Fetal Ocular Distance in Normal Pregnancies

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Objective: *To construct reference ranges of fetal ocular distance (interocular and binocular distance) and to evaluate the relationships between the gestational ages and fetal ocular distance.*
Material and Method: *Six hundred and two normal pregnant women were evaluated from the 15th to 40th week of gestation. Fetal ocular distance (interocular and binocular distances) was added to routine biometric measurements for normal fetuses. The fetal ocular distance (interocular and binocular distances) was also related to gestational age.*
Results: *Five hundred and ninety five measurements were used for analyses. A linear regression and correlation were observed between gestational age (GA) and interocular distance ($y = 2.304 + 0.510 \times GA$, $R^2 = 0.887$; $p < 0.0001$), and binocular distance ($y = 2.590 + 1.420 \times GA$, $R^2 = 0.953$; $p < 0.0001$). A linear growth function was observed between biparietal diameter (BPD) and both interocular distance ($y = 2.854 + 0.203 \times BPD$, $R^2 = 0.888$; $p < 0.0001$), and binocular distance ($y = 3.893 + 0.568 \times BPD$, $R^2 = 0.965$; $p < 0.0001$).*
Conclusion: *The present study provides normative data of fetal interocular distance and binocular distance. These data may be helpful in detection of fetal hypotelorism or hypertelorism.*

Keywords: *Fetus, Gestation age, Interocular, Binocular, distance, Ultrasound*

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Recent developments in fetal ultrasound technology represent effective tools that can be used to screen for abnormalities in fetal development. Many facial abnormalities of fetuses are characteristic and can be detected even during early gestational age. Screening results by ultrasound can identify facial and orbital defects such as hypertelorism and hypotelorism. This can be done by the measurements of ocular distance. These measurements are also useful for the estimation of gestational age. To date, there have been only limited studies to evaluated fetal ocular distance[1-5]. Two studies were performed in the early pregnancy[1,2]. Some studies evaluated the relation between fetal binocular distance and menstrual age[3,4]. One study evaluated only binocular distance[5]. The purpose of the present study was to construct reference ranges for fetal interocular distance (IOD) and binocular distance (BOD) during 15-40 weeks gestation and to evaluate the relationships between these data and gestational age.

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Material and Method

Between January 2007 and September 2007, 602 healthy pregnant women with known gestational age based on the last menstrual period, confirmed by first trimester and/or early second-trimester ultrasound examination, were recruited into the study with written informed consent. The present study was approved by the Ethics Committee of Faculty of Medicine, Chulalongkorn University. A prospective study was performed from the 15th to the 40th week gestation. These low-risk patients had no medical complications of pregnancy and underwent routine ultrasonography. Multiple gestations, cases with a discrepancy of more than 2 weeks between fetal growth and the time of pregnancy, abnormal fetuses, and complicated pregnancies such as those with diabetes mellitus and hypertension were excluded. Measurements were obtained by using an Aloka Prosound SSD-5000 SV

(Aloka Co., Ltd. Tokyo, Japan) ultrasound machine with 3.5 and 5.0 MHz abdominal transducer.

All values were obtained without prior knowledge of the gestational age. Fetal biometry and fetal structural survey was performed prior to measuring the fetal ocular distance to ensure normality of the fetuses. According to Bronshtein et al[6], IOD and BOD measurements were obtained by a transverse section of the fetal skull at the orbital plane in which the image was symmetrical with both eyes of equal and largest possible diameter. The IOD was defined as the distance between the medial border of one orbit and the medial border of the opposite side; BOD was defined as the distance between the lateral border of one orbit and the lateral border of the opposite side. The intra-observer variability, comparison of paired readings obtained on two separate occasions was calculated. All birth information and neonatal outcomes were reviewed for fetal growth and structural abnormalities.

All data processing was analyzed with the SPSS 13.0 (SPSS Inc, Chicago, IL). Data were analyzed for mean $\pm$ SD, 10^{th}, 50^{th}, and 90^{th} percentile of IOD and BOD for each week of gestational age. P-value < 0.05 was considered statistically significant. Regression analysis and correlation were used to examine the relationship between gestational age and IOD and BOD. Coefficient of determination (R2) was also presented

Results

Six hundred and two healthy singleton pregnant women underwent routine ultrasonographic examinations in the present study. Seven cases were excluded due to chromosome abnormalites (4 cases), Dandy Walker syndrome (1 case), and abortion (2 cases). Finally, five hundred and ninety five fetuses with complete data were available for analysis. None of the newborn had any clinical evidences of ocular abnormalities. The mean maternal age was 31.0 $\pm$ 6.5

Table 1. The fetal interocular distance (mm): GA, gestational age (n = 595)

