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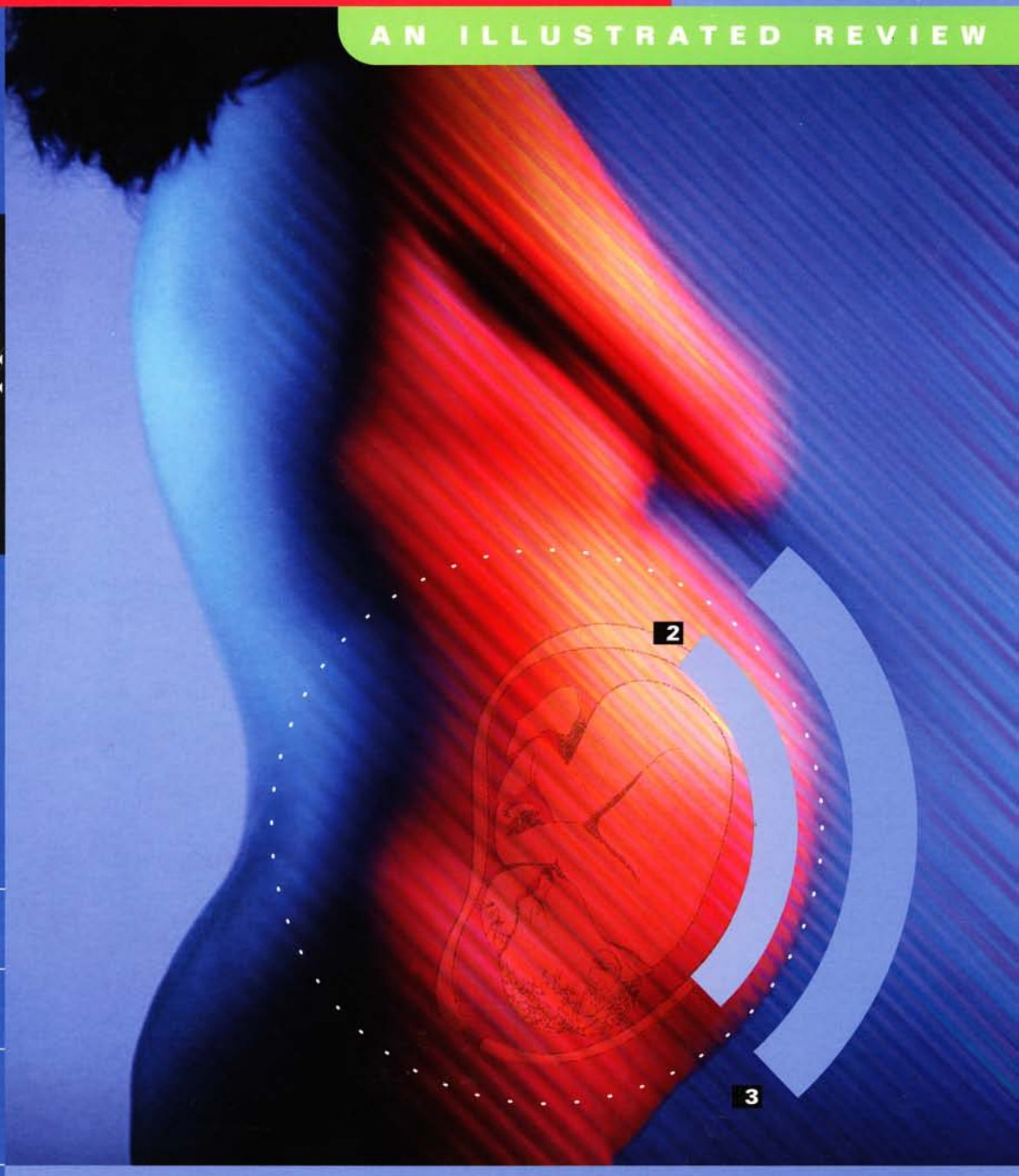

1-2-3 Step Ultrasound Education & Test Preparation

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MARIE DE LANGE | GLENN A. ROUSE

Ob/Gyn

SONOGRAPHY

AN ILLUSTRATED REVIEW

Marie De Lange, BS, RT, RDCS, RDMS, FSDMS | Glenn A. Rouse, MD

Certain to become *the* review for registry candidates, *Ob/Gyn Sonography: An Illustrated Review* is designed to serve several purposes:

- A topic-by-topic review for the ARDMS specialty exam in ob/gyn sonography.
- A concise text for those in training or cross-training.
- A clinical reference for practicing sonographers.
- A resource for interpreting physicians.
- A convenient and inexpensive means of earning continuing medical education (CME) credit.

First and foremost, *Ob/Gyn Sonography: An Illustrated Review* is an efficient and powerful means of preparing for the national registry examinations in obstetrical and gynecological sonography. It precisely follows and covers the ARDMS exam outline, succinctly and systematically explaining and illustrating each exam topic with easy-to-read text, illustrations, bullet lists, photographs, sonograms, color plates, case studies, and self-assessment questions. *Ob/Gyn Sonography: An Illustrated Review* is also a practical, manageable, reader-friendly text and reference for students, cross-training sonographers, practicing sonographers, and interpreting physicians. A complete CME application and quiz at the end of the book make it possible to earn 12 hours of SDMS-approved continuing medical education credit toward satisfaction of ARDMS, ICAVL, and other requirements for professional registration and facility accreditation.

Other publications of interest

Ob/Gyn Sonography Review, by Kathy Gill, MS, RT, RDMS, Misty Sliman, RT, RDMS, and Peter W. Callen, MD. Step 2 in Davies 1-2-3 Step Ultrasound Education & Test Preparation ob/gyn program, this registry-like mock exam delivers more than 500 questions, answers, explanations, and references to hone your test-taking skills and assess your strengths and weaknesses. 12 hours CME credit.

Ultrasound Physics Review, by Cindy Owen, RT, RDMS, RVT, and James A. Zagzebski, PhD. This is the review you've heard about; don't take the physics exam without it. Written by a sonographer and educator who delights in explaining this difficult subject to others, this mock exam contains more than 550 questions, answers, explanations, and references including an Image Gallery of more than 50 images. 12 hours CME credit.

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Marie De Lange

An internationally recognized author, teacher, speaker, Marie De Lange has been actively involved in ultrasound education and credentialing for more than 25 years. In addition to her clinical and research work, she has held numerous positions of responsibility at ARDMS, SDMS, AIUM, the *Journal of Diagnostic Medical Sonography*, and the Joint Review Committee on Education in Diagnostic Medical Sonography. In 1992 she was elevated to the status of Fellow of the Society of Diagnostic Medical Sonography. Marie is Diagnostic Medical Sonography Program Director and Ultrasound Vascular Laboratory Manager at Loma Linda University Medical Center.

Glenn A. Rouse

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Ob/Gyn Sonography

AN ILLUSTRATED REVIEW

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To all the students and sonographers who, through the years, have learned and worked in our facility. To work with them has made me a better sonologist, and a better person.

—Glenn A. Rouse, MD

To my awesome family, George, Nicole, Gina, Tom, Kit, Mom, and Dad, who supported, encouraged, and loved me. To all of my family and dear friends who cheered me on. And to all my coworkers and colleagues who have so positively impacted education at Loma Linda University and made working there such a pleasure. Special thanks to my incredible daughter Nicole for her editorial assistance.

—Marie De Lange, BS, RT, RDMS, RDCS, FSDMS

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Contents

CHAPTER 1

First Trimester

Gestational Age

There are two different methods for calculating gestational age. Embryology books calculate gestational age beginning with ovulation and fertilization of the ovum. In clinical obstetrical practice, the date of ovulation is usually unknown, and obstetricians and sonographers typically calculate the gestational age from the first day of the last menstrual period (LMP). The first day of the last menstrual period is a known event that usually precedes ovulation by about two weeks. *In this book we always use gestational age calculated from the first day of the last menstrual period.* When calculated from the last menstrual period, weeks of gestation are usually expressed as *menstrual weeks*.

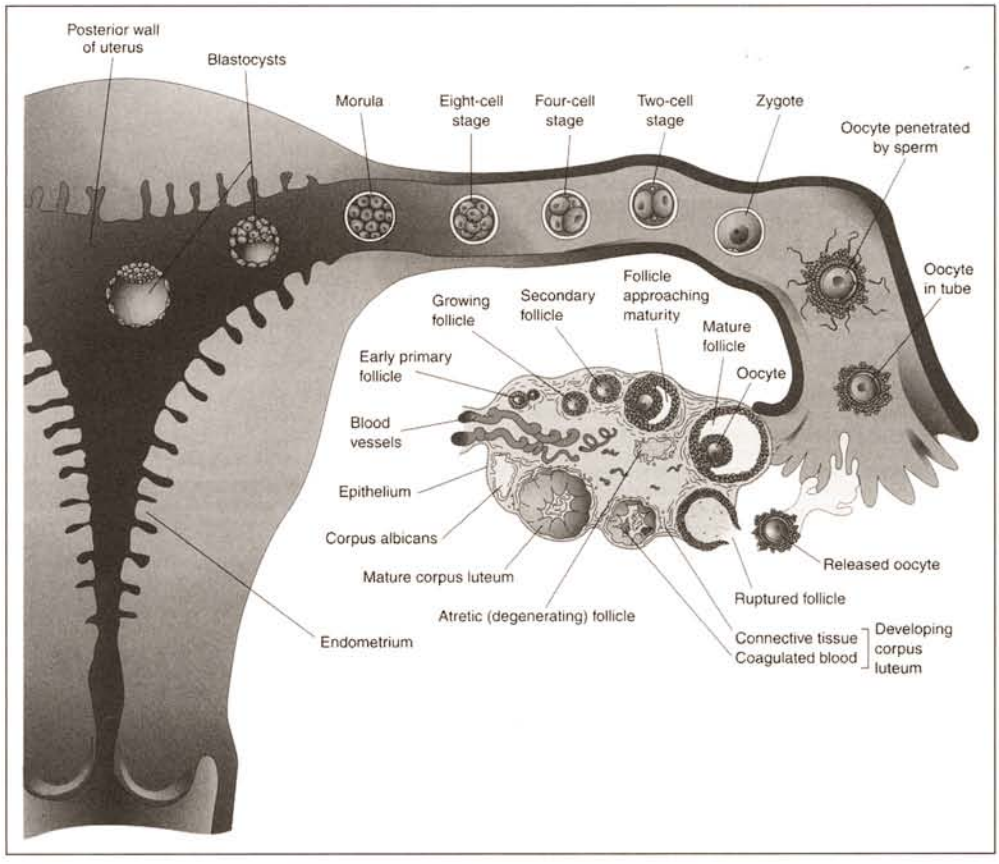

Figure 1.
Summary of the first week (third menstrual week). Summary of the ovarian cycle, fertilization, and human development during the first week. Stage 1 of development begins with fertilization and ends when the zygote forms. In stage 2 (days 2 to 3 following conception/15 to 16 days since last menstrual period) the early stages of cleavage occur (from 2 to about 32 cells)—[morula]). In stage 3 (days 4 to 5 following conception/17 to 18 menstrual days) the blastocyst becomes free. Stage 4 (days 5 to 6 following conception/ 18 to 19 menstrual days) is characterized by the blastocyst attaching to the wall of the uterus. The blastocysts are sectioned to show their internal structure. Reprinted with permission from Moore KL, Persaud TVN: *Before We Are Born: Essentials of Embryology and Birth Defects,* 6th edition. Philadelphia, Saunders, 2003, p 36.

