example, if the MSD–CRL is <6 mm, the prognosis is very poor.

Cardiac activity should be visualized when the embryonic length is greater than or equal to 4 mm, and not seeing a beating heart at this embryonic size is an ominous sign [4]. The heart rate itself may provide insight into the fate of the pregnancy. For example, Benson and Doubilet [5] noted that if the heart rate (HR) was less than

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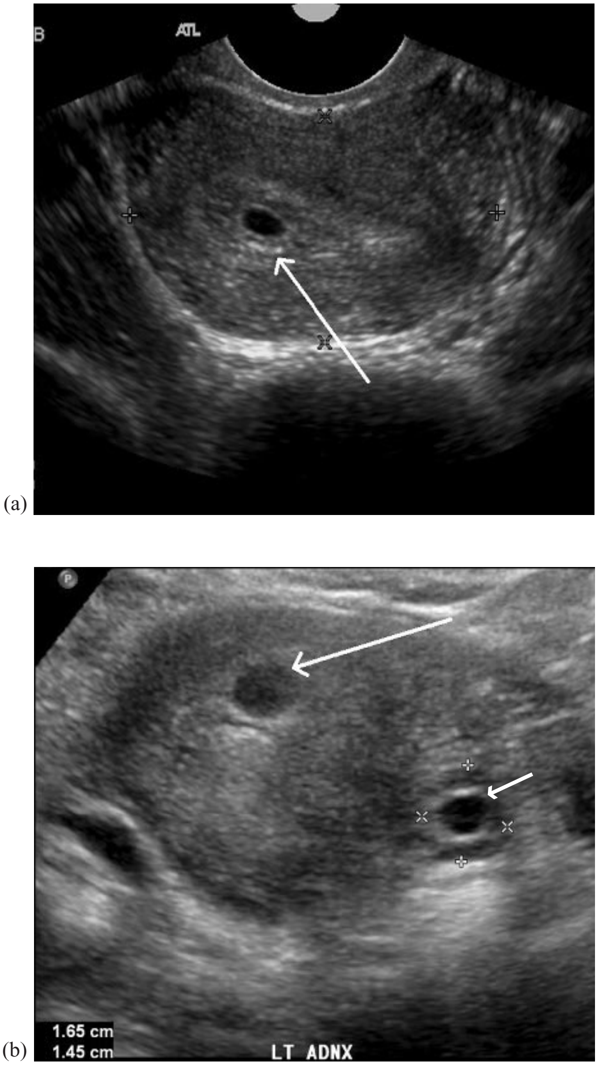
ATL
B
(a)
1.65 cm
1.45 cm
LT ADNX
(b)

Fig 1.1 (a) Early gestational sac. (b) Ectopic. Large arrow points to pseudosac. Small arrow points to ectopic next to uterus.

90 in pregnancies that were less than 8 weeks, there was an 80% chance of fetal death. If the HR was below 70, 100% ultimately had an intrauterine demise. Later in the first trimester, fetuses with HR above the 95th percentile have a markedly increased risk for trisomy 13 [6].

Human chorionic gonadotropin (hCG)

This is a product of the placenta that rises linearly throughout the first trimester and decreases through the second trimester. Although various investigators have explored subunits of the hCG molecule in screening for Down syndrome (beta subunit), the assays commonly used today for standard monitoring of early pregnancy measure intact hCG (not beta hCG).

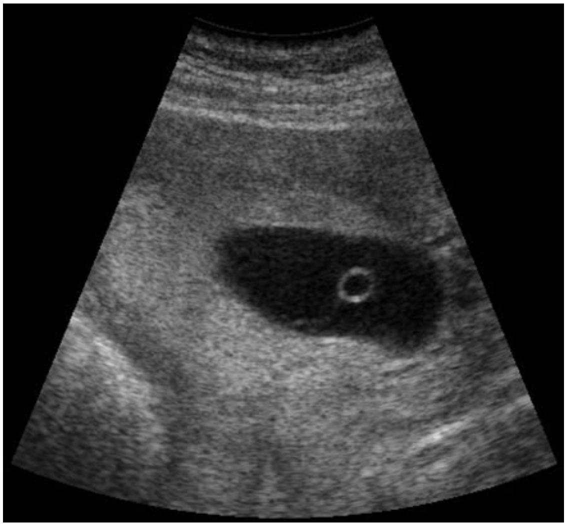

Fig 1.2 Yolk sac.

