

Sonographic Evidence of Early Pregnancy Failure

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Background

The embryonic phase of development is complete by the end of the 10th gestational week. Because of the complex sequence of events that occurs during this short time period, it is not unusual for complications to develop. Although a variety of terms are used to describe early pregnancy failure, in the presence of clear-cut sonographic evidence that a nonliving embryo is present, the term embryonic demise should apply.

Pathophysiology

In most instances, the etiology is unknown¹. In general, significant embryologic malformations that result in demise can be the result of genetic or chromosomal, environmental, or combined factors. Chromosome abnormalities are the leading known cause of pregnancy loss. An estimated 6-7% of zygotes have chromosome aberrations¹, and more than 95% of chromosomally abnormal concepti die in utero. Although the precise incidence is unknown, cytogenic abnormalities are reported in 20% of concepti in women who undergo in vitro fertilization² and in 70% of women with spontaneous abortion³. In addition, many chromosome aberrations increase with advancing maternal age⁴. This is particularly true for Down syndrome (trisomy 21) but is also evident with other less common trisomies.

Pathologic examination of chromosomally abnormal concepti confirms trisomy in approximately 50% of cases.

The timing of exposure to environmental causes or teratogens is crucial to the outcome of pregnancy. Early exposure, typically before 5 weeks gestational age (GA), has an all-or-none result such that the embryo will either die or be unaffected¹. Not surprisingly, exposure during the period of organ formation (5-10 wk) usually affects organ development and results in either demise or severe congenital abnormalities. Environmental causes include immunologic

Once implantation has occurred, another cause of early pregnancy failure relates to an inability of the corpus luteum to adequately support the conceptus⁵. This condition, which tends to occur with maternal obesity and/or advancing maternal age, can be treated successfully during the embryonic phase of development by administering human chorionic gonadotropin (hCG).

A developmental uterine anomaly such as a uterine septum or acquired uterine anomalies such as submucosal, large, or degenerating leiomyomas also can increase the incidence of embryonic demise.

Frequency

In the USA, an estimated 75% of pregnancies fail to result in a living offspring. Of course, most of these failures occur before implantation of the gestational sac. In these chemical or preclinical pregnancies, the only proof of pregnancy is a transiently positive pregnancy test and possibly a history of an atypical menstrual cycle. According to some investigators^{6, 2} the incidence of loss following implantation ranges from 20-31%.

Studies confirm that during embryonic development, the rate of pregnancy failure is inversely related to GA and that with onset of fetal development (beginning at 11 wk GA), demise becomes relatively unusual. Using vaginal ultrasound, one study⁷ showed that if a gestational sac was visible, the embryonic loss rate was 11.5%; with a yolk sac it was 8.5%; with an embryo less than 5 mm in length, it was 7.2%; and with an embryonic length of 6-10 mm, it was 3.3%. In contrast, loss during the fetal phase of development was 2%.

Trans-Vaginal Versus Trans-Abdominal Route

Transabdominal probes are limited because they typically use 3.5-5 MHz transducers compared to transvaginal probes, which use 5-10 MHz transducers with higher resolution. Even if a 5-MHz transducer is used for a transabdominal and transvaginal scan, the transabdominal images of an early intrauterine pregnancy (IUP) would be inferior to those obtained by the transvaginal probe. This is because the transvaginal probe is physically closer to the object being scanned, and the transvaginal ultrasound beam does not

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factors, drugs, infectious agents, alcohol, smoking, environmental chemicals, and radiation.

traverse the abdominal wall. This results in fewer near-field artifactual echoes. These comparative effects are most pronounced when scanning obese patients and RVF uteri.

A limitation of the transvaginal approach is if a large pelvic mass is present that precludes visualizing the intrauterine contents. Most often, large or strategically placed calcified uterine fibroids cause this problem. Under these circumstances, an abdominal approach should be used in an effort to image the uterus and its contents.

Another limitation is if the ultrasound study is performed prior to the time a yolk sac can be detected. Using a vaginal approach, this structure should be observed by 5.5 weeks GA. If a small saclike structure is imaged but it does not contain a yolk sac, it is often not possible to determine if the intrauterine finding is the result of an early IUP or a pseudosac associated with an ectopic pregnancy. In these instances, careful evaluation of the adnexa may be helpful to detect an ectopic pregnancy. Occasionally, serial ultrasound and/or hCG determinations may be required to determine the etiology for the intrauterine sac.

Sonographic Predictors for Poor Pregnancy Outcome

Abnormal Sac Criteria

1. Appearance of the Gestation Sac

An early normal intrauterine gestational sac often can be identified transabdominally by 31 days GA and can consistently be identified by 35 days GA. To confidently diagnose an IUP, most sonographers rely on the double decidual sac (DDS) finding, which is not universally present until the mean sac diameter (MSD) is 10 mm (40 d GA)⁸ (Figure 1).



Figure 1. This very small sac (arrow) is positioned within the anterior decidua. Note the linear central cavity echo positioned just deep to the sac. This relationship characterizes a normal appearing intradecidual sac sign (Courtesy of Dr K Sweedan).

2. Growth rate

In normal gestation, mean sac growth is 1.13 mm/d; in comparison, mean sac growth in an abnormal intrauterine gestation is 0.70 mm/day⁹. Based on these observations, abnormal sac growth can be diagnosed confidently if the gestational sac fails to grow by at least 0.6 mm/day.

