Guidelines for early first trimester ultrasound

WHY?

The purpose of the scan is to:

- Confirm an intrauterine pregnancy.
- Evaluate the presence, size, location, and number of gestational sac(s).
- Confirm the presence of a yolk sac and embryo/fetus.
- Confirm viability (cardiac activity, heart rate).
- Assign gestational age.
- Evaluate the uterus, cervix, adnexa, and cul-de-sac region.

WHEN?

- The embryonic stage of human development extends from conception to 10 weeks of gestation.
- Ultrasound scan can be offered during the embryonic stage at any time in the presence of any clinical concerns, pathological symptoms or specific indications (e.g. Pelvic pain, vaginal bleeding).
- This guideline will address sonographic evaluation of intrauterine pregnancies during the gestational age range of 5.0 to 8.0 weeks.

EQUIPMENT

It is recommended to use equipment with at least the following capabilities:

- Real-time, gray-scale, two-dimensional (2D) ultrasound.
- Transvaginal ultrasound transducers (TVS).
- Adjustable acoustic power output controls with output display standards.
- Freeze frame and zoom capabilities.
- Electronic calipers.
- Capacity to print/store images.

There is general consensus that, obstetrical ultrasound examinations at less than 10 weeks of gestation are best performed transvaginally.

SAFETY

- Embryonic exposure times should be minimized, using the shortest scan times and lowest possible power output needed to obtain diagnostic information using the ALARA (As Low As Reasonably Achievable) principle.
- There is a consensus that the use of B-mode and M-mode ultrasonography, due to its limited acoustic output, appears to be safe for all stages of pregnancy.
- Doppler examinations, however, should only be used if clinically indicated.

TRANSVAGINAL SONOGRAPHIC LANDMARKS

The progression of findings in normal early first trimester pregnancies follows a highly predictable sequence as documented by transvaginal ultrasound, ± 0.5 Week for the 1st visibility of each structure.

Gestational Sac

- The first sonographic evidence of pregnancy.
- The gestational sac represents the choriodecidual interface and the extra-embryonic mesoderm.
- It is first seen at 4.5-5 weeks, as a hypoechoic ring like 2-4 mm structure surrounded by a hyperechoic rim. It is located slightly paracentrically in the decidua. Figure 1
- It grows at the rate of 1 mm/day over the course of the next week.
- It shouldn't be confused with intracavitary fluid collection (pseudo-gestational sac of ectopic pregnancy). Figure 2
- With the appearance of the yolk sac and the embryo, the gestational sac becomes more ellipsoid.
- In an asymptomatic patient, it is advisable to wait until the embryo becomes visible within the intrauterine sac as this confirms that the 'sac' is indeed a gestational sac.
- In a woman with a positive pregnancy test and TVS revealed a pseudogestational sac or decidual cyst, treatments that could damage an intrauterine pregnancy should be avoided unless a potentially normal intrauterine pregnancy is certainly ruled out.

Yolk Sac

- The secondary yolk sac is the earliest embryonic landmark visualized by ultrasound.
- The yolk sac is usually seen at about 5-5.5 weeks of gestation and remains visible for most of the first trimester.
- It appears as a small ring typically close to the wall of the gestational sac with highly echogenic borders. Figure 3
- A small yolk sac with a diameter less than **3** mm between 6 and 10 weeks or a diameter of more than **7** mm before 9 weeks requires a follow-up ultrasound examination to assess normalcy of pregnancy. Figure 4

Embryo

- At the end of 5th week gestation, the embryo can be seen as a focal thickening on top of the yolk sac (at the **2** to **3** mm length size). At this stage the fetal heart rate is about 100-115 beats /minute.
- The size of the embryo increases by approximately 1 mm per day in length.