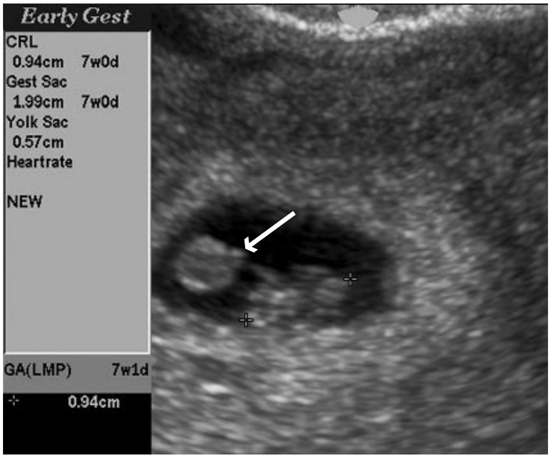
Early Gest
CRL
0.94cm 7w0d
Gest Sac
1.99cm 7w0d
Yolk Sac
0.57cm
Heartrate
NEW
GA(LMP) 7w1d
0.94cm

Fig 1.3 Filled-in yolk sac; calipers are on CRL and arrow points to yolk sac.

Should see on TVS	Time of visualization
Gestation sac	5 menstrual weeks
Yolk sac	when MSD is >7mm
Embryonic pole	5 weeks or when hCG is >1000 mIU
Fetal heart activity	when CRL is >5 mm

Initially, Kadar et al. [7] described a "discriminatory level," above which one should see an embryo (6500 mμ/mL), to help sort out pregnancy loss from ectopic pregnancy. These initial values were based on TAU and an assay that has been replaced by another (second international standard). The hCG level, above which one should identify an embryo by transvaginal sonography, is now 1000 mIU/mL to 2000 mIU/mL, as determined by the second international standard. In a patient clinically at risk for loss or ectopic pregnancy the ideal diagnostic strategy would be to obtain serial measurements of hCG, the levels of which generally double every 48 hours, but certainly should increase by more than 66% in that time period [8].

The natural progression of early pregnancy loss

A surprising number of pregnancies are lost within days of conception. Thereafter, the loss rate diminishes steeply until the twelfth week of gestation. For example, in one study where daily hCG levels were undertaken postconception, 22% of those pregnancies with an initially positive hCG never developed to a point where ultrasound demonstrated a viable pregnancy [8]. In another study from Australia, serum hCG levels were obtained at 16 days postconception in over 1000 patients having had IVF (in vitro fertilization) [9]. The average level was 182 mIU/mL in those with later pregnancy loss (8–19 weeks), compared with 233 mIU/mL in continuing pregnancies [10]. These data again strongly suggest that the die is cast soon after conception for many pregnancy losses. Below, the chances of a continuing pregnancy are laid out according to the ultrasound findings.

Ultrasound findings

When present	Chances of loss before 12 weeks
Gestational sac only	11.5%
Yolk sac only	8.5%
Embryo <6 mm	7.2%
Embryo between 5–10 mm	3.3%
Embryo >10 mm	0.5%

If first trimester bleeding occurs, the loss rates obviously increase. It has been estimated that about 25% of all patients will have some bleeding or spotting in the first trimester, and in half of these pregnancies a viable fetus will not materialize. The most common reason for early loss is aneuploidy. Ohno [11] found that 69.4% of products of conception from 144 spontaneous abortions yielded abnormal chromosomes, the majority representing trisomies. Also, the overwhelming majority of pregnancies are nonviable many days before vaginal bleeding ensues, and the size of the embryo will provide information as to when demise has occurred.

Ectopic pregnancy

The incidence of ectopic pregnancy is about 20/1000, but those with a past history of ectopic pregnancy have a 10-fold greater risk of this complication. Other predisposing factors include pregnancy by assisted reproductive technology (ART), infertility (in general), advanced maternal age, and cigarette smoking.

Identification rates with ultrasound alone range between 20 and 85% [12]. However, using ultrasound in combination with hCG levels improves the positive predictive value to 95% [13].