Fertilization/Embryology

At the beginning of the third week after the first day of the last menstrual period, ovulation occurs, and fertilization of the ovum usually follows within a day or two. The early development of the conceptus/embryo can be summarized as follows:

1 The Conceptus Period: Weeks 3–5

- Week 3 (Days 14–21): Early development of the conceptus (figure 1)

  Day 14: Ovulation and fertilization of ovum.

  Days 14–18: Zygote traverses the fallopian tube.

  8-cell stage.

  12- to 16-cell stage: *morula.*

  Day 18: Morula enters uterus.

  Days 18–21: Blastocyst cavity and inner cell mass form; blastocyst cavity becomes primary yolk sac; amniotic formation begins.

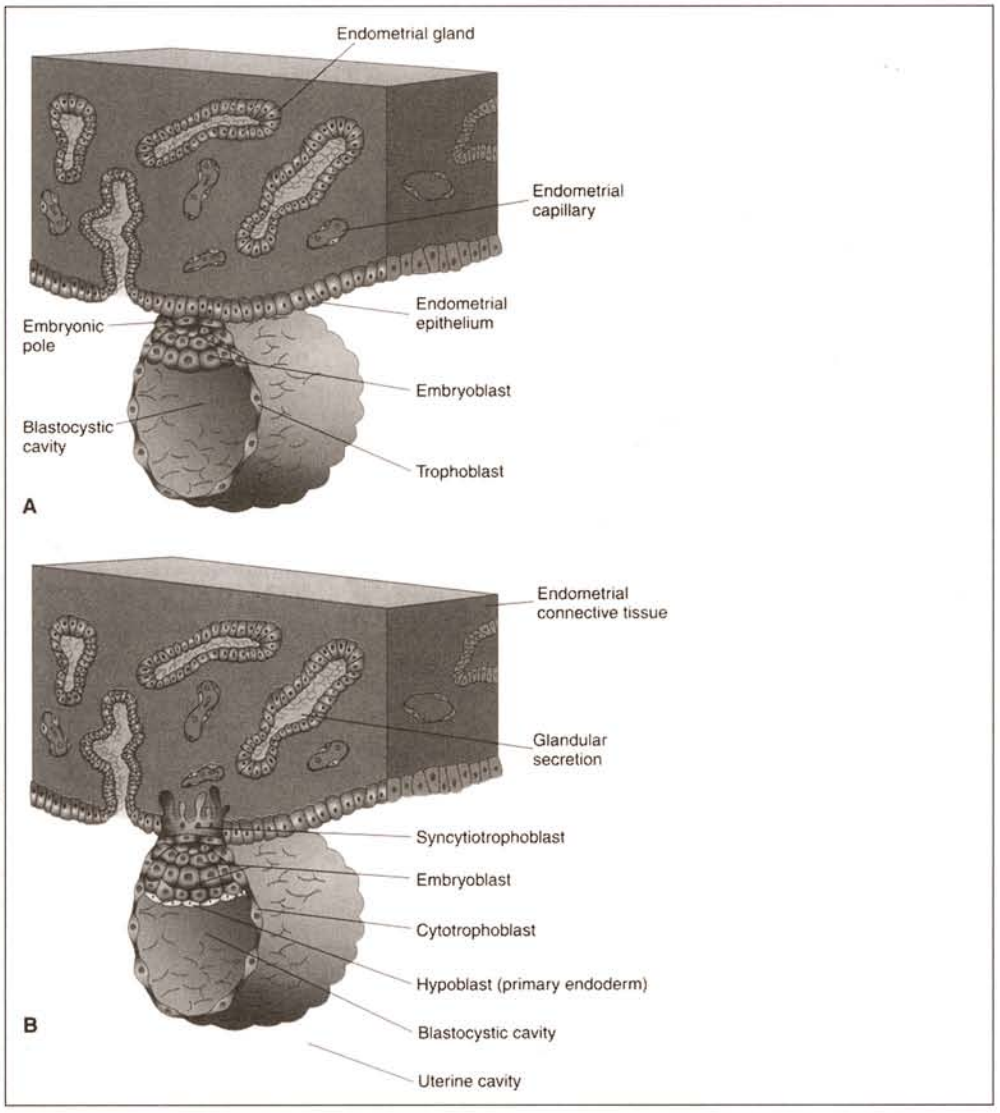

Figure 2.
Attachment of the blastocyst to the endometrial epithelium and the early stages of its implantation. **A** At six days (19 menstrual days) the trophoblast is attached to the endometrial epithelium at the embryonic pole of the blastocyst. **B** At seven days (20 menstrual days) the syncytiotrophoblast has penetrated the epithelium and has started to invade the endometrial stroma (framework of connective tissue). Reprinted with permission from Moore KL, Persaud TVN: *Before We Are Born: Essentials of Embryology and Birth Defects,* 6th edition. Philadelphia, Saunders, 2003, p 34.

- Week 4 (Days 21–28)

  Implantation of the blastocyst in the uterine wall and formation of the *syncytiotrophoblast* (placental precursor) (figure 2). Vaginal bleeding may occur at this time.

  Bilaminar embryonic disc: Transformation of inner cell mass into bilaminar embryonic disc (figure 3).

  Amnion and *chorion:* Regression of primary yolk sac and formation of secondary yolk sac and the surrounding *chorionic cavity* (figure 4). The *amniotic sac* enlarges on the side of the embryo opposite the chorionic cavity. The adjacent amnion and secondary yolk sac are sometimes visible sonographically within the chorionic cavity. This finding is called the "double bleb" sign. At the beginning of the 4th week, the gestational sac is about 1 mm in diameter.

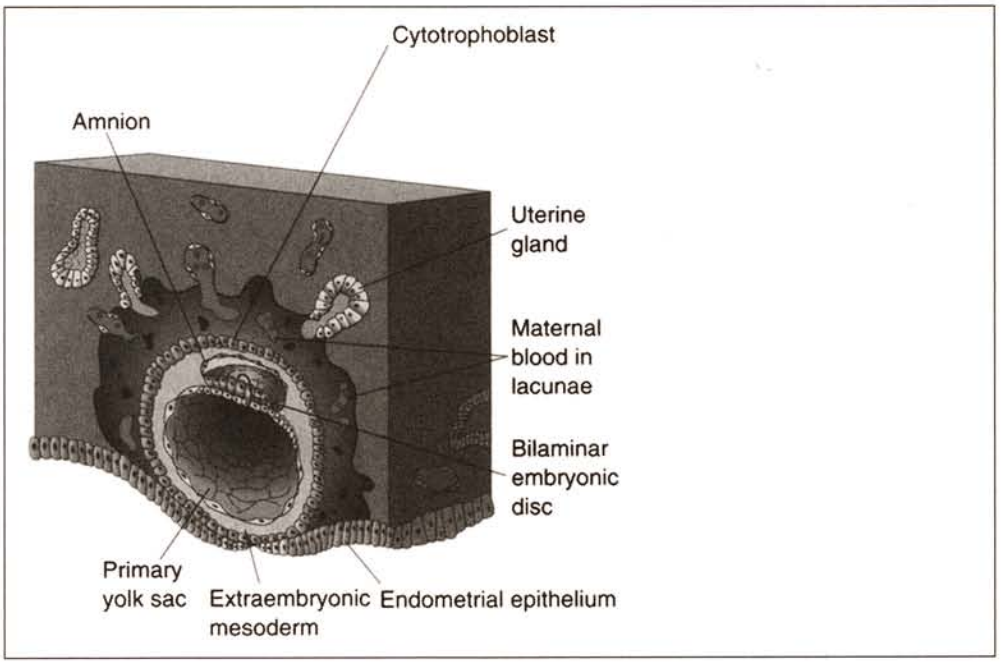

Figure 3.
Implanted blastocyst. Drawing of a section through a blastocyst of about 9 gestational days (22 menstrual days) implanted in the endometrium. Note the lacunae appearing in the syncytiotrophoblast. The actual size of the conceptus is about 0.1 mm. The type of implantation illustrated here, in which the blastocyst becomes competely embedded in the endometrium, is called *interstitial implantation.* Reprinted with permission from Moore KL, Persaud TVN: *Before We Are Born: Essentials of Embryology and Birth Defects,* 6th edition. Philadelphia, Saunders, 2003, p 38.

