

Fetal BPD and FL Nomograms in 11th-14th Gestational Weeks

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Abstract

Objective: To establish reference ranges for fetal size by gestation in the first trimester as indicated by cephalic and limb measurements according to CRL, using transvaginal sonography in normal pregnancies.

Methods: Transvaginal measurements of biparietal diameter (BPD) and Femur length (FL) were prospectively collected from 394 structurally and or chromosomally normal singleton fetuses representing for 11-14 week screening (CRL: 45-84 mm). Reference ranges were constructed and the mean, 5th, and 95th centiles were plotted against gestation using regression analysis method.

Results: Measurements of BPD, and FL were significantly correlated with CRL. Regression correlation was $BPD = 3.2956 + 0.2897 \times CRL$, $r = 0.8885$, $p < 0.001$, for BPD and, $FL = -5.2381 + 0.2100 \times CRL$, $r = 0.8336$, $p < 0.001$ for FL.

Conclusion: We have established comprehensive reference ranges for first-trimester BPD and FL by sonography which may allow to the correct dating and pregnancy follow-up.

Keywords: Nomogram, 11-14 weeks, BPD, FL, transvaginal ultrasonography.

11-14 hafta BPD ve FL nomogramları

Amaç: Prognozu bilinen normal gebeliklerde 11-14. gebelik haftalarında CRL'ye (baş makat mesafesi) göre, biparyetal çap (BPD) ve femur uzunluğu (FL) nomogramlarının elde edilmesi.

Yöntem: 11-14 hafta (CRL 45-84 mm) taraması için başvuran gebelerde, yapısal veya kromozomal olarak normal 394 fetusa ait biyometrik ölçümler transvaginal yoldan yapılarak, elde edilen BPD ve FL değerlerinin ortalama, 5. ve 95. persentil değerleri ile nomogramları regresyon analizi yöntemi ile oluşturuldu.

Bulgular: Ölçümü yapılan fetal biyometrik parametrelerin CRL ile yüksek korelasyon gösterdiği izlendi. CRL ile BPD arasındaki regresyon denklemi: $BPD = 3.2956 + 0.2897 \times CRL$, $r = 0.8885$, $p < 0.001$, femur uzunluğu arasındaki regresyon denklemi: $FL = -5.2381 + 0.2100 \times CRL$, $r = 0.8336$, $p < 0.001$ olarak saptandı.

Sonuç: 11-14. hafta düşük risk grubundan elde edilen fetusa ait BPD ve FL uzunluğuna ait nomogramlar, kendi toplumumuzda gebelik haftasının doğru saptanması ve fetal gelişimin izlenmesi için oluşturuldu.

Anahtar Sözcükler: Nomogram, 11-14 hafta, BPD, FL, vaginal ultrasonografi.

Introduction

It is found that combining maternal age with nuchal translucency measurement in between 11th and 14th gestational weeks may be used as an effective scanning test for Down syndrome.¹ It is seen that the performance of the test increases if maternal serum PAPP-A and free beta hCG are added into this evaluation.² Thus, nuchal translu-

cency scanning is increasingly being applied to pregnant in our country as in other countries.

While measuring nuchal translucency for Down syndrome scanning in the first trimester, it is possible to observe all anatomic structure of fetus and to diagnose many fetal anomalies sonographically by this way.^{3,4} Some fetal anomalies related to cranial and skeletal system can be diagnosed in between 11th and 14th gestational weeks. Fetal biomet-

ric reference values related to fetal femur length (FL) and biparietal length (BPD) were published before.^{5,6} Thus, it is possible to define symmetric or asymmetric growth retardations, chromosome anomalies which may appear in first trimester and skeletal dysplasias which are diagnosed early.

The aim of this study is to get reference values for BPD and FL in low risky population in which nuchal translucency is measured by transvaginal ultrasonography in between 11th and 14th gestational weeks.

Methods

In this study, 403 pregnant women were retrospectively evaluated who were applied to Perinatology Polyclinic of Obstetrics and Gynecology Clinic of Training and Research Hospital for first trimester scanning (nuchal translucency) within a period of year. Transvaginal ultrasonography was applied to these pregnant women in between 11th and 14th gestational weeks. Single gestations who had not any maternal disorder or first trimester bleeding and who were below 14th gestational week as to the early period ultrasonography and last menstrual period were included into the study. Fetuses which were miscarriage later or which were found having chromosomal anomaly were excluded from the study while normal reference values were determined. Scanned pregnant women who had CRL between 45 and 84 mm were included into the study protocol. All ultrasonography scanning processes were performed by a single doctor having 11th-14th gestational week scanning certificate and by the same device (Logic 400 Pro (GE, USA), 7 mHz vaginal transducer). CRL measurement was performed in sagittal position in which fetal head was on neutral position and nuchal translucency was measured. BPD measurement was performed on the plan that fetal head was on transverse position and thalamus and third ventricular was seen. Femur length was measured on the plan that the femur was displayed in the best and longest way. Each biological parameter was performed average two times and as the lowest measurement benefit to the 0.1-0.2 interval. SPSS 11.5 software was used for statistical analysis. Change of CRL with gestational week and the correlation of BPD and FL with gestational week and CRL were examined.

