

FIRST TRIMESTER B.P.D. MEASUREMENT BY TRANSVAGINAL SONOGRAPHY

R. RAJAN • B. GIRJA • VASANTHA RAJAN

SUMMARY

Fetal anatomy is best studied in the first trimester by endovaginal sonography, because of close-range inspection of the organ of interest with increased resolution and magnification. Since fetal skull anatomy is very clearly discerned, measuring the biparietal diameter is easily possible. Since BPD is an excellent parameter for determination of gestational age, and since BPD measurement is not influenced by fetal activity (unlike CRL) we feel first trimester BPD measurement must be considered as an important parameter. Concurrently BPD measurement gives an opportunity to study the fetal anatomy carefully and exclude any fetal anomalies, particularly related to the cranial cavity.

One of the four major applications of diagnostic ultrasound in obstetrics is the estimation of gestational age. This estimate is one of the cornerstones of prenatal care. Biparietal diameter (BPD) measurement is an excellent means of estimating gestational age, both because there is a close correlation between BPD and gestational age. Accuracy of pregnancy dating by BPD measurement between 13 and 20 weeks (or the whole of midtrimester) has been well recognized, documented and popularly employed Shepard and Filly, 1982, and Sabhagha and Hughey, 1978)

By contrast, during the first trimester period BPD measurement has not been considered,

Department of Obst. and Gyn. Medical College, Kottayam, Kerala.

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obviously because the fetal cranial anatomy is not precisely imaged at abdominal sonography employing low frequency (3.5 MHz) transducer probes. However, endovaginal sonography employing high frequency (5 MHz or more) probe has dramatically changed the profile of diagnostic ultrasonography. Superb visualization of the organs of interest at a closer range with optimal resolution has significantly increased the sensitivity and specificity of ultrasound diagnosis (Blumenfeld et al., 1987, Popp, 1989, and Kurjak, et al., 1990).

We observe that the cranial anatomy is quite clearly studied in the first trimester at endovaginal sonography (Rajan and Rajan, 1989). It is quite possible to recognise the intracranial structures at different scanning levels in all the three planes, namely, axial, sagittal and coronal

planes. In the axial plane of the skull when the proper section has been selected BPD measurement is easily made. Our purpose is to stress the importance and justify the rational of employing BPD as a growth parameter in the first trimester of pregnancy

ASSESSMENT OF EARLY EMBRYONIC DEVELOPMENT

Between May, 1989 and June, 1990 all the 195 first trimester pregnancies referred to us have been monitored by transvaginal sonography. Among them in 106 subjects the fetal crown-rump-length (CRL) could be measured as a parameter for determination of gestational age. In the latter half of the study BPD was measured in 51 subjects. The following sonographic landmarks could be discerned.

Gestational Sac: Gestational Sac (GS) was first located on the 30th or 31st day of a 28 days cycle, i.e., 2nd or 3rd missed menstrual date (16th or 17th day before ovulation). The GS measurement ranged from 2 to 5 mm, and the measurement was made by placing the calipers over the middle-to-middle portions of the chorionic vesicle.

Yolk Sac: The secondary or the 'definitive' yolk (YS) became evident at 5 weeks (7th missed menstrual date), and measured 4 mm in diameter, occupying about one third of the cross section of the GS. The GS measured between 6 and 9 mm in diameter.

Fetal Pole: The echogenic pole identified by the cardiac flicker has been first recognised between 38th and 41st day of LNMP, otherwise by the 10th to 13th missed menstrual date.

CRL Measurement : By the 45th day (17th missed menstrual date), or by 6 weeks and 3 day, the CRL is precisely measured as 5 mm.

Fetal Head: Identification of the fetal head became possible almost at the same time. The fetal skull occupies the major portion of the fetal pole and is identified as an echo-free oval structure very close to the cardiac flicker. The yolk sac which may be even bigger than the fetal skull at

this stage is located far away in the extramniotic space, whereas the fetus is inside the amniotic cavity. Moreover, the fetal skull reveals a central echogenic line (inter-hemispheric fissure) which is conspicuously absent in the YS. The echo-free area in the skull represents the ventricles, and even now by placing the calipers over the 'middle-to-middle' portions of the skull table it is possible to measure the BPD. The earliest BPD measured has been 3 mm for a fetus with a CRL of 5mm, at 6 weeks 3 days.