- Week 5 (Days 29–30)

  Gastrulation: Formation of the trilaminar disc, comprising the three primary germ layers: ectoderm, endoderm, mesoderm; formation of the primitive node and streak (*mesenchyme*) and formation of *notocord.* The notocord forms within the embryonic plate between the amnion and the secondary yolk sac. The notocord induces development of the

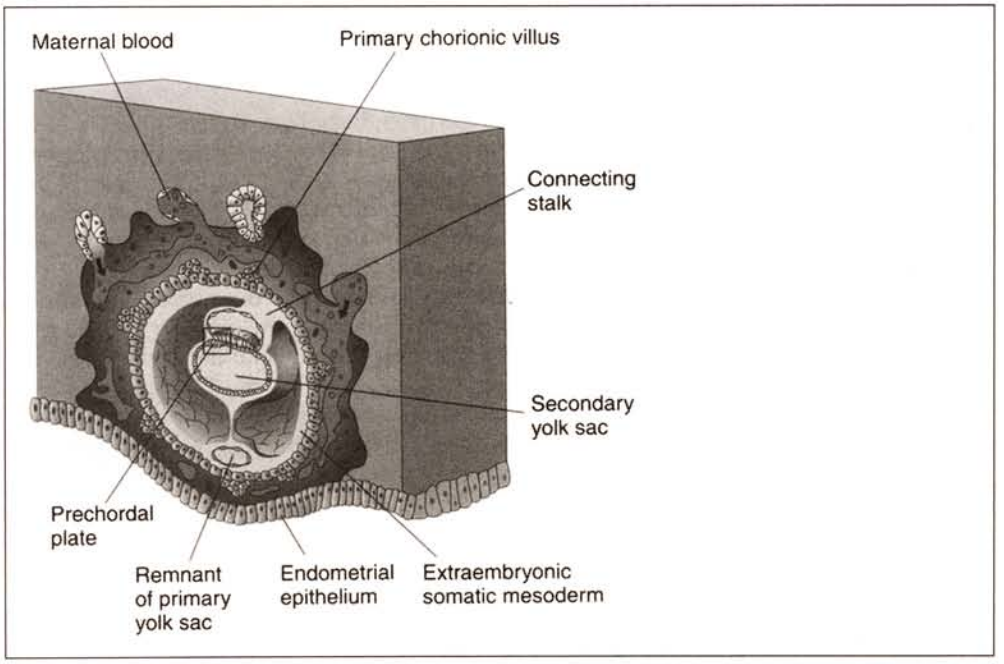

Figure 4.
Implanted embryo. Drawing of a section through an implanted human embryo at 14 gestational days (27 menstrual days), showing the newly formed secondary yolk sac and the location of the prechordal plate in its roof. Reprinted with permission from Moore KL, Persaud TVN: *Before We Are Born: Essentials of Embryology and Birth Defects,* 6th edition. Philadelphia, Saunders, 2003, p 40.

structure of the early embryo and later develops into the vertebral bodies of the spinal column.

- Week 5 (Days 31–42)

  Neurulation: Formation of the neural plate and neural tube and somites, which develop into the central nervous system (figure 5).

  Day 35: Neural tube formation begins.

  Day 40: Closing of the *rostral* (head) end of the neural tube.

  Day 42: Closing of the *caudal* (sacral) end of the neural tube.

  If the neural tube does not close properly, neural tube defects will be the result.

  Angiogenesis and *hematogenesis:* Formation of primitive blood cells and blood vessels, heart, and placental vascularity.

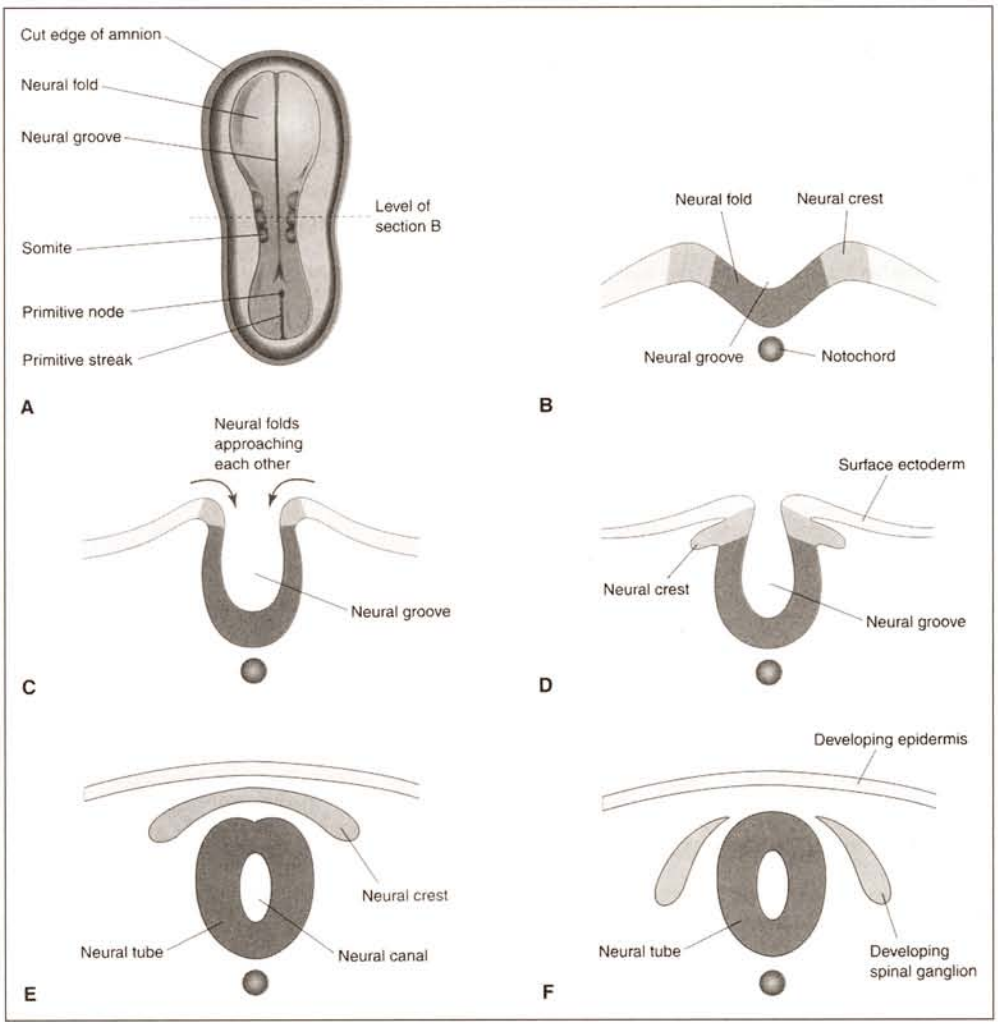

Figure 5.
The developing embryo. Diagrammatic transverse sections through progressively older embryos, illustrating formation of the neural groove, the neural tube, and the neural crest up to the end of the 6th menstrual week. Reprinted with permission from Moore KL, Persaud TVN: *Before We Are Born: Essentials of Embryology and Birth Defects,* 6th edition. Philadelphia, Saunders, 2003, p 55.

2 The Embryonic Period: Weeks 6–10: Formation of All Permanent Internal and External Structures of the Individual

- Cardiovascular system

  6 weeks: Unidirectional blood flow.

  8 weeks: Formation of the heart is complete.

  10 weeks: Formation of the peripheral vascular system is complete.

- Gastrointestinal system

  6 weeks: Formation of the primitive gut.

  8–12 weeks: Herniation of the midgut into the umbilical cord.

  8 weeks: Separation of the rectum from the urogenital sinus.

  10 weeks: Perforation of the anal membrane.

- Urogenital system

  8 weeks: Formation of the primitive kidney (*metanephros*) in the pelvis and ascension into the abdomen.

  11 weeks: Kidneys in adult position, external genitalia similar in males and females; genitalia differentiate by 14 weeks.

- Musculoskeletal system

  5.5–6 weeks: Formation of limb buds.

  7.5–8 weeks: Digital rays develop; arms bent at elbow.

  8 weeks: Clavicle begins to ossify.

  9 weeks: Mandible, palate, vertebral bodies, and neural arches begin to ossify.

  11 weeks: Long bones begin to ossify.

Sonographic Findings in Early Intrauterine Pregnancy

1 Decidual Thickening

The earliest sonographic sign of pregnancy that has been described is focal thickening of the echogenic decidua at the site of implantation.[3] This finding is quite subtle, and the predictive value of the finding has not been established.

2 Gestational Sac

- The fluid-filled gestational sac is first visible at about 4.5–5 menstrual weeks, and it is the first definitive sign of pregnancy. With the use of endovaginal scanning, it can be visualized at a mean sac diameter (MSD)

Figure 6.
Early intrauterine pregnancy. Longitudinal view of a pregnant uterus containing a small echolucency (arrow) most likely representing an early intrauterine pregnancy.

of 2–3 mm and on transabdominal scanning at approximately 5 mm mean sac diameter. It appears as a small fluid collection surrounded by an echogenic rim. The central fluid is the chorionic cavity. The surrounding echogenic rim represents the developing chorionic villi and adjacent decidual tissue. The normal position for the gestational sac is in the upper- to mid-uterus.

- Intradecidual sign: The sonographic presence of a small gestational sac (figure 6) within the decidua at approximately 4.0–4.5 weeks, with a mean sac diameter of approximately 2.5 mm, is known as the *intradecidual sign*. To distinguish a true intradecidual sign from a decidual (endometrial) cyst, the sonographer must be sure that the gestational sac is directly adjacent to the endometrial canal. Because the intradecidual sign can sometimes mimic a pseudogestational sac of ectopic pregnancy, its value appears somewhat limited.

- Double decidual sign: The echogenic ring formed by the decidua vera (parietalis) and decidua capsularis is called the *double decidual sign*. The *decidua basalis* (future placenta) may be visualized as an area of echogenic thickening on one portion of the sac. This sign can typically be visualized by 5.5–6 menstrual weeks (figure 7), when the mean sac diameter is approximately 10 mm. With the extensive use of high-resolution transvaginal sonography, the double sac sign plays a less significant role in the determination of pregnancy.

