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Ultrasound Notes for Trainees

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□ Guidelines for Dating Early Pregnancy (Callen 2000)

Stage of development	Gestational age (weeks)
Gestational sac (no yolk sac embryo, heartbeat)	5.0
Gestational sac and yolk sac (no embryo, no heartbeat)	5.5
Gestational sac and yolk sac (living embryo too small to measure)	6.0

Formulas to Calculate gestational age:

Mean sac diameter (mm) + 30 = gestational age (days) (between 5 and 11 weeks)

Crown-rump length (mm) + 42 = gestational age (days) (between 6 and 9.5 weeks)

Using the trans-abdominal approach an intrauterine gestational sac may be visible when the bHCG units are > 2000 units, and when using the trans-vaginal approach a sac may be visualised when the bHCG is > 1000 units

Calculation of Mean Sac Diameter (MSD):

$$\frac{\text{Length} + \text{Width} + \text{Anterior-posture diameter}}{3} = \text{MSD}$$

Divide by 3

□ CALCULATION OF EDD / EDC

Stage of development	Gestational Age (weeks)
0 – 6 weeks	
Gestational sac (no yolk sac, embryo, heartbeat)	5.0
Gestational sac with yolk sac but no embryo, no heartbeat.	5.5
Gestational sac with yolk sac (living embryo too small to measure)	6.0

Errors in calculation of EDD

by USG = **± 8% of the estimate.**

For example:

- CRL of 8 weeks = **± 4.5 days** (error acceptable)
- CRL of 12 weeks = **± 6.7 days** (acceptable)
- (BPD + FL) 15 weeks = **± 8.4 days** (acceptable)
- (BPD + FL) 20 weeks = **± 11.2 days** (acceptable)
-
- (BPD + FL) 24 weeks = **± 13.4 days (2 weeks)Unacceptable**
- (BPD + FL) 30 weeks = **± 16.8 days..... Unacceptable**
- (BPD + FL) 34 weeks = **± 19.04 days.....Unacceptable**

- (BPD + FL) 36 weeks = \pm 20.4 days (3 weeks)..... **Unacceptable**
- (BPD + FL) 40 weeks = \pm 22.4 days (3 weeks)..... **Unacceptable**

Crown –Rump Length (CRL)

Hansemann M et.al.

Geburtsh Frauenheilk 1979;39:656-666

GA (wks)	-2SD	Mean	+2SD
7+1	2.3	6.9	11.5
7+2	2.8	7.6	12.5
7+3	3.2	8.3	13.4
7+4	3.6	9	14.3
7+5	3.9	9.6	15.2
7+6	4.3	10.2	16.1
7+7	4.7	10.8	16.9
8+1	5	11.4	17.8
8+2	5.4	12.1	18.7
8+3	5.8	12.7	19.6
8+4	6.2	13.3	20.5
8+5	6.6	14	21.4
8+6	7	14.7	22.4
8+7	7.5	15.4	23.4
9+1	8	16.2	24.4
9+3	9.1	17.8	26.5

9+5	10.3	19.6	28.8
9+7	11.7	21.5	31.2
10+2	13.3	23.6	33.9
10+4	15.1	25.9	36.6
10+6	17	28.3	39.6
11+2	20.3	32.4	44.4
11+4	22.7	35.3	47.9
11+6	25.2	38.3	51.4
12+2	29.3		

Gestational Sac Diameter versus Gestational Age

Daya S et.al. Can Med Assoc J 1991;144:441

Mean sac diameter	95% Confidence interval	Mean	95% Confidence interval
2	4.5	5	5.5
3	4.6	5.1	5.6
4	4.8	5.2	5.7
5	4.9	5.4	5.8
6	5	5.5	6
7	5.1	5.6	6.1
8	5.3	5.7	6.2
9	5.4	5.9	6.3
10	5.5	6	6.5
11	5.6	6.1	6.6
12	5.8	6.2	6.7
13	5.9	6.4	6.8
14	6	6.5	7