BPD Measurement : The cranial anatomy is more clear at 7 weeks for measurement of BPD. BPD measurement has been 4 mm at 7 weeks.

Septum Pelucidum : The two septii pelucidi and the cavum septum pelucidi are clearly discerned between 8 and 9 weeks of gestation. By now, the echo-free lateral ventricular space is prominently occupied by the echogenic choroid plexus. The largest oval section of the fetal skull in the axial plane, with the central hemispheric fissure dividing the skull into two equal hemispheres, has been preferred for measuring the BPD. Location of cavum septum pelucidum further facilitates identification of the correct plane for BPD measurement.

After 9 Weeks: As the pregnancy grows further, the cranial anatomy becomes more clear with additional structures identified such as the thalamic bodies, hypocampal guri, insula, cerebral peduncle face and other organs are also clearly discerned and hence could be studied properly.

DATA ANALYSIS: Embryonic landmarks given in Table I)

BPD measurement by transvaginal sonography has been possible from the 6 completed weeks of gestation, and as early as 6 weeks and 3 days. BPD has been measured as 3 mm while the CRL was 5 mm. The only landmark for the recognition of fetal skull during this period has been identification of the echo-free oval skull with the central echogenic line representing the interhemispheric fissure. However from the 8th week onwards other cranial structures, particularly cavum septum pellucidum, are clearly

TABLE - I
EARLY PREGNANCY EMBRYONIC LANDMARKS
STUDY BY ENDOVAGINAL SONOGRAPHY (5 MHZ TRANSDUCER)

Menstrual Cycle length : 28 days

Duration of amenorrhoea	Anatomical landmarks
26 to 28 days (4 weeks)	— Typical hyper-echoic decidua ('Shining' endometrium)
30 to 31 days (4 weeks. 2-3 days)	— Gestational sac measuring 2 to 5 mm detected with the 'shining' endometrium.
35 days (5 weeks)	— The yolk sac becomes evident lacunar intervillous vascular spaces of 2-3 mm forming a curved area about one fourth of a circle. These are forerunners of placental circulation.
38 to 41 days (5 weeks, 3-6 days)	— Fetal pole and fetal cardiac flicker
45 days (6 weeks, 3 days)	— CRL measured (5 mm), fetal head identified.
49 days (7 weeks)	— Proper skull measurement possible. BPD : 4 mm (50th percentile)
56 days (7-8 weeks)	— Septum pellucidum, lateral ventricles with choroid plexus and falx cerebrum clearly identified. Fetal movement appreciated. Spine imaged limbs clearly imaged.
63 days (9 weeks)	— fetal cranial anatomy reveals the thalamic peduncle and insule. Umbilical cord anatomy and attachment clearly seen.
70 days (10 weeks)	— Fetal face and cerebellar hemispheres clearly defined. Choroid plexus occupies 80% of the lateral ventricles.
77 days (11 weeks)	— Other fetal organs, such as cardiac chambers, diaphragm, stomach, kidney, liver and bladder are clearly identified.
After 12 weeks	— Fetal sex identified

imaged, improving the accuracy of BPD measurement. The 50th percentile values for each week from 6 completed weeks to 12 completed weeks have been given in table II. CRL values for the corresponding gestational weeks have been given for comparison.

DISCUSSION:

CRL is the longest demonstrable length of the fetus, excluding the fetal limbs. In the first trimester of pregnancy CRL is the only fetal measurement employed for determination of gestational age. This is not necessarily because CRL is the only accurate parameter, but because

ENDO VAGINAL SONOGRAPHY

BPD AND CRL IN THE FIRST TRIMESTER

Menstrual Weeks	50th percentile values in m.m B.P.D.	C.R.L.
6 weeks	3	5
7 weeks	4	9
8 weeks	7	16
9 weeks	11	23
10 weeks	14	33
11 weeks	17	42
12 weeks	20	56