- At **6** weeks of gestation, the embryo appears as a thin cylinder with no discernible body parts, “the grain of rice appearance” adjacent to the yolk sac with a flickering motion inside it, representing the beating heart. Figures 5, 6 & movie 1.
- By 7.0 weeks, the embryo is approximately 1 cm in length and is still fairly featureless. The amnion first becomes visible around the embryo, as the amniotic cavity enlarges with fluid between the embryo and the amnion. While the yolk sac remains in the extracelomic cavity. Figures 7,8
- When the embryo is of around 12 mm length, the cephalic end of the fetus is distinguishable by the cavity of the rhombencephalon (will eventually form pons and cerebellum). The rhomboencephalon is visible as a small hypoechoic area at the cranial pole of the embryo. Figure 9
- By 8 weeks of gestation, the embryo is around 16 mm in length, and develops body curvature and delineation of a head, trunk, and limb buds “the gummy-bear appearance”. Figure 10
- More clear delineation of the head, chest, abdomen, and extremities is noted at 9- **10** weeks of gestation and beyond.

Cardiac activity

- Cardiac activity is often evident when the embryo measures 2 mm, but it can be consistently seen when the embryo reaches a 5-7 mm in length or greater.
- Cardiac activity should be seen by 6 to 6.5 weeks.
- Embryonic heart rate is around 100 to 115 before 6 weeks, rising to 145 to 170 at 8 weeks, and dropping down to a plateau of 137 to 144 after 9 weeks of gestation. Figure 11

GUIDELINES FOR EXAMINATION

Assessment of gestational age

Except in pregnancies arising following assisted reproductive technology, pregnant women should be offered an early ultrasound scan to establish accurate gestational age.

The mean gestational sac diameter (MSD)

The average of the three orthogonal measurements of the fluid-filled space within the gestational sac.

The crown rump length (CRL)

- Once the embryo is visible, the most accurate way to assign gestational age is via the CRL.
- In very early gestation, neither the crown nor the rump can be identified at this gestational age, a measurement is actually along the embryo's greatest length.
- Care must be taken to avoid inclusion of structures such as the yolk sac.
- At around 6-9 weeks the embryo is typically flexed, the actual measurement is neck to rump but it is still termed CRL.

- Gestational age can be estimated with high accuracy by measuring the CRL between 10+0 and 13+6 weeks.

- a midline sagittal section of the whole embryo or fetus should be obtained.
- Ideally, the embryo or fetus is oriented horizontally on the screen.
- The image should be magnified sufficiently to fill most of the width of the ultrasound screen.
- Electronic linear calipers should be used to measure the fetus in a neutral position (i.e. neither flexed nor hyperextended).
- The end points of crown and rump should be defined clearly. Figure 12
- Presence of amniotic fluid between the chin and chest ensure that the fetus is not flexed.

Assessment of viability/early pregnancy

1- **Viable pregnancy:** It can potentially result in a live born baby. It is identified sonographicaly by the presence of intrauterine gestational sac containing a fetus with heart activity.

2- **Non viable pregnancy:** It can not possibly result in a live born baby. A cautious approach is advised to avoid misdiagnosis.

Criteria proposed to definitively diagnose failed intrauterine pregnancy (miscarriage):

- **Initial scan criteria:**
  - MSD of equal to or greater than 25 mm without an embryo. Figure 13a
  - Crown-Rump length of equal to or greater than 7 mm without cardiac activity. Figure 13b

- **Time-based criteria (abnormal progression of findings on sequential scans):**
  - Absence of embryo with heartbeat at 2 or more weeks after an ultrasound that showed a gestational sac without a yolk sac.
  - Absence of embryo with heartbeat at 11 days or more after an ultrasound that showed a gestational sac with a yolk sac. Figure 14
  - *The time-based criteria are needed because in several cases of early pregnancy failure, the CRL and MSD never reach a size of 7 mm and 25 mm, respectively.*

3- Pregnancy of uncertain viability (PUV)

- A condition in which neither a diagnosis of viable intrauterine pregnancy or non-viable intrauterine pregnancy can be confirmed.