15	6.2	6.6	7.1
16	6.3	6.7	7.2
17	6.4	6.9	7.3
18	6.5	7	7.5
19	6.6	7.1	7.6
20	6.8	7.3	7.7
21	6.9	7.4	7.8
22	7	7.5	8
23	7.2	7.6	8.1
24	7.3	7.8	8.2

□ PREGNANCY FAILURE

An experienced operator using high quality transvaginal equipment may diagnose pregnancy failure under either or both of the following circumstances:

- When no live fetus is visible in a gestation sac and the mean sac diameter is 2.0cm or greater.
- When there is a visible fetus with a CRL of 6mm or more, but no fetal heart movements can be demonstrated. The area of the fetal heart should be observed for a long period of at least 30 seconds to ensure that there is no cardiac activity.

In situations where pregnancy failure is suspected by an operator who does not have extensive experience in making the diagnosis or does not have access to high quality equipment or if there is any doubt about the viability of the fetus, a second opinion or a review scan in one week should be recommended in the report. (ASUM Guidelines)

□ FETAL GROWTH MEASUREMENTS

These measurements are taken for dating and as a baseline for subsequent growth studies. The measurements undertaken for gestational age are based on the BPD (Accuracy at this stage + - 7 days up to 20 weeks). **Ref: Callen 2000**

- @ Biparietal diameter: BPD
- @ Head circumference: HC
- @ Abdominal circumference: AC
- @ Femur length: FL

1. BI-PARIETAL DIAMETER.

The BPD is obtained through a plane of section that transverses the third ventricle and thalami, (not necessarily the widest distance between the parietal eminencies). The calvaria are smooth and symmetric bilaterally. The calipers are placed on the outer edge of the near calvarial wall and the inner edge of the far calvarial wall.

2. HEAD CIRCUMFERENCE

The correct plane is through the third ventricle & thalami in the central portion of the brain. The cavum septum pellucidum must be visible in the anterior portion of the brain & the tentorial hiatus visible in the posterior portion of the brain.

The calvaria must be smooth and symmetric bilaterally. The calipers are placed on the outer edge of the calvaria and the machine computer generates an ellipse, which is fitted to the calvarial margins.

3. ABDOMINAL CIRCUMFERENCE (Callen, 2000)

The correct cephalo-caudal (transverse) plane is where the right & left portal veins are continuous with one other. Ensure that the transducer is right angles to the spine/aorta.

The appearance of the lower ribs is symmetric

The shortest length of the umbilical vein is seen.

The calipers are placed so that the ellipse is fitted to the skin edge

Heavy pressure of the transducer to be avoided.

4. FEMUR LENGTH

Align the transducer to the femur & freeze the plane that shows the full length of the bony diaphysis; (the normal diaphysis has a straight lateral border and a curved medial border)

Calipers are placed at both ends of the bone (avoiding the distal femoral point) ensuring square end points.

Fetal Growth Summary

Manifestation	Hypoplastic IUGR (intrinsic IUGR)	Hypotrophic IUGR (Nutritional IUGR)	Small for Gestational Age
Size	< 10%ile estimated. fetal weight	< 10%ile estimated. fetal weight	< 10%ile estimated. fetal weight
Biometrics	Symmetric head, femur abdomen small	Asymmetric, head, and femur spared, abdomen small	Symmetric, all measurements small
Doppler	Increased umbilical SD ratio if fetal distress, uterine SD normal	Increased umbilical SD ratio if fetal distress, uterine SD may be abnormal	Normal umbilical and uterine Doppler
BPP	May be predictive of fetal distress, but not reliable	Reliable prediction of fetal distress	Usually reassuring, may need to repeat in 1-2 hours

Cause	Early fetal exposure, infection, genetic abnormality	Utero-placental insufficiency, mostly maternal	Normal, just a constitutionally small baby
Course	Fetal distress common, NST/BPP may not predict	Fetal distress common, NST/BPP usually predictive	Fetal distress uncommon
Prognosis	Survivors bear stigmata of causative process	Survivors may suffer from prematurity, otherwise normal.	Essentially normal

□ AMNIOTIC FLUID BY ULTRASOUND

1. Visual impression

This is subjective impression of generalized decrease in liquor volume as noted by trained eye of the sonographer.