Regression coefficients and graphics were drawn related to contrastive FL and BPD with gestational week and CRL. Being less than 0.05 of P value was accepted as statistical significant limit. Cases included to the study were observed until to the end of their gestations.

Results

394 pregnant women were found compatible to research criteria during the study. Average gestational week was found as 12.40 ± 1.06 . Average maternal age was 27.58 ± 5.69 and age interval was changing between 17 and 44. Within 403 fetuses, it was found that four fetuses had chromosomal anomaly (three trisomy 21, one trisomy 18), one fetus became abortus in 12th week, one fetus had kyphoscoliosis, one fetus died which was preterm in 26th week due to asymmetric intrauterine growth restriction, one fetus became abortus due to fetal anomaly which was normal as karyotype and one fetus became abortus due to acrania. This 9 cases were excluded from the study while forming nomogram. 21 (5.3%) of 394 fetuses which were chromosomally and structurally normal could not measured due to the failure of obtaining required position.

Average gestational week was measured as 12.73 ± 0.66 (11.2-14.3) week, average CRL was measured as 64.86 ± 9.10 (45-86) mm, average FL was measured as 8.35 ± 2.29 (3-15.9) mm and average BPD was measured as 22.05 ± 2.96 (13-29) mm. Reference values on 2.5, 50 and 97.5 percentile related to measurement between 45-54, 55-64, 65-74 and 75-84 of CRL lengths were calculated (Table 1). 95% confidence interval was calculated by showing regression models related to gestational week, CRL, BPD and FL by means of graphics. BPD and FL values of cases increased linearly by the increase of CRL; significant relation was found between FL and BPD and CRL.

Table 1. Display of 2.5, 50 and 97.5 percentile for BPD and FL as to CRL measurements.

	BPD			FL		
CRL	2.5	50	97.5	2.5	50	97.5
45-54	13.7	18.0	21.0	3.6	5.3	7.7
55-64	17.0	20.0	24.0	5.0	7.0	10.0
65-74	20.0	23.0	26.0	6.3	9.3	12.2
75-84	24.0	26.0	28.0	7.2	11.5	14.2

When regression analysis of the correlation between gestational week and CRL was performed, regression equation was found as $y = 8.0774 + 0.0717 \times \text{CRL}$, $P < 0.001$, $r = 0.9753$ and 95% confidence interval was found as 0.9700-0.979 (Diagram 1). When regression analysis of the correlation between BPD and CRL was performed, regression equation was found as $y = 3.2956 + 0.2897 \times \text{CRL}$, $p < 0.001$, $r = 0.8885$ and 95% confidence interval was found as 0.8652-0.9080 (Diagram 2). When regression analysis of the correlation between FL and CRL was performed, regression equation was found as $y = -5.2381 + 0.2100 \times \text{CRL}$, $P < 0.001$, $r = 0.8336$ and 95% confidence interval was found as 0.7993-0.8625 (Diagram 3).

Discussion

It becomes possible today to diagnose genetic syndromes and fetal structural anomalies within first trimester by the development of the technology of ultrasonography devices.⁷⁻⁹ As the resolution of transvaginal ultrasonography devices are increased by the utilization of high frequency transducers, it is possible to detailed morphological examination of fetus in between 11th and 14th gestational week.

CRL measurements have been used routinely for gestational age determination for years. Equations and biometric growth curves based on CRL provide standardized controls of fetal measurements being easy and qualified and they enable to place appropriate indicators and to find inappropriate sonographic plans. It was found in transvaginal fetal biometric measurements done by Kusterman that CRL determines gestational age as to the last menstrual period date.¹⁰ We constituted regression curves with the help of CRL in our study.

