Original Article   Fetal Biometry

Fetal Biometry in the Third Trimester; Local Perspective

1. Ahmed Hussain Suhag 2. Muhammad Ishaque Channar 3. Abdul Rehman Lakho

1. Asstt. Prof. of Physiology, LUMHS, Jamshoro 2. Asstt. Prof. of Radiology, PUMHS, Nawabshah
3. Asstt. Prof. of Community Medicine, ACMC, Lahore.

ABSTRACT

Objective: To observe the frequently used parameters of fetal biometry along with ultrasonographic appearance and measurement of epiphyseal ossification centres of fetal peripheral long bones in our local population for assessment of gestation age in the third trimester.

Study Design: Descriptive, Observational study

Place and Duration of Study: This study was carried out at Department of Radiology, Dow University of Health Sciences/Civil Hospital Karachi from February 2009 to July 2009.

Materials and Methods: 200 pregnant females were examined having gestational age of 28 or more weeks. Obstetrical ultrasound was done using 3.5MHz convex transducer on Toshiba ultrasound scanner model Nemio-17. Measurement of Biparietal Diameter, (BPD), femur Length (FL) and abdominal Circumference (AC), placental localization and assessment of liquor was done as per standard protocol. The distal femoral, proximal tibial and proximal humeral ossification centers were identified and measured.

Results: The frequently used parameters of fetal biometry along with ultrasonographic appearance and measurement of epiphyseal ossification centres of fetal peripheral long bones for assessment of gestation age in the third trimester in our local population are in agreement with international studies.

Conclusion: Ultrasonographic visualization of the epiphyses ossification centers in correlation with fetal biometry is a useful marker of fetal gestational age in third trimester.

Key Words: Fetal Biometry, Fetal Epiphyseal Ossification Centers, Biparietal Diameter, Head Circumference, Femur Length, Abdominal Circumference.

INTRODUCTION

Fetal biometry with the help of Ultrasound scanning provides the most reliable and important information about the fetal growth and wellbeing. It is a methodology devoted to the measurement of the several parts of fetal anatomy and their growth. Fetal growth is defined as the time dependent changes in body dimensions that occur throughout the pregnancy.[1]

Multiple fetal biometric charts are available for prediction of GA from a given fetal parameter. These include measurement of gestational sac, crown-rump length (CRL), fetal Biparirtal Diameter (BPD), femur length (FL) abdominal Circumference (AC) etc.

The last three decades have seen a tremendous progress in application of US as a diagnostic modality revolutionizing the management towards better care. This is particularly due to its non-invasive and non-ionizing nature besides its cost effectiveness leading to wider acceptability. The exemplary safety record of diagnostic US is probably an important reason that it has become so widely used.[2] It is not associated with any harm to early fetal life, growth and vision or hearing during childhood.[3] Similarly no adverse effects have been observed on neurological development and subsequent school performance of the children.[4]

There are multiple fetal biometric parameters in use. Some are frequently used where as others are less frequently used. Frequently used parameters in the third trimester are: biparietal diameter (BPD), head circumference (HC), femur length (FL) and abdominal circumference (AC)

The BPD remains the standard against which other parameters of GA assessment are compared. The BPD is useful for dating a pregnancy and in estimating intrauterine fetal weight in weight equation. This parameter is used in the second trimester, from 12th week onwards.

Studies report that the growth of the BPD in the mid trimester is linear and rapid and biological variation at each week of gestation is small. The measurement of BPD from 14-26 weeks predicts the correct duration of gestation to the extent of ± 9 days in 95% of cases.

The Head Circumference is used in second and third trimester along with other parameters such as FL.[5] The accuracy of this parameter is ± 2-3 weeks with 95% confidence interval.

FL is a very useful biometric parameter used in the second and third trimesters of pregnancy. It grows linear throughout and is best measured after 14 weeks of gestation.[6-7] The accuracy of GA calculation by FL is within 6-7 days of menstrual age at 95% confidence level[8-9]

Abdominal circumference is less used for the assessment of GA. It is however, more used for monitoring fetal growth, especially in the third trimester and for estimation of fetal weight[10,11]

These parameters are most frequently used for the estimation of GA and sometimes considered as the 'gold standard' and they collectively assess the GA to the highest degree of accuracy.