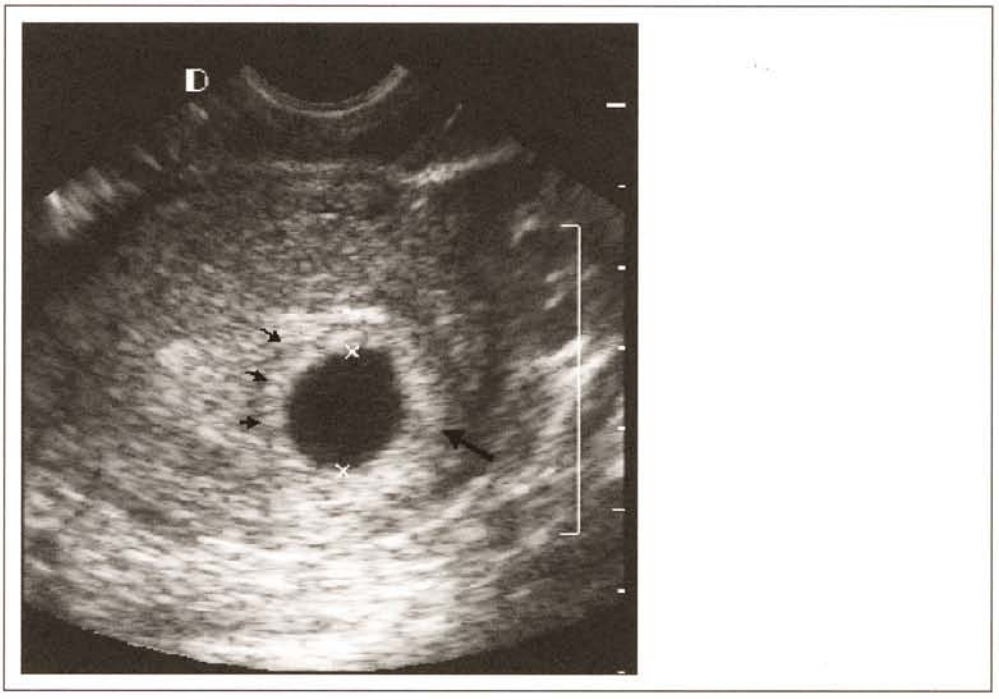

Figure 7.
Gestational sac. Note the thickening of deciduas basalis (large arrow) and "double sac" area (multiple small arrows).

- The gestational sac is measured by imaging the sac in the long axis (figure 8) and taking the A-P, longitudinal, and transverse measurements, then averaging the three measurements to get the mean sac diameter. The early gestational sac is elliptical and may be distorted by a focal myometrial contraction (FMC). The gestational sac is measured as a part of the obstetrical sonogram until about 10 menstrual weeks. After about

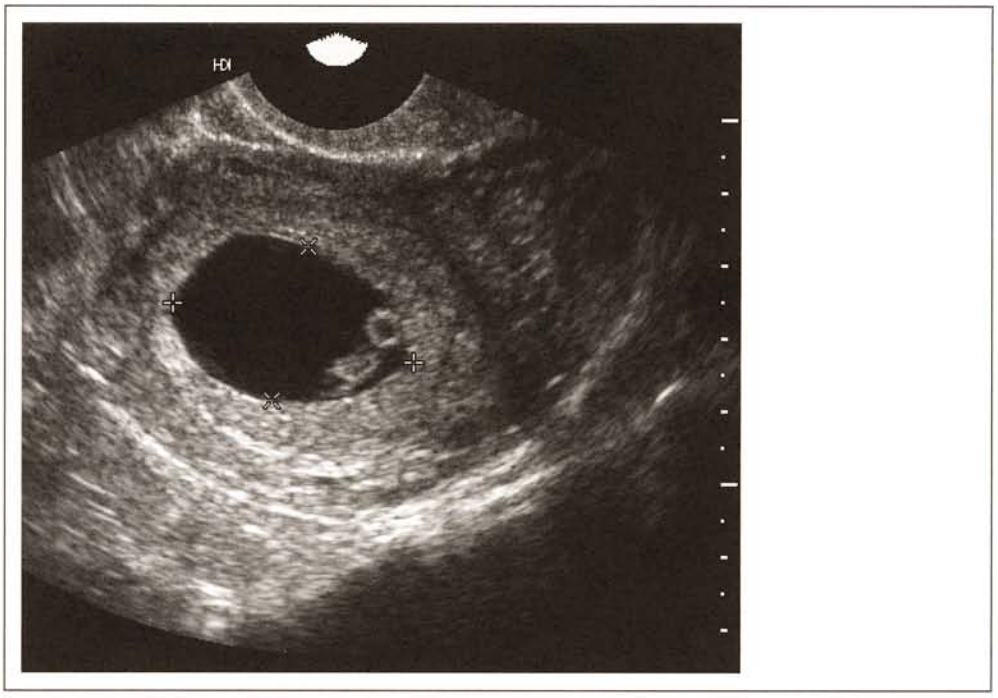

Figure 8.
Measuring the gestational sac. Longitudinal view of a gestational sac demonstrating measurements in the long and A-P axes (cursors).

Figure 9.
Crown-rump length. Sonogram of an embryo (crown-rump length) at approximately 7 menstrual weeks.

7 menstrual weeks, the gestational sac measurement is no longer used as the primary means of determining gestational age. Once the embryo is large enough to measure accurately, the crown-rump length (CRL) (figure 9) becomes the primary measurement for determining age. The comparison of embryo size and gestational sac size is helpful in assessing the risk of miscarriage.

3 Yolk Sac

- The yolk sac is the first structure visualized within the gestational sac. The sonographically visualized yolk sac is the secondary yolk sac. It is spherical in shape, with a sonolucent center and clearly defined echogenic wall (figure 10). On transvaginal sonography it is often visualized when the mean sac diameter of the gestational sac is approximately 5 mm (5 menstrual weeks) and normally should always be visualized when the mean sac diameter is 8 mm (5.5 menstrual weeks). High-frequency transvaginal sonography (7–10 MHz) is required to consistently visualize yolk sacs in 8-mm gestational sacs. On transabdominal sonography the yolk sac should always be visible at approximately 20 mm mean sac diameter or 7 menstrual weeks.

- While the placenta is developing, the yolk sac transfers nutrients to the embryo. Hematopoiesis occurs in the wall of the yolk sac in the 5th week before the liver takes over that function at about the 8th week. The upper limit of the yolk sac is 5.6 mm at approximately 5–10 weeks.

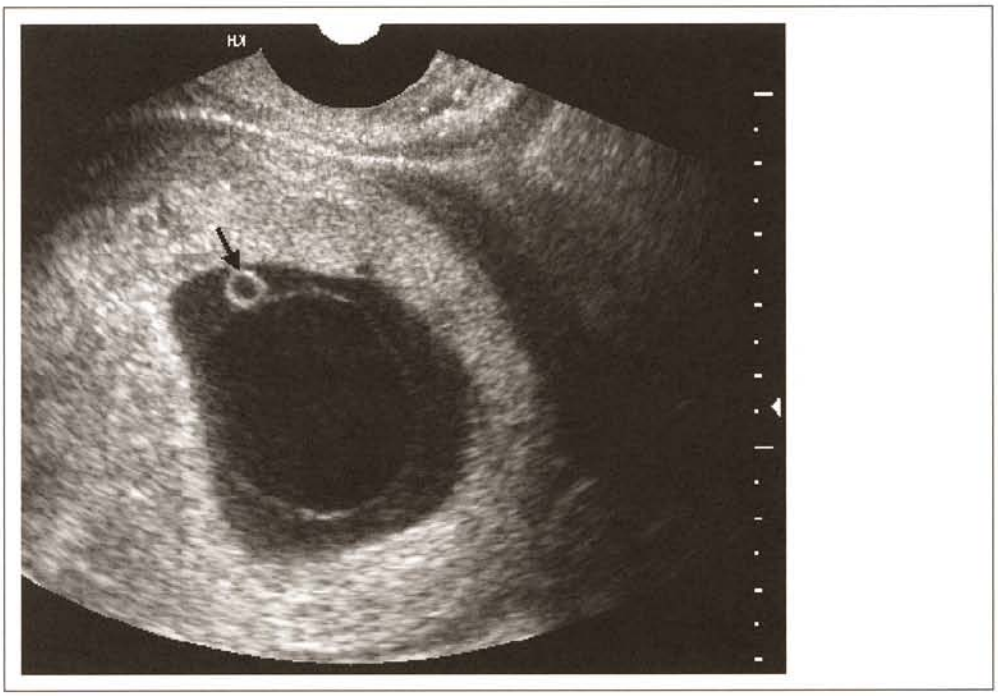

Figure 10.
Yolk sac. Sonogram of a gestational sac with yolk sac (arrow) situated normally between the amnion and chorion.

4 Double Bleb Sign

At 5.5 menstrual weeks, the developing amniotic sac measures about 2 mm in diameter and becomes visible adjacent to the yolk sac. (See figure 11.) This double sac appearance is called the *double bleb sign.* At this time the bilaminar embryonic disc lies between the yolk sac and the amnion. The double bleb sign is no longer visible by 7 menstrual weeks.

Figure 11A.
Double bleb sign. Transverse view through gestational sac. Note the amnion (black arrow) and yolk sac (white arrow) with embryo situated between.