Fetal extremity measurements within first trimester were generally performed on few fetuses and risky groups in many studies.^{11,12} It was understood within the study related with low risky general population performed by De Biasio that fetal extremities had significantly correlation with CRL measurement within the same gestational week.⁶ We also tried in our study to get nomogram related femur length for 11th - 14th gestational week. But due to the fact that the femur is small in that gestational period, it is clear that there will be wi-

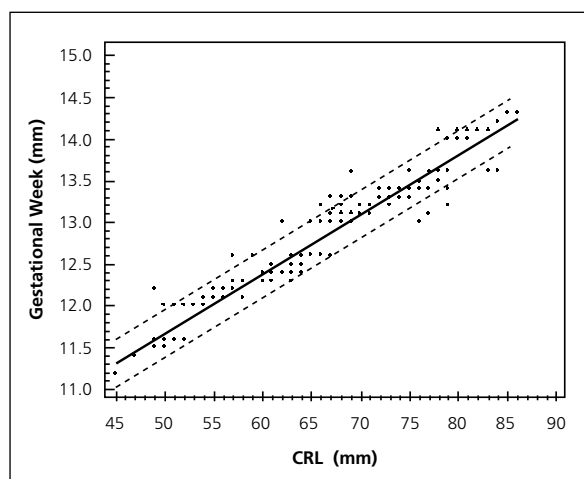


Diagram 1. Correlation between CRL and gestational week.

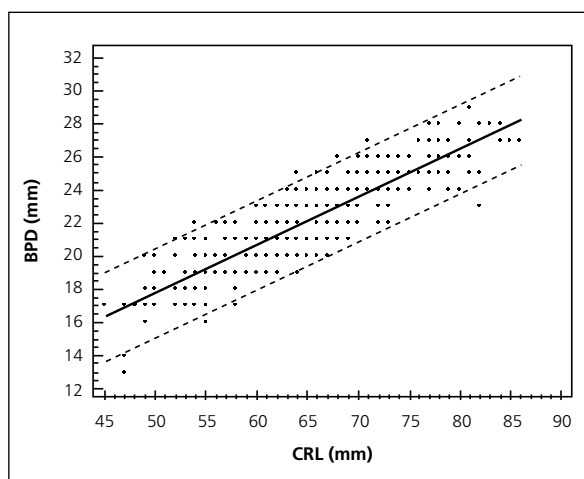


Diagram 2. Correlation between CRL and BPD.

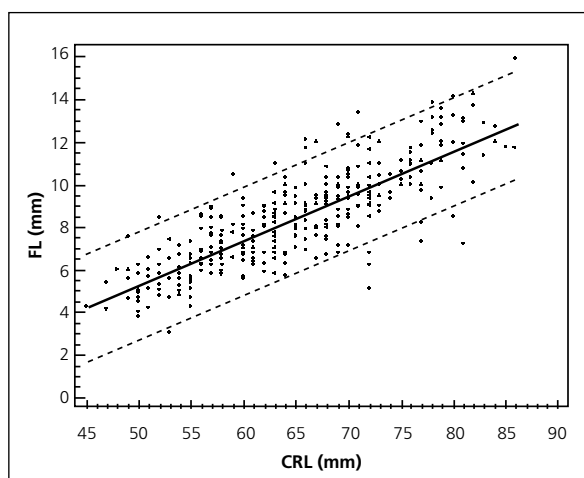


Diagram 3. Correlation between CRL and FL

de variations in placing marks and this may cause fault risk. Although some researchers mentioned that femur measurement may be used in skeletal dysplasias in that period, it will have low positive decisiveness value due to technical difficulty when applied to general population.^{13,14}

Grisolia planned a study about fetal biometric measurements within first trimester of the gestation and got CRL and BPD nomogram by correlating with gestational week and found that these values increased by gestational age.¹⁵ Similar distribution curves were obtained by Kusterman for CRL, BPD, HC and AC.¹⁰ Izquierdo performed linear regression analysis of fetal measurements for 92 gestations and found an accommodation within all measurements except FL.¹⁶ While all fetal biometric parameters increased as gestational week increased, BPD/FL rate did not change as gestation proceeded. So many fetal FL and BPD measurements were performed in our study and reference values were obtained while a positive correlation with gestational week was found.

Detailed first trimester examination in transvaginal ultrasonography performed within 11th-14th weeks in which crown-chin length may be measured may enable to recognize specific malformations such as acrania or anencephaly.¹⁷ Reference values relating to 11th-14th weeks may help diagnosis in such cases. But other morphological criteria of fetal growth are important for the diagnoses of skeletal and cranial anomalies. Although reference values are helpful for skeletal and central nervous system anomalies, these gestations certainly have to be performed ultrasonographic examination in next gestational weeks.

The aim of this study was to prepare reference tables consisting expected values of CRL, BPD and FL in 11th-14th week normal fetuses by transvaginal sonography. It is a prospective sectional study formed of gestations from general obstetric population which were resulted with no gestational prognosis complication and gestations forming the study sample came from various places of Istanbul. Pregnants sent to perinatology polyclinic from general obstetric polyclinic for 11th-14th week scanning. Our CRL measurements were found as compatible with the study of Robinson-Flemming.¹⁸ Fetal biometry generated by transvaginal ultrasonog-

raphy is very active in determining gestational week in 11th-14th weeks and helpful in distinguishing fetal growth as normal or abnormal. We believe that doctors who have first trimester scanning certificate and who are experienced transvaginal ultrasonography will contribute for getting nomograms. We also believe that getting wider series of fetal nomograms will help putting forward realistic results in our country.

