

# Value and Limitations of Obstetrical Ultrasound

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SUMMARY

**First-trimester ultrasound examination is of value to establish dates or assess fetal viability in cases of bleeding but provides limited information on the well-being of the fetus. At between 16 and 20 weeks' gestation, examination of fetal anatomy allows many abnormalities to be detected. Third-trimester ultrasound examination is predominantly for follow up of growth and normal development or of any abnormalities seen earlier.**

RÉSUMÉ

**Au cours du premier trimestre, l'échographie est utile pour préciser les dates ou évaluer la viabilité foetale en présence de saignement, mais elle fournit peu de renseignements sur le bien-être du foetus. Effectuée entre la seizième et la vingtième semaine de grossesse, elle permet d'examiner l'anatomie du foetus et de déceler de nombreuses anomalies. Pendant le troisième trimestre, l'échographie vise surtout à assurer le suivi de la croissance et du développement normal ou à surveiller l'évolution de toute anomalie identifiée antérieurement.**

*Can Fam Physician* 1992;38:121-128.



SINCE THE INTRODUCTION OF obstetrical ultrasound by Ian Donald in the early 1960s, it has been a very important tool in the evaluation of the pregnant patient and the fetus.<sup>1</sup> As equipment improves, so does our ability to display an image of the fetus. The result is that abnormalities can be diagnosed earlier and in greater detail.

**First trimester**

The ability to detect an early gestation has been improved with the use of endovaginal (EV) scanning. With this technique, a small intradecidual sac can be seen at approximately 4.5 weeks menstrual age.<sup>2</sup> The first structure to be visualized in the normal gestational sac is the yolk sac.

Using transabdominal technique, the yolk sac should always be visualized when the mean diameter of the gestational sac is 20 mm.<sup>3</sup> With EV scanning, the yolk sac should always be visualized when the gestational sac has a mean diameter of 8 mm.<sup>4</sup> The mean diameter of the gestational sac .....

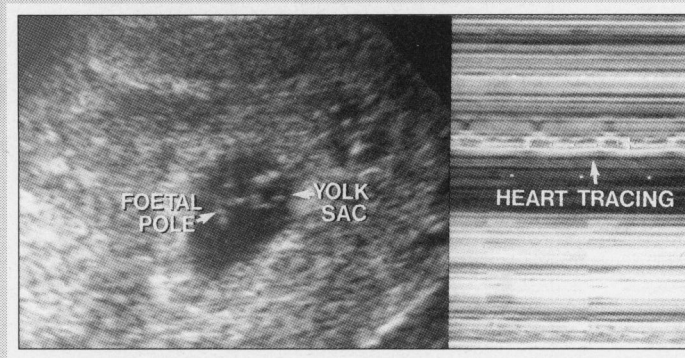
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measures 10 mm at 5 weeks and 20 mm at 6.5 weeks. With EV sonography at 6 weeks, an embryo with a crown-rump length as little as 1 to 2 mm can be seen adjacent to the yolk sac (*Figure 1*). Cardiac activity can usually be seen when the crown-rump length is greater than 3 mm.

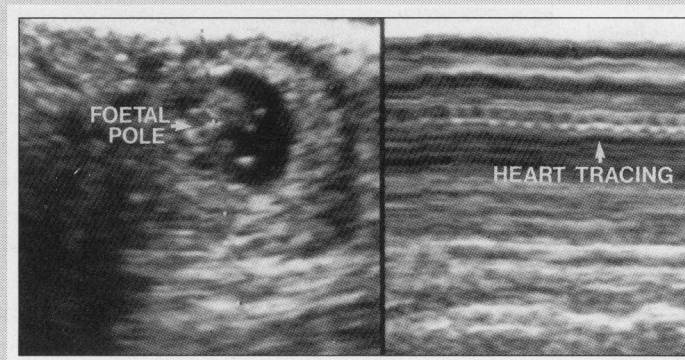
Multiple gestation can be diagnosed with examination of the chorion, amnion, yolk sac, or embryo. It is usually easier to differentiate between a monochorionic diamniotic twin pregnancy and a dichorionic diamniotic pregnancy during the first trimester than later on.<sup>5</sup>