Among the less frequently used parameters such as placental thickness, transverse cerebellar diameter, fetal kidney length, fetal clavicle length, the appearaance and size of peripheral long bones has been more frequently researched. The distal femoral, proximal tibial and proximal humeral epiphysis appearance and measurment of its size involves very little more time than that normally required for an US examination of the fetus.[12]

Chinn DH et all studied reliability of the US identification of the fetal DFE and PTE in the estimation of GA. Presence of a DFE to indicate a GA greater than or equal to 33 weeks, was 95% sensitive, 95% specific, the presence of the PTE was highly predictive (accuracy of a positive prediction 95%) of a GA greater than or equal to 35 weeks. US evaluation of fetal lower extremity EOCs was therefore found to be a promising technique for the estimation of GA during the last trimester of pregnancy.[13]

McLeary RD and Kuhns LR. examined two hundred and twenty fetuses of more than 29 weeks of GA for the presence of the DFE. One hundred and three fetuses did not demonstrate any ossification, 44 fetuses demonstrated a small slit-like ossification center, at a mean age of 33.6 weeks, and 73 demonstrated a large globular epiphyseal center, at a mean age of 35.4 weeks.[14]

Mahony B S et all observed that the DFE secondary ossification center, which can be reliably identified and measured sonographically, may assist the sonologist in predicting third-trimester menstrual age. Between 28 and 35 menstrual weeks, the percentage of fetuses with a DFE progressively increases. Although the mean age at DFE appearance is approximately 32-33 menstrual weeks, the DFE may be seen as early as 29 menstrual weeks. Nevertheless, the age of a fetus without an identifiable DFE is most likely ≥34 menstrual weeks. Measurements of the DFE showed that its size increases linearly: the menstrual age of a fetus whose DFE measures 7 mm is most likely ≥37weeks.[15]

Gentili P et all examined of 312 normal pregnancies between 20 and 40 weeks of gestation and observed the presence of DFE and PTE, from 32 and 36 weeks respectively.[16]

The accuracy of fetal biometry has been found excellent. It has proved its usefulness through last almost three decades. Its accuracy has been further authenticated by studies over gestations secondary to in-vitro fertilization. In such studies differences between US estimated GA and true GA were calculated between 11 to 14 weeks and 18 to 22 weeks of gestation for singleton, twin, and triplet pregnancies that were conceived by in vitro fertilization. It was found that US assessment of GA is very accurate and is marginally better in the first trimester as compared with the second.[17-19] In another such study, a database of 123 singleton pregnancies conceived by artificial reproductive techniques with third-trimester US measurements was studied. Biometry variables included the fetal HC and FL. In this study, it was found that US estimation of GA in late pregnancy was better than indicated by older publications. It was more accurately estimated by combining the HC with the FL than by using the FL measurements alone.[20]

MATERIALS AND METHODS

This was a case series of two hundred pregnant females with known gestational age of 28 weeks and above, attending the Department of Radiology for their routine antenatal Ultrasound examination, from February 2009 - July 2009.

The first variable i.e. gestational age as per last menstrual period was calculated. The other variables measured for data analysis were: (I) BPD (Bi-parietal diameter), (II) FL (Femur length), (III) AC (Abdominal circumference) (IV) DFE (Distal femoral epiphysis) (V) PTE (Proximal tibial epiphysis) and (VI) PHE (Proximal humeral epiphysis). The volume of each epiphysis was calculated by multiplying the three-dimensional measurements and it was taken as size of the epiphysis. The data collection tool was a pre-designed Performa. A database was created, and data analysis was carried out using SPSS 10.0 version.

Inclusion Criteria: All pregnant females having knowledge/record of LMP with menstrual age ranging 28-40 weeks and fundal height corresponded to dates.

Exclusion Criteria: Pregnant females having diabetes, hypertension, twin or multiple pregnancies, fetal anomaly, suspected IUGR (intrauterine growth restriction), suboptimal fetal position in which epiphyses could not be observed.