Consequently, the correlation between gestational age within 11th-14th weeks and fetal biometric measurement can exactly shown by regression analysis. Reference values may be useful for determining normal or abnormal fetal growth which may occur during early gestation. Getting nomograms related to fetal BPD and FL within 11th-14th weeks may facilitate to diagnose symmetric or asymmetric growth retardation and to interpret measurements in fetuses having chromosomal anomaly and also to find skeletal dysplasias and acrania-anencephaly.

References

1. Snijders RJM, Noble P, Sebire N, Souka A, Nicolaides KH. UK multicentre project on assessment of risk of trisomy 21 by maternal age and fetal nuchal-translucency thickness at 10-14 weeks of gestation. *Lancet* 1998; 351: 343-6.
2. De Biasio P, Siccaldi M, Volpe G, Famularo L, Santi F, Canini S. First-trimester screening for Down syndrome using nuchal translucency measurement with free beta-hCG and PAPP-A between 10 and 13 weeks of pregnancy--the combined test. *Prenat Diagn* 1999; 19: 360-3.
3. Braithwaite JM, Armstrong MA, Economides DL. Assessment of fetal anatomy at 12-13 weeks of gestation by transabdominal and transvaginal sonography. *Br J Obstet Gynaecol* 1996; 103: 82-5.
4. Souka AP, Nicolaides KH. Diagnosis of fetal abnormalities at the 10-14-week scan. *Ultrasound Obstet Gynecol* 1997; 10: 429-42.
5. Von Kaisenberg CS, Fritzer E, Kühling H, Jonat W. Fetal transabdominal biometry at 11-14 weeks of gestation. *Ultrasound Obstet Gynecol* 2002; 20: 564-74.
6. De Biasio P, Prefumo F, Lantieri PB, Venturini PL. Reference values for fetal limb biometry at 10-14 weeks of gestation. *Ultrasound Obstet Gynecol* 2002; 19: 588-91.
7. Dugoff L. Ultrasound diagnosis of structural abnormalities in the first trimester. *Prenat Diagn* 2002; 22: 316-20.
8. Economides DL, Braithwaite JM. First trimester ultrasonographic diagnosis of fetal structural abnormalities in a low risk population. *Br J Obstet Gynaecol* 1998; 105: 53-7.
9. Carvalho MH, Brizot ML, Lopes LM, Chiba CH, Miyadahira S, Zugaib M. Detection of fetal structural abnormalities at the 11-14 week ultrasound scan. *Prenat Diagn* 2002; 22: 1-4.

10. Kustermann A, Zorzoli A, Spagnolo D, Nicolini U. Transvaginal sonography for fetal measurement in early pregnancy. *Br J Obstet Gynaecol* 1992; 99: 38-42.
11. Zorzoli A, Kustermann A, Caravelli E, Corso FE, Fogliani R, Aimi G, Nicolini U. Measurements of fetal limb bones in early pregnancy. *Ultrasound Obstet Gynecol* 1994; 4: 29-33.
12. Goncalves L, Jeanty P. Fetal biometry of skeletal dysplasias: a multicentric study. *J Ultrasound Med* 1994; 13: 977-85.
13. Gabrielli S, Falco P, Pilu G, Perolo A, Milano V, Bovicelli L. Can transvaginal fetal biometry be considered a useful tool for early detection of skeletal dysplasias in high-risk patients? *Ultrasound Obstet Gynecol* 1999; 13: 107-11.
14. Lachman RS. Fetal imaging in the skeletal dysplasias: overview and experience. *Pediatr Radiol* 1994; 24: 413-7.
15. Grisolia G, Milano K, Pilu G, Banzi C, David C, Gabrielli S, Rizzo N, Morandi R, Bovicelli L. Biometry of early pregnancy with transvaginal sonography. *Ultrasound Obstet Gynecol* 1993; 3: 403-11.
16. Izquierdo LA, Kushnir O, Smith JF, Gilson GJ, Chatterjee MS, Qualls C, Curet LB. Evaluation of fetal sonographic measurements in the first trimester by transvaginal sonography. *Gynecol Obstet Invest* 1991; 32: 206-9.
17. Sepulveda W, Sebire NJ, Fung TY, Pipi E, Nicolaides KH. Crown-chin length in normal and anencephalic fetuses at 10-14 weeks gestation. *Am J Obstet Gynecol* 1997; 176: 852-5.
18. Robinson HP, Fleming JEE. A critical evaluation of sonar "crown-rump length" measurements. *Br J Obstet Gynaecol* 1975; 182: 702-10.

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