GA (weeks)	n	Mean $\pm$ SD	Percentile		
			10^{th}	50^{th}	90^{th}
15	22	8.78 $\pm$ 0.92	7.69	8.70	10.15
16	22	9.88 $\pm$ 1.10	8.40	10.00	11.41
17	23	10.66 $\pm$ 0.96	9.24	10.90	11.56
18	31	11.40 $\pm$ 1.10	10.12	11.10	13.16
19	22	11.72 $\pm$ 0.97	10.26	11.80	13.21
20	26	13.05 $\pm$ 0.97	11.71	13.25	14.25
21	24	13.65 $\pm$ 1.40	11.45	13.60	15.45
22	22	14.02 $\pm$ 1.29	12.20	14.20	15.37
23	23	14.43 $\pm$ 1.22	12.70	14.30	16.40
24	26	14.90 $\pm$ 1.08	13.28	15.05	16.30
25	23	15.59 $\pm$ 1.40	13.90	15.30	17.70
26	22	15.91 $\pm$ 0.98	14.73	15.85	17.42
27	22	16.17 $\pm$ 0.93	15.09	16.05	17.83
28	22	16.97 $\pm$ 1.58	15.13	16.85	19.55
29	22	17.33 $\pm$ 1.44	15.62	17.15	19.66
30	23	17.57 $\pm$ 1.50	16.00	17.30	19.24
31	22	17.90 $\pm$ 1.46	16.00	17.50	19.98
32	22	18.21 $\pm$ 1.27	16.21	18.05	19.99
33	22	18.70 $\pm$ 1.42	17.10	18.75	20.17
34	22	19.82 $\pm$ 1.38	17.92	19.55	21.91
35	22	20.25 $\pm$ 1.46	18.01	20.05	22.40
36	22	20.37 $\pm$ 1.41	18.22	20.40	22.50
37	22	20.75 $\pm$ 1.53	18.55	20.75	22.82
38	22	21.93 $\pm$ 1.94	19.22	21.70	24.72
39	22	22.18 $\pm$ 1.95	19.79	22.00	25.00
40	22	22.41 $\pm$ 1.29	21.13	22.10	25.16

Table 2. The fetal binocular distance (mm): GA, gestational age (n = 595)

GA (weeks)	n	Mean $\pm$ SD	Percentile		
			10^{th}	50^{th}	90^{th}
15	22	20.20 $\pm$ 2.10	17.22	20.00	22.96
16	22	23.19 $\pm$ 1.34	21.80	22.90	25.04
17	23	25.59 $\pm$ 1.30	24.08	25.40	27.70
18	31	27.30 $\pm$ 1.75	24.88	27.10	30.28
19	22	29.52 $\pm$ 1.74	27.49	29.20	31.71
20	26	31.14 $\pm$ 1.56	29.17	31.10	33.19
21	24	32.88 $\pm$ 1.12	31.40	33.00	34.25
22	22	35.06 $\pm$ 1.03	33.69	35.10	35.94
23	23	36.17 $\pm$ 1.85	34.12	36.00	39.18
24	26	37.52 $\pm$ 1.54	34.87	37.85	39.42
25	23	39.45 $\pm$ 1.85	36.74	39.40	42.00
26	22	41.05 $\pm$ 1.52	39.23	40.95	43.79
27	22	42.63 $\pm$ 1.87	39.62	43.00	44.72
28	22	43.87 $\pm$ 2.02	41.12	44.10	46.07
29	22	45.43 $\pm$ 1.95	43.00	45.15	48.88
30	23	46.31 $\pm$ 1.88	43.70	46.00	48.98
31	22	47.89 $\pm$ 1.93	44.46	48.00	50.04
32	22	48.24 $\pm$ 2.02	45.37	48.25	51.13
33	22	49.31 $\pm$ 2.07	46.23	49.60	51.70
34	22	51.98 $\pm$ 2.64	48.66	51.95	55.77
35	22	52.99 $\pm$ 2.35	49.32	53.00	56.99
36	22	53.32 $\pm$ 2.36	50.18	53.15	57.08
37	22	54.04 $\pm$ 1.89	51.65	53.80	57.44
38	22	55.49 $\pm$ 2.12	52.58	55.60	58.27
39	22	55.79 $\pm$ 2.26	52.66	56.05	58.69
40	22	55.97 $\pm$ 1.89	53.66	56.15	58.77

years, and mean birth weight at delivery was 3,068.8 ± 448.7 grams. There was no newborn of Apgar score at 5 minutes below 7. The intraobserver error was less than 3%.

The statistic values such as mean ± SD, 10th, 50th and 90th percentile for IOD and BOD are listed in Table 1-2.

A statistically significant linear relationship was found between gestational age (GA) and IOD ($y = 2.304 + 0.510 \times GA$, $R^2 = 0.887$; $p < 0.0001$), and BOD ($y = 2.590 + 1.420 \times GA$, $R^2 = 0.953$; $p < 0.0001$) (Fig. 1).