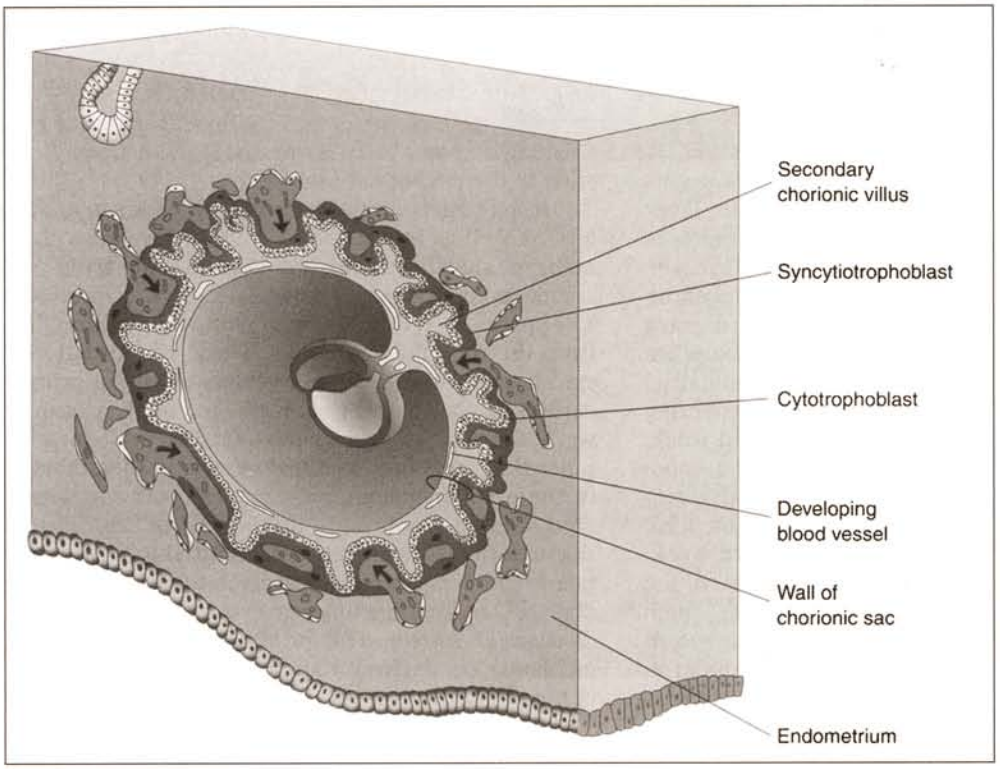

Figure 11B.
The embryo. Sagittal section of an embryo (about 29 menstrual days/16 gestational days). Reprinted with permission from Moore KL, Persaud TVN: *Before We Are Born: Essentials of Embryology and Birth Defects,* 6th edition. Philadelphia, Saunders, 2003, p 59.

5 Embryo

- With the use of endovaginal sonography (EVS), the embryo is often visible at 5–5.5 menstrual weeks, measuring 1–2 mm in crown-rump length, adjacent to the yolk sac. Embryonic cardiac activity may be visualized when the crown-rump length is approximately 2–4 mm and will be observed in normal embryos greater than 5 mm in length. In normal pregnancies when the gestational mean sac diameter is greater than 16 mm, the embryo and heartbeat will also be visualized. High-frequency (7–10 MHz) endovaginal sonography probes, appropriate focusing, and low-persistence settings are needed to adequately image the embryo and heartbeat.

- Cardiac activity: Embryonic cardiac activity may sometimes be detected between 5 and 6 weeks' menstrual age (figure 12), and the rate is relatively slow. Most investigators have reported a normal range of 100–115 bpm between 5 and 6 weeks' menstrual age. The mean heart rate increases to approximately 140 bpm by 9 weeks' menstrual age. There appears to be a correlation between slow heart rates and miscarriage in embryos: less than 100 bpm before 6.2 menstrual weeks and less than 120 bpm between 6.3 and 7.0 weeks.[4] If the embryonic heart rate is abnormally low, follow-up sonography is advisable.

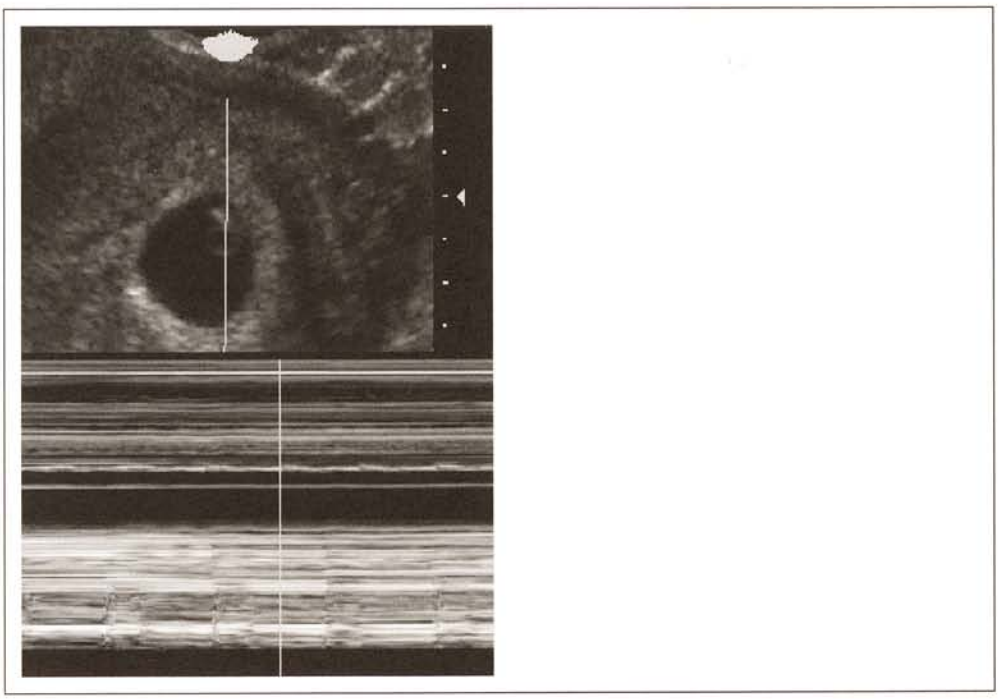

Figure 12.
Embryonic cardiac activity. M-mode sonogram of gestational sac with cursor demonstrating embryonic cardiac activity.

6 Amnion

Gradually the amnion grows to fill the chorionic cavity by approximately 12–16 weeks. With high-resolution equipment, occasionally, diffuse low-level echoes may be observed filling the chorionic cavity (figure 13). The cause of the low-level echoes is unknown but most likely represents the thick proteinaceous material contained within the cavity.

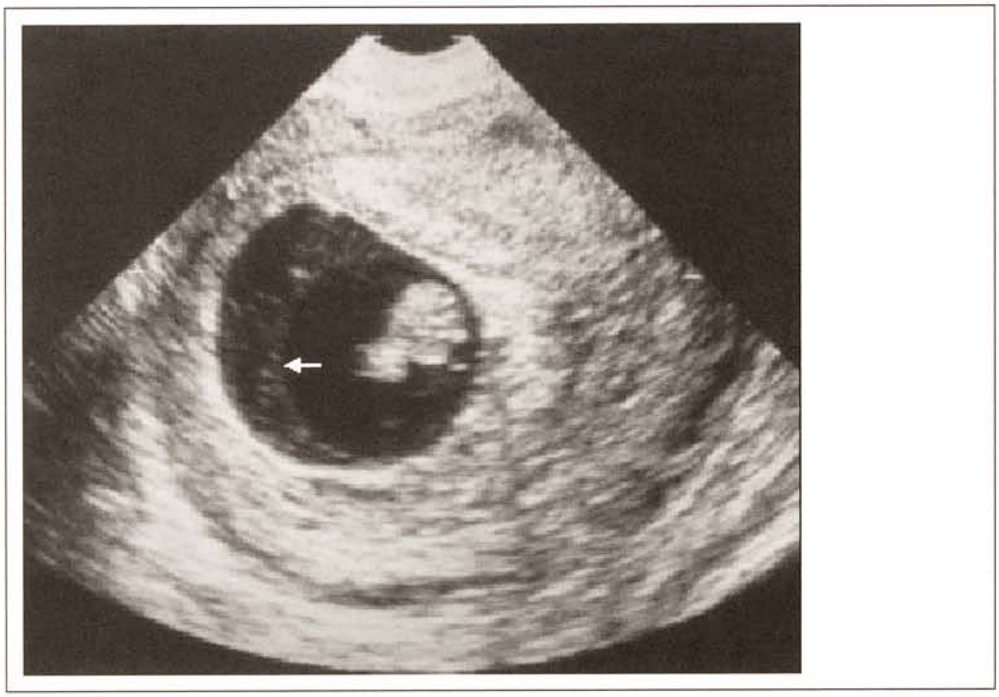

Figure 13.
Amnion. Gestational sac containing amnion (arrow). Note the subtle echoes located between the amnion and chorion representing proteinaceous material.

7 Beta-Human Chorionic Gonadotropin and Sonographic Findings

The serum beta–human chorionic gonadotropin hormone (serum hCG) level can be correlated with sonographic findings in early pregnancy. Two different systems have been used to measure beta-hCG. The International Research Preparation (IRP) measuring system was developed first, and later the Second International Standard (SIS) came into use. In samples that have equivalent beta-hCG levels, the numerical result using the SIS system will be approximately double the result using the IRP system. At this time, most laboratories have reverted to using the IRP system. Recently a third standard, the Third IRP (3IS), has been introduced. The 3IS system yields levels similar to the initial IRP. A correlation can be made between sonographic identification of the gestational sac in early pregnancy and maternal serum beta-hCG levels. The gestational sac must be visualized normally:

	IRP or 3IS	**SIS**
Endovaginal sonography	1000–2000 IU/ml	500–1000
Transabdominal sonography	3600 IU/ml	1800

Abnormal First Trimester (Failed Pregnancy)

Wilcox and others have demonstrated a 20–31% rate of early pregnancy loss after implantation in the normal healthy volunteer.[5, 6] Overall, 75% of pregnancies will fail. Vaginal bleeding is not uncommon and occurs in approximately 25% of patients during the first few weeks of pregnancy. Often the bleeding is temporary and likely due to implantation of the conceptus into the endometrium. Sonography plays a major role in assessing the patient who has first trimester bleeding to diagnose early pregnancy failure.

Threatened abortion can be defined as spotting, bleeding, or cramping in the 1st trimester with a closed cervical os. About half of such patients will have a normal outcome and half will subsequently abort. Loss rates are influenced by maternal age, smoking, and alcohol or caffeine consumption, as well as other causes, such as failure of the corpus luteum sufficiently to support the implanted conceptus. The corpus luteum secretes progesterone to support pregnancy until the placenta takes over the hormonal function. It forms during the secretory phase of the menstrual cycle and during pregnancy is usually less than 5 cm in diameter with a variety of appearances. The corpus luteal cyst usually regresses or decreases in size at approximately 16–18 weeks. When the corpus luteal cyst persists beyond 18 weeks it should be followed.