RESULTS

The accuracy of standard parameters of fetal biometry i.e. biparietal diameter (BPD), femur length (FL) and abdominal circumference (AC) varied from ± 2 weeks 2 days to 3 weeks and 1days (Table-1).

During 28 and 29 weeks it was ± 2 weeks 2 days, during 30 and 31 weeks it was ± 2 weeks 3 days, during 32 and 33 weeks it was ± 2 weeks 4 days, during 34 weeks it was ± 2 weeks 5 days, during 35, 36 and 37 weeks it was ± 2 weeks 6 days, during 38 and 39 weeks it was ± 3 weeks 0 days, and during 40 weeks it was ± 3 weeks 1 days.

As for as epiphyses of peripheral long bones is concerned, the results show that with the increasing gestational age the proportion of fetuses in which epiphyses have appeared also increases, thus showing positive linear correlation (Table 2).

Table No.1: Week-wise variability range in gestational age based on BPD, FL and AC.

Gestational age in weeks	Variability range ± in weeks and days
28	2 weeks 2 days
29	2 weeks 2 days
30	2 weeks 3 days
31	2 weeks 3 days
32	2 weeks 4 days
33	2 weeks 4 days
34	2 weeks 5 days
35	2 weeks 6 days
36	2 weeks 6 days
37	2 weeks 6 days
38	3 weeks 0 days
39	3 weeks 0 days
40	3 weeks 1 days

Table No.2: Week-wise proportional appearance of epiphyses

Gestational Week	No. of Cases	Distal Femoral Epiphysis appeared cases (%)	Proximal tibial epiphysis appeared cases (%)	Proximal humeral epiphysis appeared cases (%)
28	25	0	0	0
29	21	23.80	0	0
30	22	45.45	0	0
31	22	60.86	0	0
32	21	85	15	0
33	19	100	26.31	0
34	15	100	46.66	0
35	15	100	73.33	0
36	14	100	85.71	14.28
37	12	100	100	25
38	9	100	100	66.66
39	3	100	100	100
40	2	100	100	100

Table No.3: Week-wise mean BPD, FL, AC and mean size of DFE, PTE and proximal humeral epiphysis.

Gestational Week	Mean BPD	Mean FL	Mean AC	Mean size of DFE in mm.	Mean size of PTE in mm.	Mean size of proximal humeral epiphysis in mm.
28	69.39	56.32	226.12	0	0	0
29	68.65	60.75	263.55	2.7	0	0
30	72.82	60.61	262.54	1.68	0	0
31	77.39	62	283.72	73.3	0	0
32	80.56	62.5	289.85	93.07	3.99	0
33	82.53	64.43	297.42	118.98	6.42	0
34	85.3	66.12	306.93	136.58	7.7	0
35	86.71	67.16	321.2	122.98	22.45	0
36	88.31	68.94	333.17	199.14	82.7	5.28
37	88.32	69.48	335.58	244	91.77	4.81
38	89.01	72.24	363.55	239.22	95.98	4.7
39	90.36	73	376	386.78	312.08	107.93
40	92.4	72.95	378.5	450.87	353.95	98.09

Table No.4: Variability in predicting gestational age.

Parameters used	Variability±2 SD	
	30-36wks	36-40wks
BPD	3.08	3.20
HC	2.98	2.70
AC	2.96	3.04
	2.96	3.04
BPD, AC	2.60	2.88
BPD, HC	2.86	2.64
BPD, FL	2.60	2.62
HC, AC	2.68	2.52
HC, FL*	2.52	2.28
AC, FL	2.66	2.60
BPD, AC, FL*	2.50	2.52
BPD, HC, FL*	2.52	2.34
HC, AC, FL*	2.52	2.34
HC, AC, BPD,	2.60	2.52
BPD, HC, AC, FL*	2.44	2.30

The mean size of DFE was 0.27cm at gestational age of 29 weeks, increasing to 1.9cm at 33 weeks, 2.4cm at 37 weeks and 4.5cm at 40 weeks.

The mean size of PTE was 0.4cm at gestational age of 32 weeks, increasing to 9.2cm at 37 weeks and 3.5cm at 40 weeks.