One study estimated that the average rate of miscarriage is 31%, with the mean time around 11 weeks menstrual age.<sup>6</sup> Thus, an important function of ultrasound examination during the first trimester is to determine fetal viability. With EV techniques, the fetal heartbeat can be detected in embryos that are 2 mm long; however, normal embryos 4 mm long have been seen showing no cardiac activity. Therefore, if no cardiac activity is seen when the crown-rump length is less than 4 mm, a repeat scan is required.<sup>7</sup> At 6.5 weeks, when the crown-rump length is 6 mm, cardiac activity should always be seen by EV scanning. Other criteria for a missed abortion are a gestational sac with a mean diameter of 8 mm or more without a yolk sac or a gestational sac with a mean diameter of

**Figure 1. FETUS AT 6 WEEKS' GESTATION EXAMINED WITH ENDOVAGINAL TECHNIQUE**



**Figure 2. FETUS AT 8 WEEKS' ECTOPIC GESTATION IN LEFT ADNEXA: Thick wall surrounds the ectopic gestational sac.**



16 mm or greater without an embryo by EV sonography.<sup>4</sup>

Patients often present with endovaginal bleeding as the indication for an early scan. Subchorionic hemorrhage can appear in a live gestation. The volume of the hematoma can allow one to predict the outcome of the pregnancy. One study showed a correlated loss rate of 50% in a group of patients with endovaginal bleeding and subchorionic hemorrhage.<sup>8</sup>

Evaluation of the embryo is limited in the first trimester. Normal early development can resemble abnormal changes seen later on, such as midgut herniation. Embryos that appear normal in the first trimester can subsequently appear abnormal. A discrepancy between embryonic size and dates sometimes is the only indicator of embryonic abnormality in the first trimester. With improved technology, embryonic ab-

normalities, such as anencephaly and renal agenesis, can be diagnosed in the first trimester.

Ultrasound has been used for estimation of fetal age for the past 20 years. We can estimate menstrual age based on the gestational sac size or crown-rump length in the first trimester. The embryo can be visualized during the sixth week (menstrual age).

We prefer using crown-rump length from 7 to 12 weeks for dating; dates can then be established within 5 days menstrual age.<sup>9</sup> The high degree of accuracy probably can be achieved because there is little biologic variability in the early stages of development. Later on in fetal development, one has to take into account individual genetic variations, especially in our heterogeneous society.

The appearance of a molar pregnancy can be characteristic; however, such a preg-

nancy often is diagnosed by identifying the combination of a gestational sac without an embryo and high levels of human chorionic gonadotropin B (hCG-B).

Ultrasound plays an important role in the diagnosis of ectopic pregnancy. The incidence of ectopic pregnancy has been increasing, and in Western countries, it is now a leading cause of maternal death.<sup>10</sup> There are certain high-risk groups, such as women with a documented history of pelvic inflammatory disease, women who have undergone in vitro fertilization, and women who have been treated for infertility with tubal microsurgery. The presence of an intrauterine gestation makes the possibility of an extrauterine gestation extremely unlikely; however, concomitant intrauterine and extrauterine gestations occur in as many as one per 7000 pregnancies.<sup>11</sup> Ultrasound examination, including endovaginal scanning, is appropriate when ectopic gestation is suspected.

In some studies, overall accuracy for diagnosing ectopic pregnancy by EV scanning is 90% or better. In the study by Cacciatori,<sup>12</sup> the common finding suggestive of an ectopic gestational sac was an adnexal ring with a thickened echogenic wall; this was seen in 62% of patients with ectopic pregnancies (*Figure 2*). Within this ring, a yolk sac was seen in 15% and fetal echoes and heartbeat in 17%. A complex mass was seen in 32% of cases.<sup>12</sup>

Concomitant measurement of hCG-B and correlation with ultrasound findings is of great value in assessment of ectopic gestation.<sup>12,13</sup> In the normal pregnancy, there is a rapid increase in the hCG-B levels up to 8 weeks of gestation, after which levels plateau and subsequently decline. A gestational sac size between 5 and 25 mm has been shown to have a linear correlation with hCG-B.<sup>14</sup> In ectopic gestations, the hCG-B level also rises, but usually more slowly.