In a *complete abortion,* all the gestational tissue, including the embryo, has passed out of the uterus, and the uterine cavity is empty. If gestational tissue remains within the uterus and bleeding persists, the appropriate term is

incomplete abortion or *abortion in process*. The term *missed abortion* is vague and has fallen out of use.

If a gestational sac is present in the uterus but no embryo is identified in a sac large enough to require one, the condition is called *blighted ovum* or *anembryonic pregnancy*. In *embryonic demise*, an embryo greater than 5 mm is observed without a heartbeat. Some have suggested the general term *failed pregnancy* to describe all these conditions.

Sonographic Signs of Abnormal Early Pregnancy

1 Abnormal Gestational Sac

- Reasonably reliable early findings that suggest an abnormal pregnancy include:

1. Gestational sac greater than 8 mm without a yolk sac.
2. Gestational sac greater than 16 mm without an embryo or heartbeat.
3. Amniotic sac noted within the gestational sac and absent embryo.
4. Embryo greater than 5 mm without a heartbeat.
5. Mean sac diameter minus crown-rump length less than 5 mm between 5.5 and 9 weeks.
6. Gestational sac much larger than the embryo.

Many physicians allow 2- or 3-mm leeway in mean sac diameter as a margin for error.

- Signs of abnormal pregnancy that are less reliable or not as well established include:

1. Irregular shape of the gestational sac.
2. Missing double sac sign.
3. Weak decidual echoes at the edge of the gestational sac.
4. Low position of the sac in the uterus.
5. Yolk sac less than 2 mm or greater than 5.6 mm, irregular shape, or calcified.
6. Growth of the gestational sac mean sac diameter of less than 0.6 mm per day. (Normal growth is 1.13 mm per day.)
7. Embryonic bradycardia.

In one study, embryos less than 5 mm in size had 100% mortality if the heart rate was less than 80 bpm, 64% if the heart rate was 80–90 bpm, 32% if the heart rate was 90–99 bpm, and 11% if the heart rate was 100 bpm or more.[4]

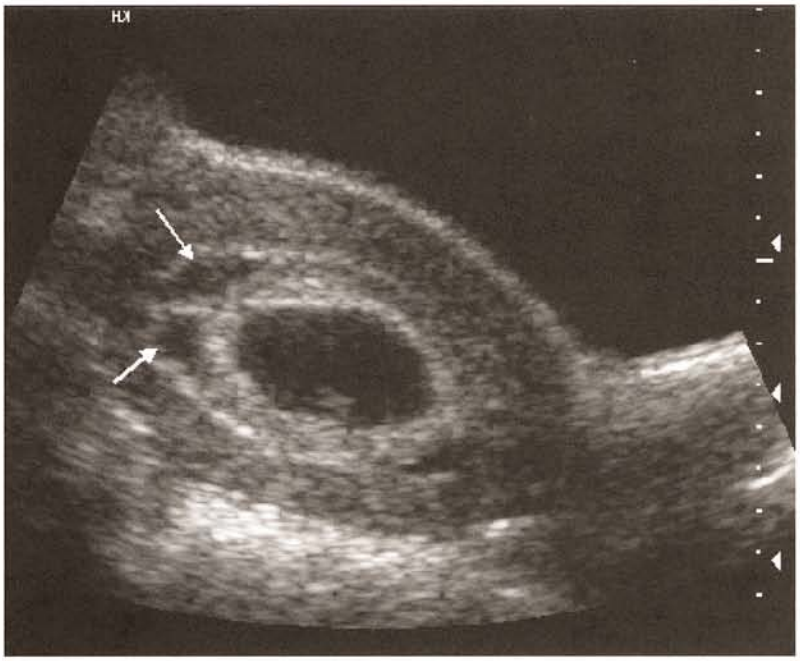

Figure 14.
Subchorionic hemorrhage. Longitudinal view through the uterus demonstrating the gestational sac with hypoechoic area superiorly (arrows) representing hemorrhage.

2 Intrauterine Blood

Blood within the uterine cavity and outside the gestational sac is a marker for an increased risk of miscarriage. The blood collection may be adjacent to or opposite the placenta (subchorionic hemorrhage) (figure 14), or it may be partly or completely retroplacental. During early pregnancy the blood visualized may be due to implantation of *chorion frondosum* (the fetal contribution to the placenta) as it penetrates into *decidua basalis* (the maternal contribution to the placenta). The risk of miscarriage increases with the size of a subchorionic hemorrhage. Abruption is more likely to result in miscarriage than is subchorionic hemorrhage.

3 Fetal Anomalies

- As *endovaginal sonography* has become more widely used, many physicians and sonographers are imaging various anatomical structures in embryos and fetuses late in the first trimester. *Normal fetal structures* that can be confused with abnormality include:

1. Normal herniation (i.e., physiological herniation) of bowel into the base of the umbilical cord. The herniation occurs at about 8 weeks and should return to the abdomen before 14 weeks (figure 15).
2. Prominent rhombencephalon. The early appearance (7–9 menstrual weeks) of the fourth ventricle resembles a posterior fossa cystic mass (figure 16).

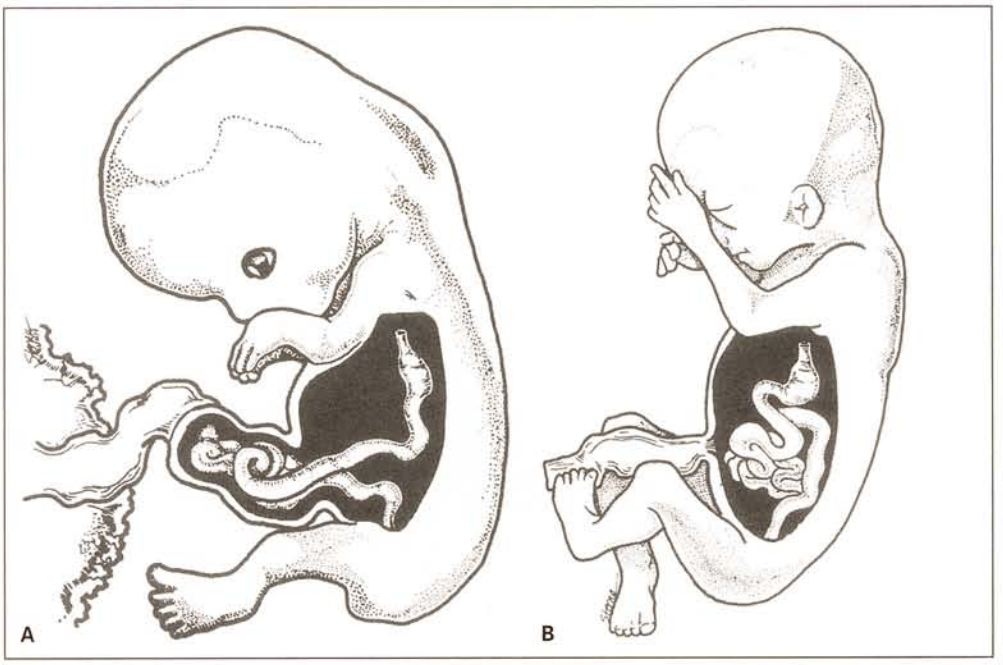

Figure 15.
Physiological herniation. **A** Drawing of a fetus at 9 menstrual weeks demonstrating normal herniation of bowel into the cord. **B** Drawing of a fetus at 14 menstrual weeks showing return of bowel into the abdominal cavity. Reprinted with permission from Cyr DR, Mack LA, Schoenecker SA, et al: Bowel migration in normal fetus: US detection. *Radiology* 161:119–121, 1986.

- *Anencephaly* cannot be detected in the first trimester. Many physicians have observed normal-appearing late first-trimester fetuses that later demonstrated anencephaly.

- *Nuchal translucency.* In late first trimester an important part of fetal evaluation is assessment of the thickness of the posterior nuchal translucency, found along the posterior neck of most embryos. The nuchal translucency is a hypoechoic area between the posterior soft tissues of

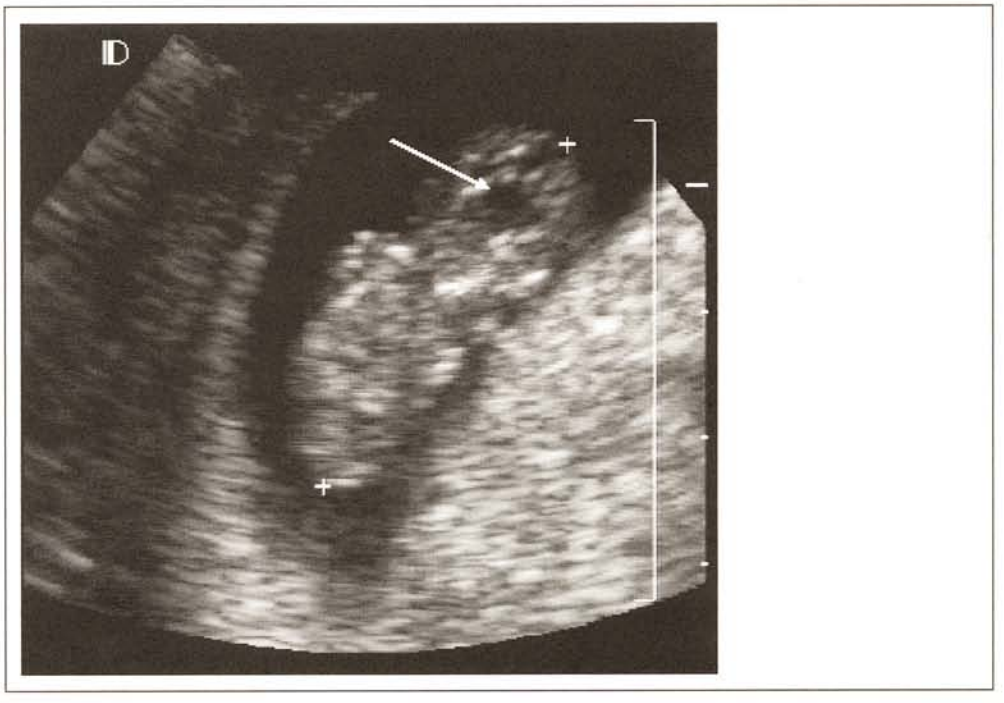

Figure 16.
Rhomboencephalon. Coronal view of an embryo showing the normal rhomboencephalon (arrow).