Since with transvaginal sonography (TVS) it is sometimes difficult to identify an extrauterine pregnancy, the first diagnostic stop should be the uterus. A true gestation sac should be present when the hCG is >2000 mIU/mL, and, in most cases is present when an hCG is >1000 mIU/mL. In general, hCG rises sluggishly in ectopic pregnancy, rarely ever doubling in 48 hours. However, very occasionally a normal early pregnancy will not meet the criteria for an expected rise. Therefore, if no adnexal mass is seen in a patient with symptoms of an ectopic, and the initial hCG level is between 1000 and 2000, a conservative approach might be warranted. On the other hand, if the hCG level is >2000 and no intrauterine sac is identified in a patient with symptoms of ectopic pregnancy, there is a very high likelihood of an extrauterine pregnancy. Obviously, the ultrasound finding of a fetus in the tube or even an adnexal mass should trump any of the above diagnostic subtleties in a symptomatic patient with a positive pregnancy test.

As indicated above, one can be fooled by the "pseudosac" (Figure 1.1b) that masquerades as a true intrauterine sac. It does not have a double ring and is not seen in conjunction with a yolk sac. Also, seeing an intrauterine sac does not completely rule out a heterotopic pregnancy when conception has been accomplished through ART. The prevalence of heterotopic pregnancy has been cited to be about 1 in 30,000, but with ART it could be as high as 1 in 100.

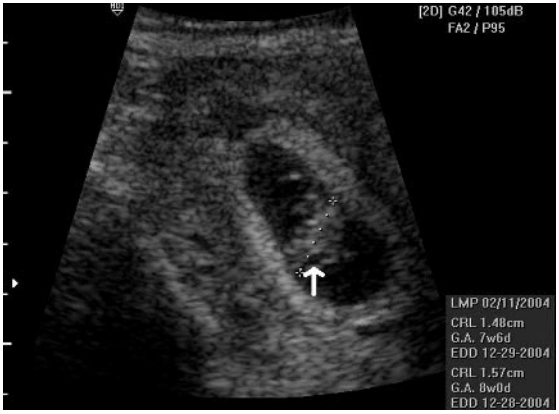
[2D] G42 / 105dB
FA2 / P95
LMP 02/11/2004
CRL 1.48cm
G.A. 7w6d
EDD 12-29-2004
CRL 1.57cm
G.A. 8w0d
EDD 12-28-2004

Fig 1.4 Seven-week embryo. Prominent echo-spared area is marked by an arrow.

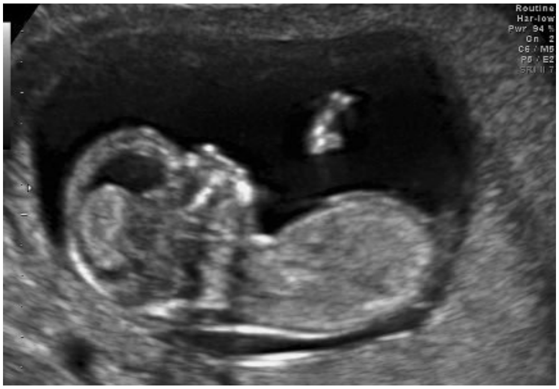
Routine
Har-low
Pwr 94 %
Gn 2
C6 / M5
P5 / E2
SRI II 7

Fig 1.5 Normal first trimester fetus with frontal echo-spared area.

Identification of major fetal abnormalities in the first trimester

In the embryonic stage the organs are just forming so, in general, one must wait until organogenesis is complete and, most importantly, embryos are large enough to visualize, before making diagnostic judgments. An example of an early diagnostic misfire is thinking that an echo-spared structures in the posterior and anterior calvarium (Figures 1.4 and 1.5) before 11 menstrual weeks is an abnormality. With watchful waiting it will become clear that this finding actually represented the normal rhombencephalon that, although visually striking, should not have generated concern.

On occasion, seeing a ventral wall herniation prior to 11 1/2 weeks can raise unwarranted anxiety if one does not realize that this is a normal finding. If the herniation has a wide base, this could represent a true omphalocele, which is, fortunately, a rare finding (Figure 1.6).