3. Chorionic Appearance

This refers to the sonographic appearance of the echoes that surround an early intrauterine gestational sac. An abnormal appearance includes a distorted sac shape; a thin (<2 mm), weakly



echogenic, or irregular chorionic reaction (Figure 2)

Figure 2. Distorted sac shape with thin hypoechoic chorionic reaction (Courtesy of Dr K Sweedan).

The Difference between CRL & MSD

From 5.5-9 weeks GA, the mean gestational sac size (MSS) is normally at least 5 mm greater than the CRL. When this difference is less than 5 mm, the subsequent spontaneous abortion rate exceeds 90%¹⁰ (figure 3). The etiology for first trimester (oligohydramnios) is unclear, but this observation suggests that with suboptimal first trimester gestational sac growth, a high likelihood of pregnancy loss exists.

Abnormal Yolk Sac / Amnion

The yolk sac normally forms by 28 menstrual days and is the first structure visible in the gestational sac. Normally, it should be seen on a transabdominal scan when the mean sac diameter (MSD) is 20 mm or larger¹¹. This corresponds to

a GA of 7 weeks. Transvaginal transducers can uniformly detect the yolk sac when the MSD is 8 mm or larger¹². This corresponds to a GA of 5.5 weeks. Failure to visualize a yolk sac when the GA has reached these discriminatory values signals the pregnancy is not progressing normally.

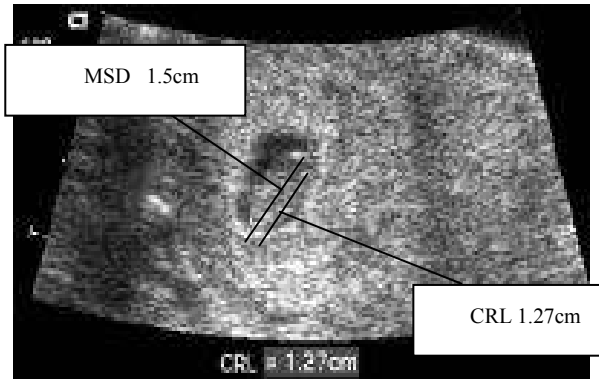


Figure 3. This embryo was 8 weeks gestational age. Lack of fluid surrounding the embryo results in a disproportionately small sac. A follow-up scan 1 week later revealed demise (Courtesy of Dr K Sweedan).

An abnormal appearing yolk sac also can predict subsequent demise. Abnormal features include large size (diameter greater than 6 mm), calcification or echogenic material within the yolk sac, and a double appearance to the yolk sac¹³.

The amnion develops somewhat earlier than the yolk sac, but because this membrane is so thin, it is more difficult to visualize than the yolk sac. Normally, the amnion is visible on transabdominal scans late in the embryonic period. If the amnion is easily seen, it is probably too thick and most likely is abnormal. Other features consistent with pregnancy failure include a visible amnion without a simultaneously visible yolk sac, embryo, or cardiac activity. An enlarged amniotic sac is another sonographic sign that predicts a failed pregnancy or embryonic death¹⁴.



Figure 4. Abnormal enlarged Yolk Sac (Courtesy of Dr K Sweedan).

Figure 5. Double Yolk sac for single fetus (Courtesy of



Dr K Sweedan).

Subchorionic Hemorrhage

As many as 18% of women with vaginal bleeding during the first half of pregnancy have sonographic evidence for a subchorionic hemorrhage as the etiology for their bleeding¹⁵. The clinical significance of this type of hemorrhage is controversial, with some investigators reporting an increased incidence of spontaneous abortion^{16, 17}, while others conclude this condition does not adversely affect pregnancy outcome¹⁵. Several authorities have suggested that the size of the blood clot can be used to predict the outcome¹⁶; this has not been universally accepted¹⁸.



Figure 6. Subchorionic hematoma Sac (Courtesy of Dr K Sweedan).

Bradycardia

At 5-6 weeks GA, the mean embryonic heart rate is 101 (bpm). This rate increases to 143 bpm by 8-9 weeks and plateaus at approximately 140 bpm. It is not unusual for an initially detected embryonic heart rate to be somewhat slower than

the fetal heart rate recorded later in pregnancy. In one study, all embryos from 5+ to 8+ weeks GA in which the heart rate was less than 85 bpm resulted in spontaneous miscarriage¹⁹.

Doppler Findings

Some reports suggest if the resistive index is measured at the subchorionic level and exceeds 0.55, a high likelihood of spontaneous abortion exists²⁰; however, others claim that Doppler analysis of these vessels are not predictive of outcome²¹.

Visualizing a living embryo

One group of investigators, who used a transabdominal approach²², recommended that when using a transabdominal approach, 9 mm should be considered the discriminatory CRL for detecting cardiac motion. Used in this manner, the discriminatory level denotes the numeric value when a certain finding should always be present.

Given its superior resolution, vaginal ultrasound scans can detect cardiac activity with a smaller embryonic CRL. Investigators recommend that when a transvaginal approach is used, 4 mm be considered the discriminatory embryonic length for detecting cardiac motion. Other investigators suggest 5 mm as the discriminatory embryonic size for detecting cardiac motion²².

If an embryo exceeds the discriminatory length and cardiac activity is absent, a nonviable gestation should be diagnosed. This observation should be made by two independent observers, and interpretive caution must be exercised in any questionable case.

If the length of the embryo is less than the discriminatory value, the patient should be managed expectantly, and a repeat ultrasound examination should be performed when the expected embryonic CRL exceeds the discriminatory value. Alternatively, or additionally, the level of serum hCG may be useful for determining whether a normal IUP is present.

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