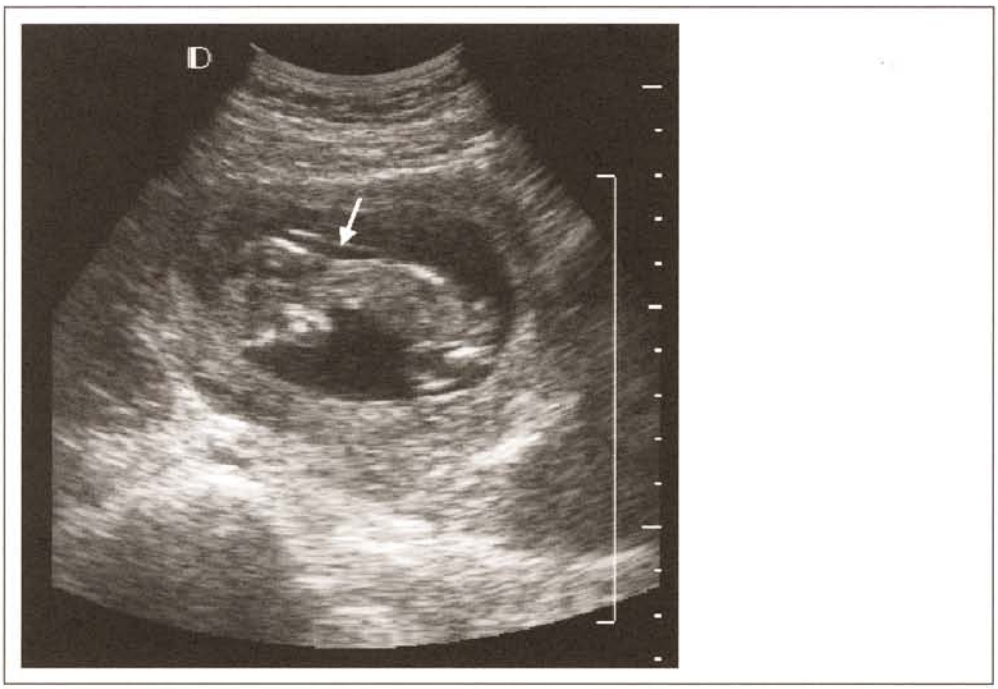

Figure 17.
Nuchal translucency. Sagittal sonogram of a fetus demonstrating abnormal nuchal translucency (arrows).

the neck and the overlying skin. The measurement includes only the translucent portion; it is an inner-to-inner measurement that does not include the thickness of the overlying skin (figure 17). This translucency usually becomes visible by about 10 weeks and is present in normal individuals. The thickness changes during the first trimester, peaking at 13 to 14 weeks, then becoming thinner.

Normal values for nuchal translucency have been established.[7] The 95th percentile for normal fetuses in early pregnancy is 2.2 mm at 11 weeks to 2.8 mm at 14 weeks. Nuchal translucency measurements over the 95th percentile are generally considered to be abnormal. Careful technique is important, for this is a small structure. Enlarging the image makes it easier to accurately measure the translucent area, and the measurement should be taken with the neck of the fetus flexed. A common error is confusing the unfused amnion with the fetal skin, so it is helpful to observe the fetus as it moves away from the edge of the amniotic sac. Both transabdominal and transvaginal techniques have proven successful for assessing the nuchal area. A fetus that has an abnormally thick nuchal translucency will be found to have an abnormal karyotype in 46% of cases overall.[8] The most commonly encountered abnormalities are trisomy 18, trisomy 21, and Turner's syndrome (45,XO). When the translucency contains septations, there may be even higher risk of aneuploidy.

The clinical management of pregnancies with thickened nuchal translucency is still evolving. Most investigators combine the nuchal

translucency measurement and biochemical testing when deciding if chromosome testing is required.

Some investigators recommend karyotyping above the 95th percentile, while others would not recommend additional genetic testing unless the nuchal translucency measurement is over 2.5 or 3.5 mm. In most cases, the nuchal translucency will resolve. *Resolution of an abnormally thickened nuchal translucency does not indicate the fetus has normal chromosomes.*

In the case of a normal karyotype with thickened nuchal translucency, the fetus remains at risk. A complete, detailed sonogram in the second trimester is essential in these cases. Most experts have noted a good outcome when both karyotype and follow-up detailed fetal sonogram are normal. Others, however, cautioned that these fetuses remain at increased risk for poor outcome as a result of preterm delivery or growth restriction.

Ectopic Pregnancy

An *ectopic pregnancy* is one that occurs outside the uterine cavity. This may happen because the fallopian tubes are unable to function normally as a result of scarring, intrinsic embryonic abnormalities, pelvic masses, an intrauterine device (IUD), or because of in vitro fertilization. The incidence has been increasing since 1970. Today, sensitive tests such as serum beta-hCG accompanied by physical exam and high-resolution ultrasound exam allow earlier diagnosis of previously unsuspected cases. It is therefore possible to take a more elective approach to management and treatment in these patients. Laparoscopy is considered the gold standard for the diagnosis of ectopic pregnancy. Currently, clinical assessment includes both transvaginal sonography and beta-hCG testing.

The clinical presentation associated with ectopic pregnancy sometimes includes "the classic triad"—pain, bleeding, and palpable adnexal mass—but this combination of symptoms is present in only 45% of patients who have ectopic pregnancy.

Other conditions that can have similar clinical presentation include:

- Symptomatic ovarian cysts.
- Pelvic inflammatory disease (PID).
- Dysfunctional uterine bleeding (DUB).
- Spontaneous abortions.

1 Incidence

Patients who have an increased risk for ectopic pregnancy include those with a history of:

- Previous ectopic pregnancy.
- Pelvic inflammatory disease.
- Previous tubal surgery.
- Use of IUD.
- In vitro fertilization.

Although some patients are at higher risk for ectopic pregnancy, any pregnant woman may have an ectopic pregnancy.

2 Serum beta-Human Chorionic Gonadotropin

Correlating the clinical presentation, sonographic findings, and serum beta-hCG is very important. A negative beta-hCG essentially excludes the diagnosis of a live pregnancy, although a chronic, nonliving ectopic pregnancy may have a negative beta-hCG. Serum beta-hCG is a widely available blood test, which becomes positive at approximately 23 menstrual days (9 days postconception). This occurs before the first missed period and before a gestational sac can be visualized with transvaginal sonography. If the beta-hCG level is less than 1000–2000 IRP, sonography may be negative in a normal pregnancy. In such cases, serial hCG levels or repeat sonograms can be helpful. In a normal pregnancy, the serum beta-hCG doubles every 2 days (1.2–2.2 days), whereas in ectopic pregnancy, the beta-hCG level does not usually rise as quickly.

3 Treatment

Patients suspected of having an ectopic pregnancy may be treated surgically with laparotomy or laparoscopy. Currently, some patients who have early ectopic pregnancy are being treated with systemic methotrexate to inhibit trophoblastic cell growth. Treatment with methotrexate seems to be most effective in early pregnancy, before the embryo appears.

4 Early Intrauterine Pregnancy vs. Ectopic Pregnancy

A small cystic sac may be visualized within the endometrium and represent a:

- Small normal intrauterine pregnancy
- Decidual cyst
- Pseudogestational sac of ectopic pregnancy

Visualization of an intrauterine fluid collection with double sac sign is a more reliable indicator of normal early intrauterine pregnancy than the intradecidual

sac. However, the double sac sign does not absolutely rule out a pseudogestational sac. The presence of the yolk sac and embryo further confirm the diagnosis of a normal intrauterine pregnancy. In any case, it is important to evaluate the adnexa, particularly in those patients who have undergone in vitro fertilization.

Scan technique: Some examiners begin with a transabdominal sonogram to evaluate any masses that may not be visualized by transvaginal sonography. In an emergency situation when the bladder is not full, the endovaginal scan can be performed alone, but in those cases upper pelvic masses may be missed. Endovaginal sonography will usually give much better detail of the uterus and endometrium than is possible with transabdominal sonography. Visualization of early intrauterine pregnancy, which is not visible transabdominally, would greatly diminish the likelihood of ectopic pregnancy.

5 Sites of Ectopic Pregnancy

Ectopic pregnancy occurs in the ampullary portion of the fallopian tube approximately 80% of the time and in the isthmic or interstitial portions 10–15% of the time. Rare locations include the cervix, abdomen, and ovaries (figure 18). It is important to scan above and below the ovary and between the ovaries and uterus because the tube is the most common location for ectopic pregnancy. If an adnexal mass is visualized, it should be examined for yolk sac, embryo, and cardiac activity. If a thick-walled cyst is visualized in the adnexa, differentiation must be made between a corpus luteum cyst and tubal ring of ectopic pregnancy.