Similarly the mean size of proximal humeral epiphysis was 2.28mm at gestational age of 36 weeks, increasing to 98.09mm at 40 weeks.

Each of the 3 epiphyses was most useful indicator of a critical period of gestational age.

Presence of the DFE in 100% of cases at 33 weeks, PTE at 37weeks and proximal humeral epiphysis at 39weeks offered greater diagnostic accuracy for that gestational age (Table 3).

The mean gestational age for appearance of DFE was calculated as 33.81, for PTE it was 35.92 and for proximal humeral epiphysis, it was 38.00.

DISCUSSION

The accuracy of standard parameters of fetal biometry i.e. biparietal diameter (BPD), femur length (FL) and abdominal circumference (AC) varied from $\pm$ 2 weeks 2 days to 3 weeks and 1days (Table-1). It ranged from $\pm$ 2 weeks 2 days during 28 and 29 weeks gestational age to $\pm$ 3 weeks 1 days during 40 weeks of gestational age. This result is in conformity with international reseach(Table-1)[12]-. Correlating it with the presence or absence as well as size of epiphyseal ossification centers of femur, tibia and humerus further narrows down this variability and thus enhances accuracy.

CONCLUSION

Ultrasonographic visualization of the epiphyses ossification centers in correlation with fetal biometry is a useful marker of fetal gestational age in third trimester.

REFERENCES

1. Shehzad K, Ali M, Zaidi S. Fetal Biometery, Pak J Med Sci [serial online] 2006 Oct-Dec [cited 2009 Jul 5]; 22 (4) 503-508. Available from: URL: http:// www.pakmedinet.com.htm

2. Nyborg WL. [Abstract of: Safety of Medical Diagnostic Ultrasound. Seminars in Ultrasound, CT and MRI 2002; 23(5): 377-86] [electronic] [cited on 2009 Jul 06]. Available from: URL: http:// www.pubmed.com.htm

3. Kieler H, Hagloud B, Waldenstrom U, Axelssson O. [Abstract of: Routine ultrasound screening in pregnancy and the children's subsequent growth, vision and hearing. Br J Obstet Gynaecol 1997; 104:1267-72] [electronic] [cited on 2009 Jul 06]. Available from: URL: http:// www.pubmed.com.htm

4. Salaveen KA, Vatten LJ, Eik-Nes SH, Hugdhal K, Bakketeig LS. [Abstract of: Routine ultrasonography in utero and the subsequent handedness and neurological development. BMJ 1993;307(6897):159-64] [electronic] [cited on 2009 Jul 06]. Available from: URL: http:// www.pubmed.com.htm.

5. Ott WJ. [Abstract of: Accurate gestational dating: revisited. Am J Perinatol 1994;11(6):404-8] [electronic] [cited on 2007 Jul 06]. Available from: URL: http:// www.pubmed.com.htm.

6. Warda AH, Deter RL, Rossavik IK, Carpenter RJ, Hadlock FP. [Abstract of: Fetal femur length: a critical re-evaluation of the relationship to menstrual age. Obstet Gynaecol 1985;66(1):69-75.] [electronic] [cited on 2007 Jul 06]. Available from: URL: http:// www.pubmed.com.htm.

7. Exacoustos C, Rosati P, Rizzo G, Arduini D. [Abstract of: Ultrasound measurements of fetal limb bones. Ultrasound Obstet Gynecol 1991;1(5): 325-30] [electronic] [cited on 2007 Jul 06]. Available from: URL: http:// www.pubmed. com.htm.

8. Deter RL, Rossavik IK, Hill RM, Cortissoz C, Hadlock FP. [Abstract of: Longitudinal studies of femur growth in normal fetuses. J Clin Ultrasound 1987;15(5): 299-305] [electronic] [cited on 2007 Jul 06]. Available from: URL: http:// www. pubmed.com.htm.