With transabdominal scanning, if the quantitative hCG-B level is greater than 1800 mIU/mL Second International Standard (2IS) and the uterus is empty on ultrasound examination, there is a strong likelihood of ectopic gestation or a spontaneous abortion. With EV scanning, an intrauterine gestation should be visible when the hCG-B level is 1000 mIU/mL (2IS). The

higher the hCG-B level in a patient with an empty uterus, the more likely the presence of an ectopic gestation. An hCG-B level lower than 1000 mIU/mL (2IS) with an empty uterus can indicate a normal early intrauterine gestation, an ectopic gestation, or a spontaneous abortion; a follow-up hCG-B measurement and ultrasound examination is suggested.

### **Second trimester**

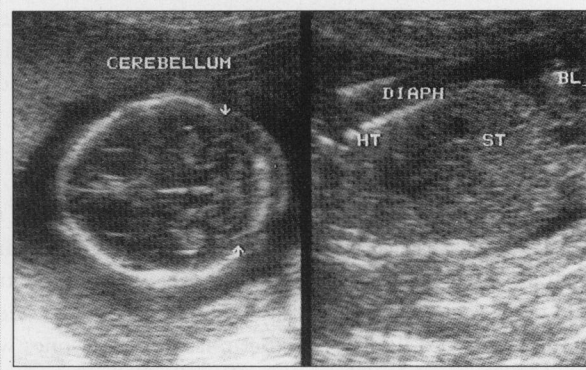
With the advancement of modern technology, a vast array of anomalies can be detected early in the second trimester, primarily between 16 and 20 weeks; only some of the more common ones will be described.

"Detailed" scans or "Level II" scans are usually indicated for high-risk women. Examples would include women who have previously had a fetus with a neural tube defect or other developmental anomalies, women with gestational diabetes, women age 35 and older, and those who have alcohol or drug addictions. Ultrasound plays a significant role in high-risk diagnostic procedures, such as amniocentesis and chorionic villi sampling.

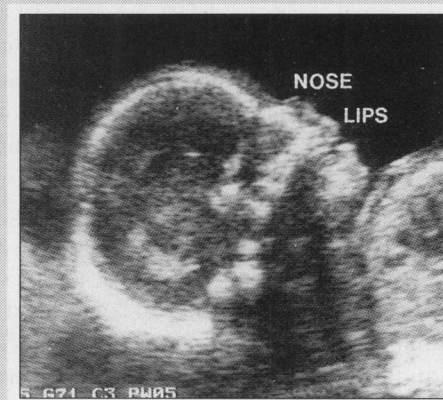
Central nervous system anomalies are among the most common abnormalities that can be detected with ultrasonography. Hydrocephalus is often the presenting sign of any CNS abnormality. Some causes are subarachnoid hemorrhage, Dandy-Walker syndrome, and aqueductal stenosis.<sup>15</sup> When scanning the fetal brain, careful attention should be given to the anterior and posterior horns of the lateral ventricles; the anterior horn measurement is normally no greater than 2 cm and the posterior horn measurement no greater than 1 cm.<sup>15,16</sup> The cerebellum should be identified, as well as the septum pellucidum. The cisterna magna should measure between 2 and 11 mm in sagittal diameter (*Figure 3*).

Many fetal spine anomalies can be detected by ultrasonography, but we will discuss only the most common. By far the most commonly detected anomaly is spina bifida occulta, in which the failure of the neural tube to close at the end of the sixth week results in non-fusion of the vertebral arches, most commonly detected in the lumbar region. Ultrasonography demonstrates abnormal neural arches, a normal spinal cord, and intact skin covering.

**Figure 3. SCAN THROUGH HEAD AND BODY OF A FETUS AT 16 WEEKS' GESTATION:** Anatomic details of the head and body are visible: HT – heart, ST – stomach, BL – bladder



**Figure 4. FETAL HEAD IN PROFILE AT APPROXIMATELY 28 WEEKS' GESTATION**



Associated CNS anomalies range from a meningocele or meningomyelocele to a totally open defect known as myeloschisis. There is also almost always a malformation of the brain known as the Chiari II malformation (or Arnold-Chiari deformity): a spectrum of anomalies with a basic malformation of the brainstem and cerebellum associated with dysraphism of the spinal cord and spine.