2. Single Pocket Method

The amniotic fluid is measured using the single largest vertical pocket technique. This measurement is obtained by measuring a pocket of amniotic fluid without fetal limbs or umbilical cord. The largest pocket of liquor is recorded. Below 2cm is regarded as low (oligohydramnios) and over 8 cm is high (polyhydramnios).

Largest pocket of liquor must be recorded and documented

<2cm = low (Oligohydramnios)

> 8 cm = high (polyhydramnios)

3. Amniotic Fluid Index (AFI)

AFI is the sum of the maximum vertical pocket of liquor in each of the four quadrants of the uterus. This value fairly remains stable after 20 weeks till end of third trimester.

Normal range of AFI :	10 to 20
Lower borderline	5 to 10
Upper borderline	20 to 24
Oligohydramnios	0 – 5
Polyhydramnios	≥24

□ PLACENTAL LOCALIZATION

The relationship between the lower margin of the placenta and the internal os should be determined. It is not possible to diagnose low lying placenta accurately before 20 weeks as the lower segment development in later pregnancy. However, it is important as a standard practice to locate the placenta at the early scan especially at the time of anatomy scan (18 – 22weeks).

A) Placenta previa / low lying

is defined as implantation of the placenta in the lower uterine segment.

- **Complete placenta previa** : Placenta covers internal os completely.
- **Marginal / Partial previa**: placenta doesn't cover internal os but extends within 2 – 3 cm of the internal os.

Posterior low lying placenta /previa is difficult to scan as fetal parts obstructs sound waves. It needs review by transvaginal (TV) scan or diagnostic MRI.

Placenta previa is important as it may cause APH, IUGR and preterm labour.

The lower segment of uterus forms in second and early third trimester and early low lying placenta may move up by 34 weeks (**migration of placenta**). All low lying placenta/ previa needs re-scan by 32- 34 weeks.

B) Placental Abruption/Haemorrhage :

is defined as separation of a normally situated (in upper uterine segment) placenta before the birth of the baby. Bleeding sites may be

- Retroplacental haemorrhage
- Subchorionic haemorrhage
- Sub chorial (pre placental) haemorrhage
- Subamniotic haemorrhage
- Intra-placental haemorrhage

□ BIOPHYSICAL PROFILE

This tells about the fetal well-being. A compromised fetus will not be active to save energy.

BPP has four parameters to look closely during scanning. Biophysical profile should be done up for up to 30 minutes of scan time if the fetus is not active. The minimum scanning period should be spent however if there is a active fetus.

Amniotic fluid: If deepest vertical pocket is 2cm or greater a score of 2 is given. If less than 2cm the score is 0.

Fetal Breathing: If 30 seconds of continuous fetal breathing is seen the score is 2, if not a score of 0.

Fetal movement: If there is three major fetal movements give a score of 2, less is a score of 0.

Fetal tone: This is considered to be present if there is flexion of the fetal hand. Prolonged extension of the fetal fingers would give a score of 0; otherwise the score should be 2.

Technique and Interpretation of BBP

Biophysical variable	Normal (score = 2)	Abnormal (score = 0)
Fetal breathing movements.	≥ 1 episode of ≥ 30 secs in 30 minutes.	Absent or no episode of ≥ 30 secs in 30 mins.
Gross body movements	≥ 3 discrete body/limb movements in 30 mins (episodes of active continuous movement considered as single movement).	≥ 2 episodes of body/limb movements in 30 minutes.
Fetal tone	≥ 1 episode of active extension with return to flexion of fetal limb(s) or trunk. Opening and closing of hand considered normal tone.	Either slow extension with return to partial flexion or movement of limb in full extension or absent fetal movement.
Reactive fetal heart	≥ 2 episodes of acceleration of ≥ 15 bpm and of ≥ 15 secs associated with fetal movements in 20 mins.	< 2 episodes of acceleration of fetal heart rate or acceleration of < 15 bpm in 20 minutes.
amniotic fluid	≥ 1 pocket of fluid measuring ≥ 2 cm in two perpendicular planes.	Either no pockets or a pocket < 2 cm in two perpendicular planes.