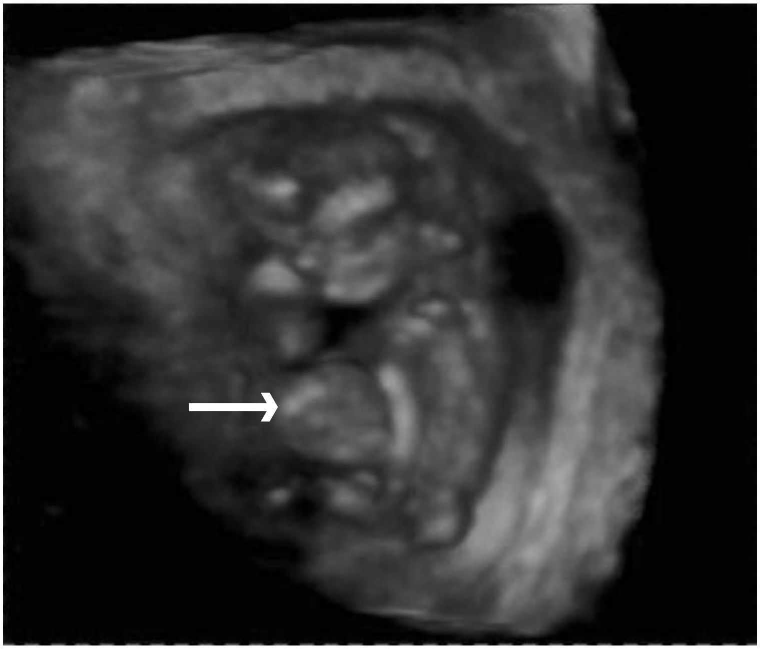

Fig 1.6 3D image of first trimester omphalocele. Arrows points to ventral wall defect.

Table 1.1 Studies in the literature dealing with the identification of anomalies with transvaginal ultrasound. (From Souka AP et al. [14], with permission from Elsevier.)

Author(s)	Population	*N*	Major anomalies (%)	First trimester sensitivity (%)	Total (%)
Hernardi and Torocsik (1997)	Low risk	3991	35 (0.9)	36	72
Economides and Braithwaite (1998)	Low risk	1632	13 (0.8)	54	77
Calvalho et al.	Low risk	2853	66 (2.3)	38	79
Taipale et al.	Low risk	4513	33 (0.7)	18	48
Chen et al.	High risk	1609	26 (1.6)	64	77
Souka et al.	Low risk	1148	14 (1.2)	50	92

Possible false negative observations can also occur. For example, the neural tube closes between 20 and 28 days postconception and a failure of closure early in that window will result in anencephaly. However, since the calvarium is not well mineralized until later in pregnancy, the rudimentary brain will herniate upward and often the fetal cranial pole will appear similar to that of an unaffected fetus. For this reason, in the past a few anencephalic fetuses have evaded diagnosis until after 11 weeks.

In the fetal period, there are now many reports of various fetal abnormalities being identified with 2D and 3D ultrasound, and the nonspecific finding of an increased nuchal translucency (NT) has allowed investigators to search more thoroughly with TVS for anomalies that might ordinarily have been missed.