- **Sonographic findings suspicious for but not diagnostic of pregnancy failure:**

- Crown-rump length of < 7 mm and no heartbeat.
- Mean sac diameter of 16-24 mm and no embryo.
- Absence of embryo ≥ 6 weeks after last menstrual period.
- Empty amnion (amnion seen adjacent to yolk sac, with no visible embryo). Figure 15
- Expanded amnion (Embryo with no cardiac activity, with amnion visible around it).
- Enlarged yolk sac (> 7 mm).

- *When findings are suspicious for pregnancy failure, follow-up ultrasound in 7 to 10 days is generally appropriate.*

ULTRASOUND IN THE EMBRYONIC PERIOD OF TWIN PREGNANCY

Pregnancy number (singleton, twin, triplet, and higher order multiples) assessed prior to 6 weeks of gestation may subsequently decrease owing to the vanishing twin phenomenon or may increase by one or more additional embryos that appear on a follow-up scan.

Dating of twin pregnancy

In pregnancies conceived spontaneously, the larger of the two CRLs should be used to estimate gestational age.

Determining chorionicity/amnionicity in twin pregnancy

- Until 8 weeks of gestation, the presence of two distinct gestational sacs with embryos/cardiac activities confirms a dichorionic/diamniotic twin gestation. Figure 16
- In monochorionic- diamniotic twins; one gestational sac is identified but each embryo has its own amniotic sac and yolk sac. Figure 17
- Later on, when two adjoining gestational sacs are seen within the endometrial cavity, If the placenta appears to fill the junction of the dividing membrane(s) at its insertion into the placenta, resulting in a thick wedge-shaped configuration (**lambda** or **twin-peak sign**), this is diagnostic of dichorionic/diamniotic placentation. Figure 18
- In monochorionic pregnancies, the dividing membrane attach to the uterine wall in a thin **T-shaped** configuration without any placental tissue at its insertion site.

Labeling of twin fetuses

Twins are labeled according to their site, either left and right, or upper and lower and should be documented clearly.

SELECTED REFERENCES

1. ISUOG Practice Guidelines: performance of first-trimester fetal ultrasound scan. Ultrasound Obstet Gynecol 2013; 41: 102–113.
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3. Fetal biometry and pregnancy dating in the first trimester. In: Abuhamad A and Chaoui R. First Trimester Ultrasound Diagnosis of Fetal Abnormalities. Wolters Kluwer. 2018; p 86-107.
4. Preisler J, et al. Defining safe criteria to diagnose miscarriage: prospective observational multicentre study. BMJ 2015;351:h4579.
5. ISUOG Practice Guidelines: role of ultrasound in twin pregnancy. Ultrasound Obstet Gynecol 2016; 47: 247–263.
6. Multiple pregnancies in the first trimester. In: Abuhamad A and Chaoui R. First Trimester Ultrasound Diagnosis of Fetal Abnormalities. Wolters Kluwer.2018; p 200-229.
7. Doubilet PM, Benson CB. Ultrasound of the Early First Trimester. In: Callen`s ultrasonography in obstetrics and Gynecology. Elsevier. Six edition 2017: 82-97.