(Manning, 1980)

Ultrasound provides a score out of 8, the remaining 2 being provided by the cardiotocograph (CTG).

Reporting of BPP/8

Interpretation BPP SCORE:

- 8 - 10 Normal fetus
- 4 - 6 Suspect asphyxia
- 0 - 2 Strong likelihood of asphyxia.

CERVICAL INCOMPETENCE

Some women have repeated pregnancy loss due to incompetent cervix.

Normal length of cervix (internal os to external os) should be more than 2.5 cm long. Incompetent cervix undergoes shortening (effacement). Normal competent cervix canal looks like letter **T**. During effacement the cervical canal will change to **Y** shaped

and finally to **V** shaped with extension of bag of water into the canal. If you see any patient with such problems, they must be referred to obstetricians for proper management.

□ ANATOMY SCAN

One of the standard non-invasive screenings in pregnancy is the anatomy scan done between 18 to 22 weeks. It needs time and proper training to build up experience to do the anatomy scan. Ideally this should be done for all pregnant women. At present due lack of trained people, anatomy scan is being done for high risk group of women at JDWNRH from July 2003. However, it is best to start doing them whenever it is feasible and slowly provide the service to all pregnant women in future.

Basic components of anatomy scan

- I. Proper dating and calculation of the EDD (if not done before).
- II. Liquor volume
- III. Placental localization
- IV. Fetal Growth estimation
- V. Examination of the fetus from head to toe for abnormalities
- VI. Examination of Maternal pelvic anatomy

Examination of the fetus for congenital abnormality is done by a systematic approach as shown in the table below.

(1) Skull	Examination of integrity and normal shape, and measurement of biparietal diameter and head circumference
(2) Brain	Examination of cerebral ventricles, choroid plexuses, mid-brain, posterior fossa (cerebellum and cisterna magna), and measurement of the anterior and posterior horns of the lateral ventricles

- | | |
|-------------|---|
| (3) Face | Examination of the profile, orbits and upper lip |
| (4) Neck | Measurement of nuchal fold thickness
Examination both longitudinally and transversely |
| (5) Spine | |
| (6) Heart | Examination of rate and rhythm, four-chamber view, and outflow tracts |
| (7) Thorax | Examination of the shape of the thorax, the lungs and diaphragm |
| (8) Abdomen | Examination of the stomach, liver, kidneys, bladder, abdominal wall and umbilicus, and measurement of abdominal circumference |
| (9) Limbs | Examination of the femur, tibia and fibula, humerus, radius and ulna, hands and feet (including shape and echogenicity of long bones and movement of joints), and measurement of femur length |

The following figures show the normal anatomy standard views:

REAL TIME STANDARD NORMAL ANATOMY VIEWS

□ NORMAL VALUES IN GYNECOLOGICAL PELVIC SCANS

Uterus

Nulliparous uterus : 7cm long and 4 cm wide

Multiparous women : 8.5 cm long and 5.5 cm wide

Endometrium: thickness varies with the monthly cycle phase

Proliferative phase

5 layered appearance

5 -10 mm

Ovarian dominant follicle < 20 mm

Midcycle phase

3 layered appearance

8 – 15 mm

Dominant ovarian follicle ≥ 20 mm

Early secretory phase

Echogenic rim at margins

8 -15 mm

Corpus luteum seen

Late secretory phase

Over all echogenic appearance

No midline echo seen

Corpus luteum may have blood

Postmenopausal women

≤ 5 mm

Small atrophied ovary

Women on OCP

≤ 5 mm

No dominant follicle seen in ovary

Ovary (Normal volume): 10 ml \pm 5 ml (9.8 \pm 5.8 ml) (Ref: Callen 2000)