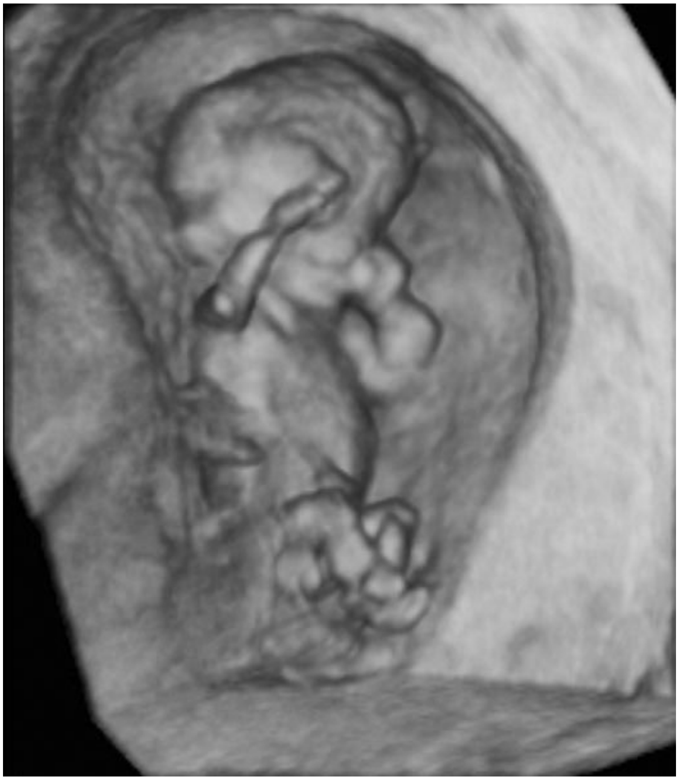

Fig 1.7 First trimester 3D.

Souka et al. [14]. published the results of studies in the literature dealing with the identification of anomalies with transvaginal ultrasound (Table 1.1).

Although 3D ultrasound can provide some beautiful images of the first trimester fetus (Figure 1.7), we utilize this generally useful tool infrequently in the first trimester except to get a better view of the NT when the position of the fetus persistently keeps us from using the necessary midline sagittal approach.

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2

Placenta and umbilical cord

Everyone performing a standard ultrasound evaluation should systematically fulfill the criteria published jointly by the American Institute of Ultrasound in Medicine (AIUM) and the American College of Radiology (ACR). In the first part of this book, dealing with the findings unveiled during this examination, I will discuss each of the eight steps included in the above guidelines. Since each of the first three steps only warrants a few words, I will lump them together in this chapter on the placenta, a topic that deserves substantial attention.

Fetal presentation

The presentation of the fetus has little clinical meaning until the third trimester, when a breech presentation or a transverse lie should alert the clinician to the need for a cesarean section, the option of an external version, or the possibility of a placenta previa.

Very few obstetricians today will attempt to deliver a breech vaginally after a study emerged by Hannah et al. [1] suggesting a higher rate of perinatal mortality and morbidity when infants, presenting as breeches in late gestation, were delivered vaginally, rather than by cesarean section. Seemingly, this has put a permanent nail in the coffin for vaginal delivery in this setting, even though another paper later revealed the flaws in the above study, as well as later prospective studies showing no difference in outcomes between routes of delivery for breeches [2,3].

In the first and second trimester, fetal presentation has little bearing on whether a malpresentation will be found at term.

Fetal number

Looking for more than one fetus is an important 3-second task that has clinical impact, as well as providing insurance against the later embarrassment of someone else finding a missed twin or triplet. The identification of multiple gestations should single out a patient for a specific plan of management that could impact the outcome of pregnancy—as will be discussed in the section on twins.

Fetal life (viability)

I am mystified as to why the common practice today is to document scrupulously with M-mode the presence of a fetal heart rate. If you can see a heartbeat and there is clearly fetal movement, should that not be enough? I guess not, because the current paranoia is that there is always someone lurking in the shadows waiting for a sonographer/sonologist to make a diagnosis of intrauterine demise when there is no demise, or vice versa.

Examination of the placenta

This is a fetal organ, and many, if not most, of the problems fetuses can get into are linked in some way to the placenta. In fact, since early maternal complications, such as preeclampsia, can be directly traced to the placenta, it is surprising that the placenta garners so little attention in most obstetrical textbooks.

Placental position

Determining placental location is a requirement of every set of guidelines for a basic ultrasound examination. Frankly, however, the only real point of interest should be its relationship to the lower uterine segment and cervix. In other words, whether it is anterior, posterior, or fundal has little clinical bearing, as long as it is not within the immediate neighborhood of the cervix.

Let's look at the data in the literature. The incidence of placenta previa at the end of pregnancy is about 2.8/1000. However, it rises with increased parity, approaching 5%

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in patients with five or more pregnancies. The rate of placenta previa is higher in AMA women, in those with twin pregnancies, and in those having had previous cesarean sections. With a cesarean section rate that has risen to 29% in the USA today, we can now expect to see an increase in the prevalence of placenta previa, and with it, an increase in associated complications, such as preterm birth and placenta accreta.

First, a low-lying placenta that is within 2 cm of the cervix (a Williams' textbook definition) should get one's attention, but the likelihood of this placenta remaining in this position is small. For example, about 5% will have a "placenta previa" diagnosed between 10 and 20 weeks, but only 10% of these will remain over, or close to, the endocervix at term [4]. However, if the diagnosis is made at 28 to 31 weeks, 62% will persist, and if found between 32 and 35 weeks, about 75% will remain at delivery.