A mass lesion worth noting is the cystic hygroma. Cystic hygromas form secondary to sequestration of lymphatic tissue or lymphatic obstruction and are commonly detected in the cervical aspect of the fetus.<sup>17,18</sup>

The fetal long bones should be noted, and special attention should be paid to the measurements of these long bones if, for example, dwarfism is suspected.

Gastrointestinal abnormalities are also commonly detected in the second trimester.

The fetal stomach is routinely imaged as a fluid-filled structure in the left upper quadrant by 14 or 15 weeks.<sup>19</sup> Inability to detect the fetal stomach can indicate esophageal atresia; it can, however, be a normal variant under 20 weeks. Duodenal atresia is demonstrated on sonography as an overdistended stomach in the left upper quadrant connecting with an enlarged duodenum ("double bubble" sign). It can be diagnosed as early as 19 weeks.<sup>20,21</sup>

The colon can be identified as early as 22 weeks; by 28 weeks portions of the colon are identified in almost all fetuses.<sup>22</sup> Fetal bowel that appears acoustically abnormal, with intraperitoneal calcifications, can indicate meconium peritonitis, which results from intrauterine bowel perforation, and follow-up scans are always suggested.

Two main types of anterior abdominal wall defects are detected by ultrasound:

omphalocele and gastroschisis. Omphaloceles are more severe because they are commonly related to other types of abnormalities, including cardiac lesions, neural tube defects, and trisomies. Careful scanning of the entire fetus is therefore essential. Abdominal wall defects should not be diagnosed sonographically until 14 weeks because the fetal bowel migrates into the base of the umbilical cord as a normal embryonic event during the first trimester and returns to the abdominal cavity by 10 to 12 weeks.<sup>23</sup>

Diaphragmatic anomalies, which are much less common, involve herniation or displacement of abdominal contents into the thorax, thus distorting normal anatomic relationships. They can be seen by sonography in the early part of the second trimester.

Major genitourinary abnormalities of the fetus include agenesis, obstructive lesions, and renal cystic disease. The fetal kidneys can be seen as early as 14 weeks and routinely at 18 weeks.<sup>24</sup> Minimal caliectasis in fetal kidneys is commonly seen. Information about the fetal kidneys can be obtained through ultrasound evaluation of the amniotic fluid volume and observation of the bladder for urine production. The fetal bladder should be routinely seen by 16 weeks.<sup>25</sup>

The four-chamber view of the heart has become a routine view of any obstetrical scan in the second trimester. It is not possible to rule out all congenital disease, but it has been estimated that up to 95% of all serious congenital heart defects are suspected by abnormalities of the four-chamber view.<sup>26</sup> Any suspected abnormality calls for detailed scanning and fetal echocardiography.

### **Third trimester**

Scanning in the third trimester may be ordered to follow up conditions noted earlier, to investigate suspected growth disturbances, to monitor fetal well-being, or to collect information that will help in planning delivery management.

Dynamic fetal episodes of swallowing, hiccups, "breathing," eye movement, and even urinating can sometimes be seen. The fetal profile (*Figure 4*) and facial features, including the lip, palate, and nostril area, can sometimes be examined for cleft abnormalities. Such things as fetal hair, vernix in the amniotic fluid, and the fetal genital area

can also be visualized. Sex determination is a complex issue. People often enquire about the sex of their fetus, believing it is their right to know. Determining the sex of the fetus is sometimes helpful for certain diagnoses, but generally is not part of a routine obstetrical scan; the parent's wish to know the sex is not a good reason to order a scan.