9. Chitty LS, Altman DG, Henderson A, Campbell S. [Abstract of: Charts of fetal size: 4. Femur length. Br J Obstet Gynaecol 1994;101(2):132-5] [electronic] [cited on 2007 Jul 06]. Available from: URL: http:// www.pubmed.com.htm

10. O'Brien GD, Queenan JT, Campbell S. [Abstract of: Assessment of gestational age in the second trimester by real-time ultrasound measurement of the femur length. Am J Obstet Gynecol 1981; 139:540-5] [electronic] [cited on 2007 Jul 06]. Available from: URL: http:// www.pubmed. com.htm.

11. Campbell S, Wilkin D. [Abstract of: Ultrasonic measurement of fetal abdomen circumference in the estimation of fetal weight. Br J Obstet Gynaecol 1975;82:689] [electronic] [cited on 2007 Jul 06]. Available from: URL: http:// www.pubmed.com.htm

12. Donne HD, Faundes A, Tristao EG, de Sousa MH, Urbanetz AA. Sonographic identification and measurement of the epiphyseal ossification centers as markers of fetal gestational age. J Clin Ultrasound 2005;33(8):394-400.

13. Mongelli M, Yuxin NG, Biswas A, Chew S. [Abstract of: Accuracy of ultrasound dating formulae in the late second-trimester in pregnancies conceived with in-vitro fertilization. Acta Radiol 2003; 44(4):452-5] [electronic] [cited on 2007 Jul 06]. Available from: URL: http:// www.pubmed.com.htm.

14. Mongelli M, Chew S, Yuxin NG, Biswas A. [Abstract of: Third-trimester ultrasound dating algorithms derived from pregnancies conceived with artificial reproductive techniques. Ultrasound Obstet Gynecol 2005;26(2):129-31] [electronic] [cited on 2007 Jul 06]. Available from: URL: http:// www.pubmed.com.htm.

15. Bennett KA, Crane JM, O'shea P, Lacelle J, Hutchens D, Copel JA. [Abstract of: First

trimester ultrasound screening is effective in reducing postterm labor induction rates: a randomized controlled trial. Am J Obstet Gynecol 2004;190(4):1077-81] [electronic] [cited on 2007 Jul 06]. Available from: URL: http:// www. pubmed.com.htm.

16. Sys SU, Verdonk P. [Abstract of: Fetal biometry in different ethnic groups. Early Hum Dev 2000; 57(1):1-13] [electronic] [cited on 2007 Jul 06]. Available from: URL: http:// www.pubmed. com.htm.

17. Salomon LJ, Duyme M, Crequat J, Brodaty G, Talmant C, Fries N, et al. [Abstract of: French fetal biometry: reference equations and comparison with other charts. Ultrasound Obstet Gynecol 2006; 28(2):193-8] [electronic] [cited on 2007 Jul 06]. Available from: URL: http:// www.pubmed. com.htm.

18. Jung SI, Lee YH, Moon MH, Song MJ, Min JY, Kim JA, et al. [Abstract of: Reference charts and equations of Korean fetal biometry. Prenat Diagn 2007;27(6):545-51] [electronic] [cited on 2007 Jul 06]. Available from: URL: http:// www. pubmed.com.htm.

19. Ashraf-un-nessa, Jehan AH, Chowdhury SB, Sultana F, Haque JA, Khatun S, et al. [Abstract of: Construction of fetal charts for biparietal diameter, fetal abdominal circumference and femur length in Bangladeshi population. Bangladesh Med Res Counc Bull 2003;29(2):67-77] [electronic] [cited on 2007 Jul 06]. Available from: URL: http:// www.pubmed.com.htm

20. Shohat T, Romano-Zelekha O. [Abstract of: Ultrasonographic measurements of fetal femur length and biparietal diameter in an Israeli population. Isr Med Assoc J 2001;3(3):166-8] [electronic] [cited on 2007 Jul 06]. Available from: URL: http:// www.pubmed.com.htm

21. Goldberg BB, McGahan JP. Atlas of Ultrasound Measurements. 2nd ed. Mosby-Elsivier: Philadelphia; 2006.p.53.

Address for Corresponding Author:
Dr. Muhammad Ishaque Channar,
Assistant Professor of Radiology,
Peoples University of Medical Health Sciences,
Nawabshah.
E-mail: channarishaque@yahoo.com
Cell No. 03337051170