In placenta previa, the extent to which the placenta overlaps the cervix appears to be extremely important. Studies show that if the placenta extends past the cervix by 1.5 cm in the second trimester, the likelihood of placenta previa at term is about 20% [5]. If the overlap is more than 2.4 cm, then 40% of these will remain [6]. The point is that the glass is more than half full even when the tip of the placenta is clearly over the cervix earlier in pregnancy (Figure 2.1).

Why does the placenta seem to migrate upward as pregnancy progresses? In the first trimester, the lower uterine segment makes up the lower 10% of the uterus. However, into the third trimester about 30% of the uterine volume is occupied by the lower uterine segment. The idea is that the placenta gets passively moved away from the cervix as the segment stretches out.

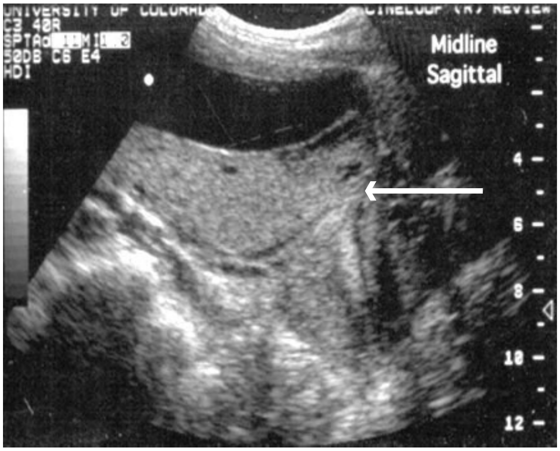

Fig 2.1 Placenta previa-transabdominal scan. Arrow points to endocervix.

Trophotropism [7] is an intriguing concept that also may explain this relative placental migration, and can also explain ectopic or velamentous insertions of the umbilical cord. The theory is that there are some areas within the uterine cavity where the placenta has chosen to alight that may not represent an ideal environment for it to flourish. So the placenta compensates by atrophying in the less hospitable area near or over the cervix, while, at the same time, proliferating northward to a territory that is more accepting. We documented this phenomenon by serial ultrasound examinations on at least two occasions where, with time, the umbilical cord insertion appeared to stay in the same relative position with regard to the cervix, while passively gravitating toward or, actually, onto the placental edge.

The message here is that, whatever the etiology, a majority of placentas initially noted to be in the neighborhood of the cervix will not remain there. If a second trimester patient has no symptoms, and the placenta does not overlap the cervix by more than 1.5 cm, there is no need to alter these patients' lifestyles by instituting "pelvic precautions," or by interdicting travel or exercise. In fact, in these patients we often avoid the use of the word "previa" and simply suggest that they return after 30 weeks for another examination unless there is intervening vaginal bleeding.

In the evaluation of a possible previa in patients with vaginal bleeding, the examination usually starts with a standard transabdominal approach. After identifying its relative location, one can then tell how high in the uterus the placenta starts. If there is any placenta in the vicinity of the fundus, it is unlikely that the placenta will be over the cervix by the end of pregnancy. However, this does not rule out an accessory lobe as a reason for the vaginal bleeding.

The next step is to evaluate the lower uterine segment. If there is truly a placenta previa, then the presenting part of the fetus will always be floating and one can easily move it out of the way so that the area of the endocervix can be examined (Figure 2.2). This should be done with a bladder that is not full because one can artificially create the impression of a low-lying placenta by the bladder compressing the lower uterine segment. The same confusion can also be created by lower uterine segment contractions that are often concentric (Figure 2.3).