If fetal hydronephrosis is noted in the late second or third trimester, it should be monitored, because prenatal diagnosis allows quicker and more effective management at birth. Kidneys that show a grade II or grade III hydronephrosis must be followed closely after birth; kidneys with a grade IV or grade V hydronephrosis are certainly pathologic and will require surgery. Hydronephrosis grades I through III should generally be followed up 3 to 7 days after birth when babies are better hydrated, so that mild to moderate hydronephrosis will not be overlooked.<sup>27</sup>

Vaginal bleeding in the second or third trimesters is an ominous sign. Bleeding in the third trimester occurs in approximately 4% of all pregnancies; approximately 20% of cases are caused by placenta previa and 30% by abruptio placenta. Both conditions increase fetal and maternal morbidity and mortality.<sup>28</sup>

The ultrasound report should comment on the site of the developing placenta as soon as it is seen. A 20% incidence of placenta previa is noted earlier than 20 weeks' gestation.<sup>29</sup> The incidence at term, however, has been reported in various studies to be approximately 0.3% to 0.5%.<sup>28,29</sup> This is because of placental migration, thought to be caused by differential growth of the lower uterine segment. A follow-up ultrasound could still be indicated in the late third trimester. Scanning with an overdistended bladder or during a myometrial contraction can artificially produce a placenta previa. At times the fetal lie can obstruct the lower edge of the placenta; endovaginal scanning can be used when the transabdominal method proves ineffective.

Abruptio placentae is a serious obstetrical complication associated with premature labor and delivery. It is seen in approximately 0.5% to 1.3% of all gestations and has been shown to account for 15% to 25% of all perinatal deaths.<sup>28,30-33</sup> The diagnosis

of abruptio placentae is often clinical rather than sonographic. There are many reasons for the varying reports of sonographic sensitivity in detecting abruptio placentae. The sonographic appearance of the bleed has been shown to vary with the time at which the ultrasound is performed. The location of the bleed plays an important factor, as hematomas can be confused with normal placenta, myomas, myometrial contractions, or chorioangiomas.<sup>28,33</sup> Comparison with a recent scan or a follow-up scan can be helpful in establishing a diagnosis.<sup>33</sup>

The biophysical profile, as outlined by Manning and colleagues,<sup>34</sup> attempts to gauge fetal well-being by examining fetal tone, movement, breathing, and amniotic fluid volume. The authors provide a point system to score these factors, along with the result of the non-stress test; recommendations for management are given for different scores. The biophysical profile has been used with varying results for high-risk pregnancy, post-dates pregnancy, intrauterine growth retardation (IUGR), premature rupture of membranes, and some maternal disorders.<sup>35</sup>

The primary measurements used to estimate fetal age and growth are the biparietal diameter, head circumference, abdominal circumference, and femur length.

Intrauterine growth retardation occurs when insufficient nutrition is supplied to the fetus. Fetuses are at risk for a variety of reasons, including chronic maternal disease, maternal drug ingestion, maternal age (under 17 or over 35), or maternal malnutrition. In symmetrical IUGR, the entire fetus is smaller than normal; in asymmetrical IUGR, the fetal trunk is smaller but the head is virtually normal. Approximately 10% of IUGR cases are due to a congenital anomaly, so detailed scanning is important. Scanning an IUGR fetus can be difficult for many reasons. If there is oligohydramnios present, visibility is greatly decreased and can make normal anatomy difficult to delineate.<sup>36</sup>

Intrauterine growth retardation is usually diagnosed by ultrasound when growth is less than expected in the third trimester.<sup>36</sup> However, diagnosis can be difficult unless the mother has accurate known dates or gestational age has been estimated from a previous appropriate ultrasound examination for dating. If the dates are not known,

the best approach is to try to establish the best estimated gestational age and rescan in approximately 2 weeks for appropriate interval growth. The head circumference to abdominal circumference ratio can give information as to whether the growth retardation is symmetrical or asymmetrical.<sup>36,37</sup>

### **General indications and uses for ultrasound**

The overall goals of obstetrical sonography are, on the one hand, to demonstrate fetal well-being by evaluating fetal morphology and biometry and, on the other hand, to identify abnormal fetuses and fetuses at increased risk of morbidity and mortality. Ultrasound makes it easier to look at the fetus as a separate entity while still keeping in mind maternal risk factors. There is ongoing research into finding better ways to establish gestational age and growth patterns, but it is a difficult task.