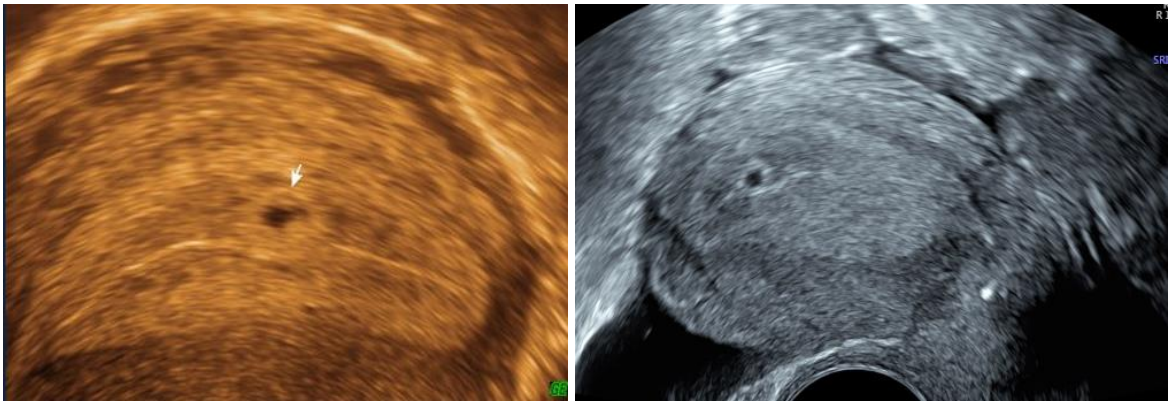

Figure 1. 4.5-week pregnancy. The intrauterine gestational sac with echogenic ring and no identifiable internal structures, lies within the decidua. The sac abuts the endometrial canal eccentric to linear interface of endometrial surfaces (intradecidual sac sign).

Figure 2. a. A mid sagittal plane of the uterus with intracavitary fluid (pseudosac),
b. Extrauterine **e**ctopic gestational sac with a yolk sac adjacent to left ovary.

Figure 3. Two gestational sacs at 5 and 5.5 weeks' gestation each containing a yolk sac (small ring with highly echogenic borders). No embryo is seen.

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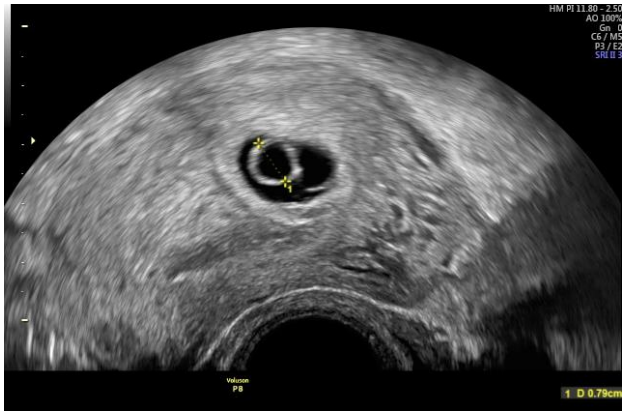


Fig 4. a gestational sac containing a large yolk sac measuring 7.9 mm.

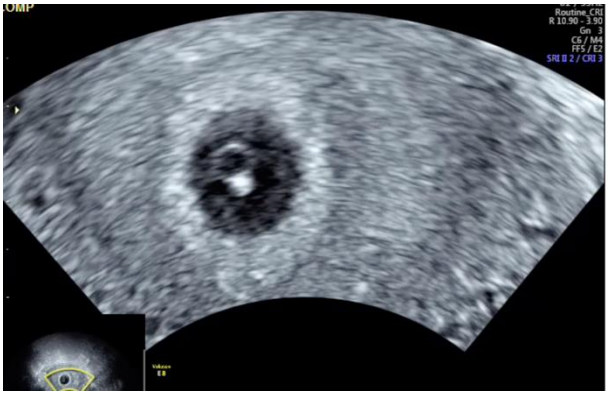


Figure 5. A 6weeks' pregnancy, the gestational sac containing a yolk sac and an embryo measuring 3.2 mm in CRL. Note the close proximity of the embryo to the free wall of the yolk sac that give the appearance of a diamond engagement ring at this gestation.