The transvaginal examination with the bladder empty represents the best way ultimately to make the diagnosis of placenta previa (Figure 2.4), although the combination of transabdominal ultrasound (TAU) and transvaginal ultrasound (TVS) may be needed to identify an accessory lobe. The crux of this endeavor is to make sure

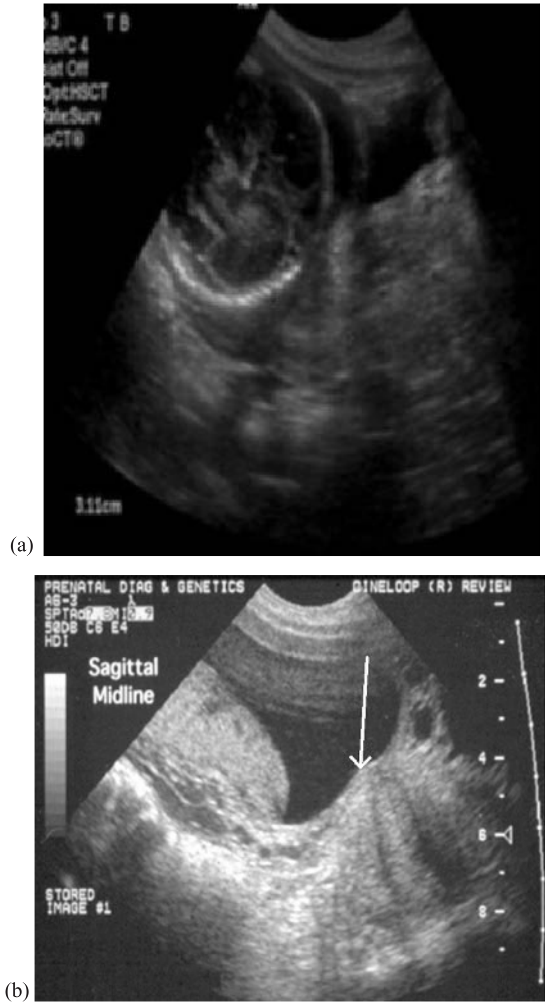

Fig 2.2 (a) Head obscuring view of cervix and placenta. (b) Previa excluded after head removed. Arrow points to endocervix.

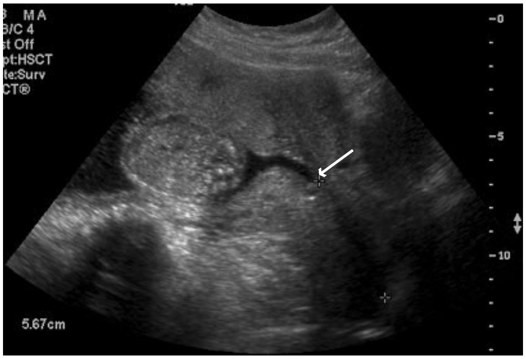

Fig 2.3 Concentric contraction obscuring endocervix. Arrow marks the probable location of the endocervix.

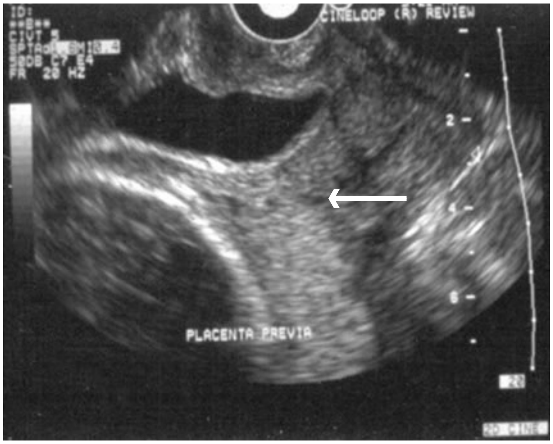

Fig 2.4 Placenta just covering cervix in late gestation by transvaginal scan. Arrow marks endocervix.

nothing—placenta, umbilical cord, or interconnecting vessels to an accessory lobe—is in the vicinity of the cervix.

Some have advocated the use of transperineal ultrasound (TPU) to evaluate the endocervix. Perhaps TPU evolved when clinicians were reluctant to enter the vagina with an ultrasound probe in someone who was bleeding from a possible placenta previa. However, the TVS probe goes in the vagina and not in the cervix and, although TPU can often produce reasonable views of the cervix, it is inferior to TVS in locating the placenta.

A case in point regarding placental position

Patient was sent in for consultation because she was noted to have "placenta previa" at 21 weeks. She reported no bleeding but had been on reduced activity and pelvic precautions, since the diagnosis was made. We found a low-lying posterior placenta that was just touching the endocervix. The cervical length measured at 3.5 cm. We indicated that the chances of her having a placenta previa at term were very small, and that she could return to normal daily activities. However, she should report any vaginal bleeding or spotting.