**Multiple gestation.** Ultrasound is extremely useful for diagnosis and monitoring of multiple gestations. Multiple births show an increased rate of perinatal morbidity and mortality, due largely to premature labor (75%) but also to a host of potential problems: an increased incidence of IUGR (10%)<sup>38,39</sup>; monoamniotic gestation; twin transfusion syndrome; maternal complications, such as diabetes mellitus and hypertension; and the fact that up to 30% of all unscanned twin pregnancies are clinically missed until birth, endangering the second fetus.<sup>38</sup>

Congenital anomalies are up to three times as prevalent with twins as with singletons.<sup>38-40</sup> At least one third of all twin pregnancies diagnosed in the first trimester end up as singletons; however, twins observed in the second trimester are likely to continue to term. Therefore, one can diagnose twins during the first trimester but should confirm the diagnosis during the second trimester.

A detailed scan should be performed between 16 and 18 weeks for size, diagnosis of anomalies, amniotic fluid volume estimation, visualization of membranes (to rule out monoamniotic twins), separate placentas (which can help to decrease the risk of twin transfusion syndrome), and sex (which can be helpful to determine dizygotic twins). As the pregnancy continues, serial

examinations will show growth, amniotic fluid volume, lie and presentation of the fetuses, and some anomalies that do not show up until late in pregnancy.<sup>38</sup>

**Insulin-dependent diabetic pregnancy.** Insulin-dependent diabetic mothers can benefit from serial ultrasound screening. The incidence of late pregnancy stillbirth has declined with better medical management, but mortality from lethal congenital anomalies and traumatic delivery because of macrosomia are still concerns. The incidence of congenital anomalies is approximately three times as great in the infant of a diabetic mother (cardiac anomalies are three to four times as likely; neural tube defects are three times as likely; and gastrointestinal and genitourinary anomalies are common).<sup>41</sup>

Along with maternal  $\alpha$ -fetoprotein levels at 16 weeks' gestation, detailed ultrasound examination to rule out anomalies is suggested between 16 and 18 weeks, possibly including fetal echocardiography performed by specialized, skilled personnel. Serial ultrasound examinations should be done to rule out growth disturbances, such as IUGR and macrosomia. Growth curves are generally parallel to the normal population until approximately 28 weeks' gestation. In macrosomia, recent studies have shown that the biparietal diameter usually stays in the normal to low-normal range throughout the pregnancy, while the femur and the abdominal circumference can be greater than the 90th percentile; therefore, abdominal circumference growth is important in assessment of the diabetic pregnancy. Serial ultrasound examinations beginning in the late second trimester will provide more information on either IUGR or macrosomial tendencies than a single estimation of fetal weight close to term, as fetal weight estimates have a high margin of error no matter which formula is used.<sup>41</sup>

**Planning delivery.** At any time during the pregnancy, but especially nearing term, valuable information can be obtained to aid in labor and delivery management. It is useful in determining an unusual fetal lie, especially when a cesarean section is being considered. Demonstrating the location of the placenta, the amount of amniotic fluid,

and the possibility of a nuchal cord can be of clinical significance.

**Ultrasound quality.** Many factors affect the quality of an obstetrical ultrasound examination: the type of equipment, the skill of the operator, maternal body habitus, patient bladder preparation and tolerance, gestational age, fetal movement, and the amount of amniotic fluid surrounding the fetus.

### Conclusion

Whether an obstetrical ultrasound examination or examinations should be performed routinely is controversial. In most European countries, it is performed routinely, but not in North America. Scanning during the first trimester should be reserved for questions of fetal viability or ectopic gestation.

If there is to be one scan during pregnancy, it should be performed between 16 and 18 weeks. This provides accurate dating and is good for diagnosing abnormalities in time for genetic counseling and decision making, if necessary.

A scan during the third trimester is sometimes indicated for follow up of growth complications or fetal well-being. The referring physician must decide what information he or she wishes to obtain from the ultrasound examination and the appropriate time to schedule it. ■

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### Acknowledgment

The authors thank Barb Ascott for her valuable assistance in the preparation of this manuscript and Dr R.M. Campbell for reviewing it.

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