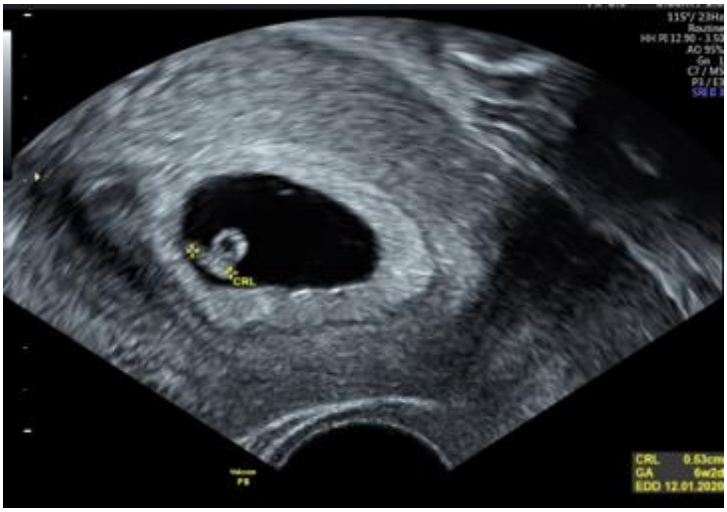


Figure 6. A 6 + 2 weeks' pregnancy. The gestational sac containing a yolk sac and an embryo with a 5.3 mm CRL. Note the straight shape of the embryo with no discernible body parts, "the grain of rice appearance".

Figure 7. A7 weeks' pregnancy. The embryo is surrounded by a thin membrane. Fluid is present within the amniotic cavity, separating the amnion from the embryo.

Figure 8. A7 weeks + 5 days dichorionic twin pregnancy. The amnion surrounds the shown embryo but not the yolk sac, which remains in the extracelomic cavity.

Figure 9. An embryo with CRL measuring 12 mm keeping with 7 weeks + 3 days' gestation. The rhomboencephalon is visible as a small hypoechoic area at the cranial pole of the embryo. The amnion surrounds the embryo but not the yolk sac, which remains in the extracelomic cavity.

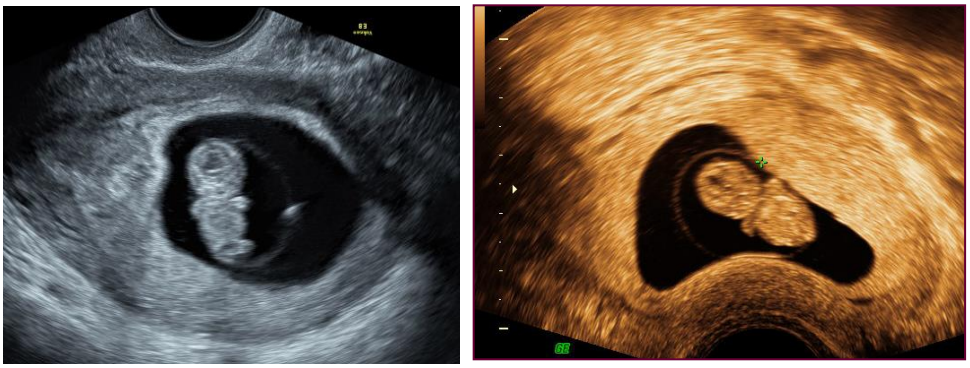


Figure 10. Gestational sac with an embryo at 8weeks+ 5days. Note the body curvature of the embryo and delineation of a head, chest, abdomen, and limb buds, resembling a "gummy bear" in shape.

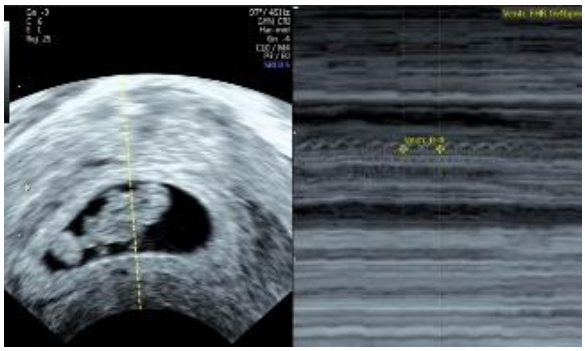


Figure 11. Embryonic heart rate measurement by M-mode.

Figure 12. A 12-week fetus. The crown-rump length (CRL) measurement corresponds to the longest straight line from the top of the head to the rump region.