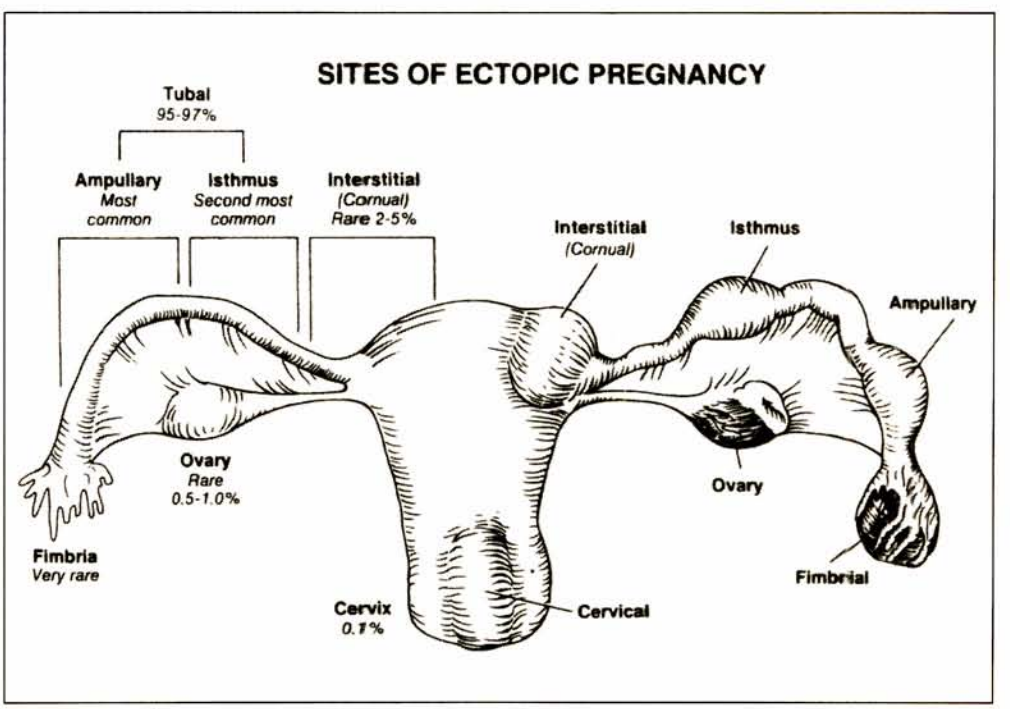

Figure 18.

Sites of ectopic pregnancies. Common locations of ectopic pregnancy. Note that 95% to 97% of ectopic pregnancies occur somewhere along the course of the fallopian tube. (Modified from Benson RC: *Handbook of Obstetrics & Gynecology,* 8th ed. Los Altos, CA, Lange Medical Publications, 1983; Schoenbaum S, Rosendorf L, Kappelman N, et al: Gray-scale ultrasound in tubal pregnancy. *Radiology* 127:757, 1978.)

The *cul de sac* must also be evaluated for free fluid. Complex fluid is suggestive of blood and possibly ectopic pregnancy. A small amount of fluid is seen in both normal and abnormal pregnancies; however, large amounts of fluid, particularly complex fluid, increase the likelihood of ectopic pregnancy.

Sonographic Findings Related to Ectopic Pregnancy

1 The *endometrium* has no specific findings for ectopic pregnancy. The thickness of the endometrium in ectopic pregnancy seems to vary from thin to thick. A thin-walled, simple-appearing decidual cyst can be seen with ectopic pregnancy or normal intrauterine pregnancy. In a stable patient at risk for ectopic pregnancy, a serial hCG can be obtained as well as a follow-up sonogram.

2 *Fluid* is a nonspecific finding for ectopic pregnancy, though a large amount of fluid is suggestive of ectopic pregnancy. Complex fluid (figure 19) is consistent with hemoperitoneum and is associated with ectopic pregnancy but not necessarily rupture of the fallopian tube.

3 If an *extrauterine adnexal ring, yolk sac,* and *heartbeat* (figure 20) are visualized, these findings are consistent with ectopic pregnancy. Also, a complex adnexal mass separate from the ovary is quite suspicious for ectopic pregnancy in a patient with a positive pregnancy test. Approximately 25% of patients who have an ectopic pregnancy have a completely normal sonogram.

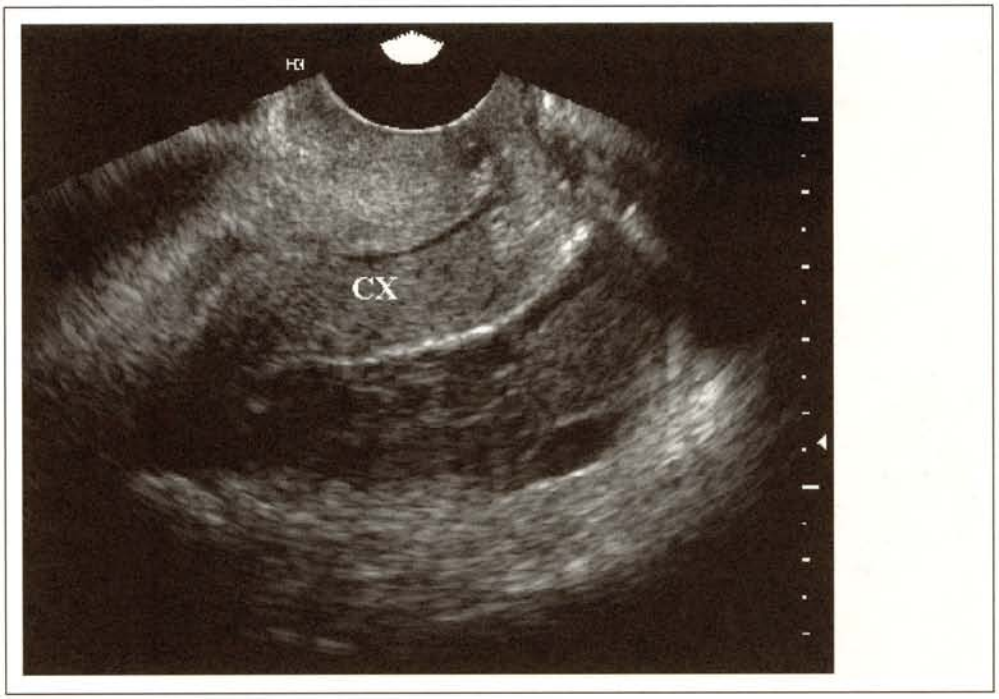

Figure 19.
Complex fluid. Longitudinal midline sonogram of cul de sac area. Note the complex echoes posterior to the cervix (CX) representing hemorrhage.

When a patient is pregnant and has no identifiable intrauterine gestational sac, one of the following is most likely:

- The pregnancy is too small for definitive identification.
- A recent spontaneous abortion has occurred.
- Ectopic pregnancy is present.

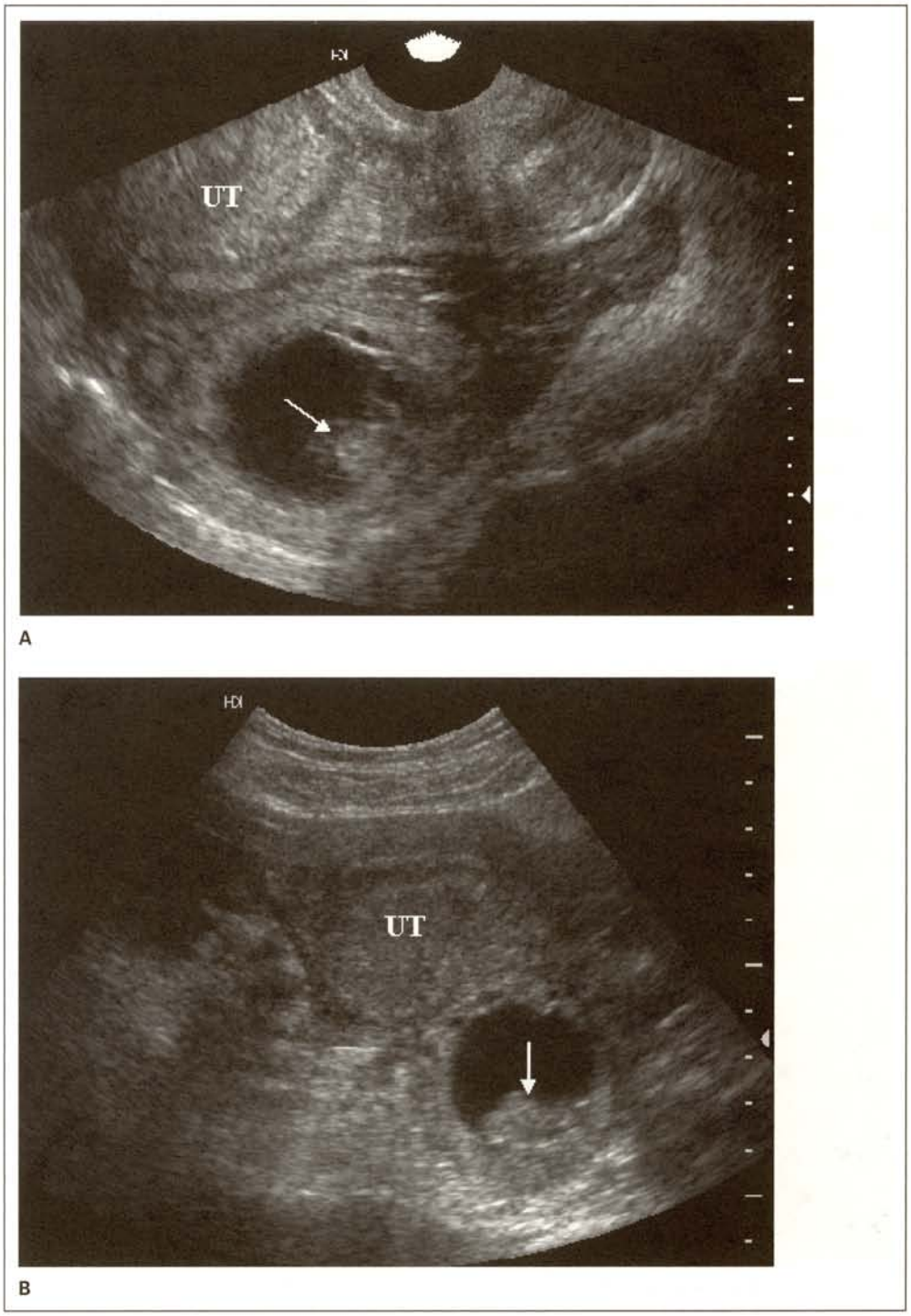

Figure 20.

Ectopic pregnancy. Longitudinal (**A**) and transverse (**B**) views through the uterus (UT). Note the gestational sac with embryo (arrow) located posterior to the uterus.