**ENDOVAGINAL SONOGRAPHY
SONO-EMBRYOLOGY LANDMARKS
(4 to 7 WEEKS)**

<i>MENSTRUAL CYCLE LENGTH : 28 DAYS</i>	
AMENORRHOEA	EMBRYONIC LANDMARKS
4 weeks (26 to 28 days)	Hyper-echoic decidua (shining endometrium)
4 weeks, 2-3 days (30-31 days)	Gestational sac (2 to 5 mm)
5 weeks (35 days)	Yolk sac, Lacunar spaces
5 weeks, 3-6 days (38-41 days)	Fetal pole and cardiac flicker
6 weeks 3 days (45 days)	CRL : 5 mm, BPD : 3 mm
7 weeks (49 days)	Proper skull measurement BPD : 4 mm (CRL 9 mm)

**ENDOVAGINAL SONOGRAPHY
SONO-EMBRYOLOGY LANDMARKS (8
to 12 WEEKS)**

<i>MENSTRUAL CYCLE LENGTH : 28 DAYS</i>	
AMENORRHOEA	EMBRYONIC LANDMARKS
8 weeks	Fetal movement; lateral ventricles, septum pellucidum, flax cerebrum, choroid plexus, and fetal limbs and fetal spine
9 weeks (63 days)	Thalamus, hippocampal gyri, insula cerebral peduncle, Cord anatomy
10 weeks (70 days)	Choroid plexus occupies 80% of lateral ventricles Face clearly seen
11 weeks (77 days)	Cardiac chambers, diaphragm, liver, stomach, kidney, bladder
After 12 weeks	Fetal sex

there is no alternate parameter available during the first trimester when one employs transabdominal sonography. Nor CRL is that accurate always, as it was considered earlier. Earlier than 9 weeks the greatest problem in measurement lies in knowing whether the maximum longitudinal diameter of the fetus has actually been measured. Fetal limbs and part of yolk sac could be wrongly included to give a falsely elevated values.

These problems have been well settled by the transvaginal sonographic approach of CRL measurement. Vaginal sonography, by virtue of higher magnification and improved resolution, images the longest axis of the fetus clearly, separate from the fetal limbs and yolk sac. Hence we find that the CRL measurement done at vaginal sonography is more accurate, beginning as early as 6 completed weeks.

Nonetheless, vaginal sonographic measurement of CRL cannot completely nullify certain inherent pitfalls of employing CRL in dating

the pregnancy. This is related to the fetal activity, which is discerned from the 8 completed weeks of gestation. Flexion and extension of fetal trunk (signifying fetal tone whose controlling center in the brain has been developed as early as 8 weeks) could falsely decrease or increase the actual CRL measurement. By contrast, if a static structure, such as the fetal skull, could be measured there is no possibility for such an error. Moreover, unlike abdominal sonography, vaginal sonography could image the fetal skull with high resolution and increased magnification.

Based on these arguments, the logical conclusion is to employ BPD measurement as an important parameter to determine gestational age in first trimester of pregnancy. Being a static structure, measurement of skull diameter will not be influenced by the fetal activity. Yet

another advantage of BPD measurement is that the sonologist is compelled to make a thorough study of the fetal anatomy, particularly the fetal head. This will facilitate recognition of normal fetal anatomy and detection of malformations related to cranial cavity.

CONCLUSION

We conclude with the following note:

- i. Transvaginal sonography should replace transabdominal sonography for monitoring early pregnancy.
- ii. A thorough study of the fetal anatomy, yolk sac, amniotic membrane, and trophoblast-decidua complex should be possible.
- iii. Since fetal anatomy is well delineated, both the fetal growth parameters, namely, CRL and BPD should be obtained.
- iv. In addition to excluding certain fetal anomalies, complementary application of both parameters should improve upon the accuracy of a single parameter.
- v. If there is gross disagreement between the two parameters there will be opportunity for more careful scrutiny of the parameters and better decision making.
- vi. Both parameters are necessarily complementary in the earlier half of the first

trimester (between 6 and 8 weeks). This is because anatomical landmarks are somewhat obscure and error in the parameter could be compensated by the other parameter.

- vii. However, after 8 completed weeks BPD is certainly superior to CRL, considering the obvious fallacies in the latter related to fetal activity.
- viii. Employing multiple fetal growth parameters always has the advantage of complete global study of the fetus.

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