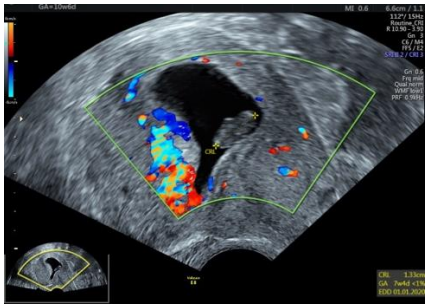
a.  b. 

Figure 13. Non viable pregnancy. a. mean sac diameter ≥ 25mm no embryo
b. CRL ≥ 7mmm no heart activity

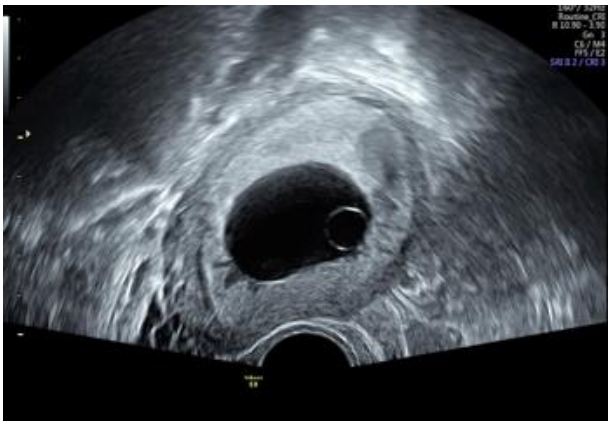


Figure 14. Failed intrauterine pregnancy: an initial scan demonstrated a gestational sac with a yolk sac but no embryo, followed by a scan 11 days later in which no embryo with a heartbeat was visible.

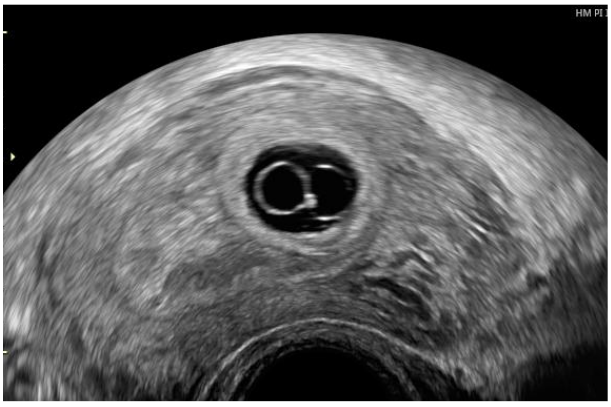


Figure 15. Suspected pregnancy failure: empty amnion sign; two circular structures within the gestational sac representing the yolk sac and amnion. No embryo is visible.

Figure 16. Dichorionic-diamniotic twin pregnancy (7 weeks' gestation)**.** Two distinct gestational sacs with embryos/cardiac activities.

Figure17. A 7 -weeks monochorionic- diamniotic twins; one gestational sac but each embryo has its own amniotic sac and yolk sac.

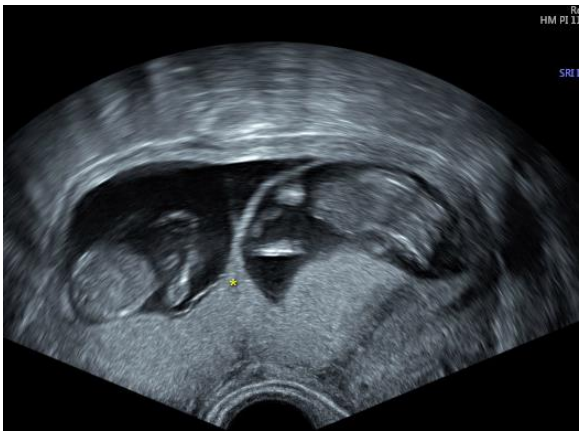


Figure 18. Dichorionic-diamniotic twin pregnancy. Note the thick dividing membrane with a twin-peak sign (*star*) at the placental insertion of the membranes.