Our reward was a big box of candy from her husband. The couple had grown tired of their routine daily regimen of abstinence.

Vasa previa

This potentially lethal problem complicates approximately 1 in 2500 pregnancies. One recent study [8] indicates that

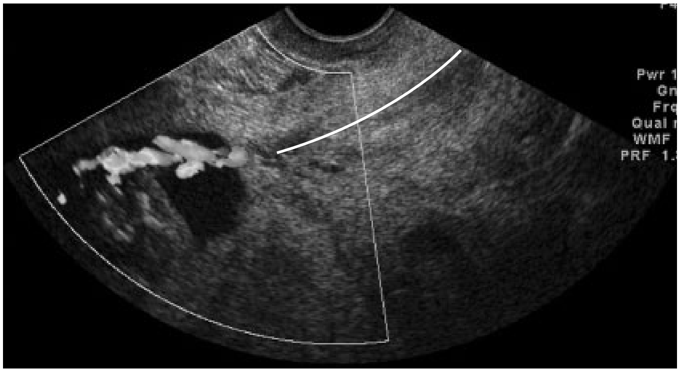

Fig 2.5 Vasa previa. Line marks cervical canal.

if the diagnosis is known prior to delivery, the perinatal survival improves from 44 to 96%.

As suggested above, there are two ways that vasa previa can occur. First, when the connecting vessels from a primary placenta to an accessory lobe course directly over the cervix. Secondly, where a velamentous insertion of the cord resides in the membranes immediately over the cervix. In the latter case, the trophotropism theory of Bernischke fits the clinical picture. Since the vascular environment of the lower uterine segment is poorly suited to support placental development, the placenta preferentially grows superiorly while atrophying inferiorly, leaving the umbilical cord in the same place—over the cervix—but with no cushion of intervening placental tissue (Figures 2.5 and 2.6).

Although standard guidelines for the performance of a basic ultrasound examination do not include a search for the cord insertion, from the above statistics it is clear that this simple task can occasionally be lifesaving by alerting the clinician to perform a timely cesarean section. Cord insertion assessment certainly should be accomplished in those in whom there is a question of placenta previa.

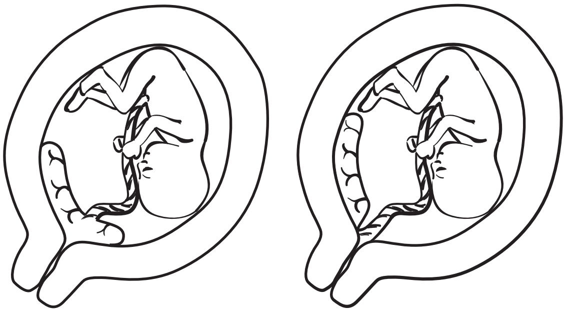

Fig 2.6 Trophotropism: evolution of vasa previa.

The diagnosis of vasa previa itself can be made with color Doppler demonstration of vessels or a cord immediately over the endocervix. This is best done with TVS, and with pulse Doppler the artery in question can be seen to be beating at a fetal rate.

Patients in whom a search for the cord insertion should always be undertaken are those conceived through IVF. One study shows that their risk of vasa previa is about 1 in 293 [9].

Placenta accreta

This complication occurs in about 1 in 10 patients with placenta previa, compared with 4 per 10,000 in others [10]. The risk for this condition is elevated in patients over 35 with previa who have had a previous cesarean section. They have a 40% chance of placenta accreta.

Finberg [11] initially laid out some diagnostic suggestions that have continued to hold true. However, the individual most recently cited in the literature is Comstock [12], who has shown that the strongest clues to its presence are placental lakes, often in the area just underneath an old cesarean scar, that possess a typical slow lacunar flow. Although, by definition, the placenta invades into the myometrium, focusing on the uterine wall can be unrewarding since, at times, it is difficult to outline an uninterrupted myometrial margin (clear space), even when there is no accreta (Plate 2.1).

The diagnosis is easier to make when there is invasion through the serosa (increta), or into the bladder (percreta), conditions which unfortunately have serious maternal consequences (Figure 2.7).