There was a strong relationship between biparietal diameter (BPD) and both IOD ($y = 2.854 + 0.203 \times BPD$, $R^2 = 0.888$; $p < 0.0001$), and BOD ($y = 3.893 + 0.568 \times BPD$, $R^2 = 0.965$; $p < 0.0001$) (Fig. 2).

There was a linear relationship between IOD and BOD ($y = 1.605 + 0.354 \times BOD$, $R^2 = 0.902$; $p < 0.0001$).

Eye measurements of four fetuses that were later found with chromosomal abnormalities (1 case of trisomy 13, 2 cases of trisomy 18, and 1 case of trisomy 21) and one case of Dandy Walker syndrome were plotted on the constructed nomograms (Fig. 3). Data of these fetuses showed only one case of trisomy 18 had shortening in IOD, one case of trisomy 13, and two cases of trisomy 18 had shortening in BOD.

Discussion

The present study showed linear growth of fetal IOD and BOD from 15-40 weeks gestation. They are consistent with previous studies (5) that in a Thai population, GA significantly correlated with IOD and BOD.

BPD, abdominal circumference, and femur length have been used to evaluate fetal growth. Tongsong et al reported that fetal binocular distance

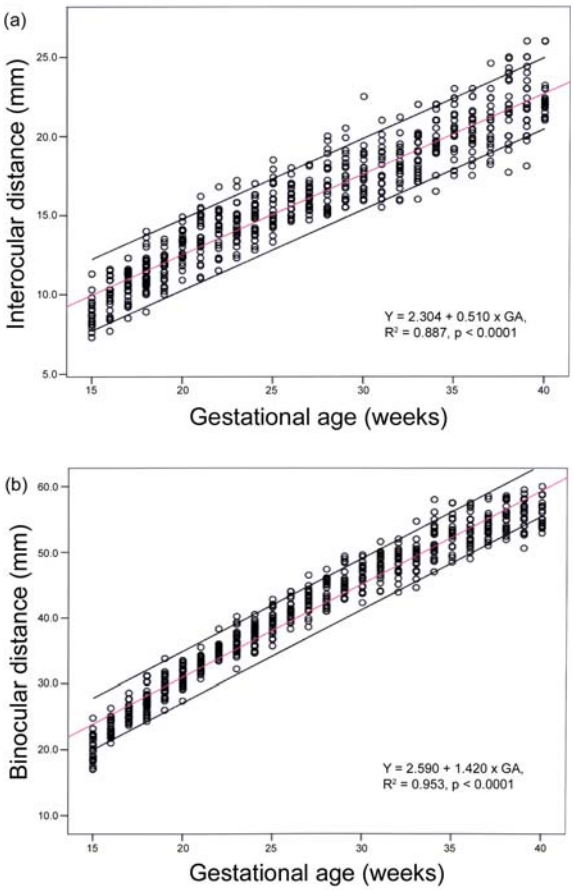

Fig. 1 Relationship between fetal interorbital distance (a), and binocular distance (b) and GA

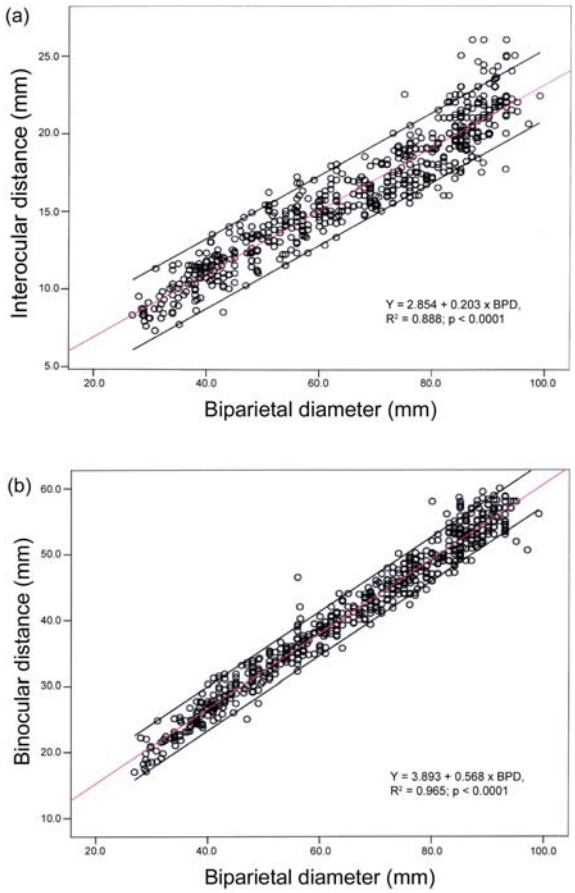

Fig. 2 Relationship between fetal interorbital distance (a), and binocular distance (b) and BPD

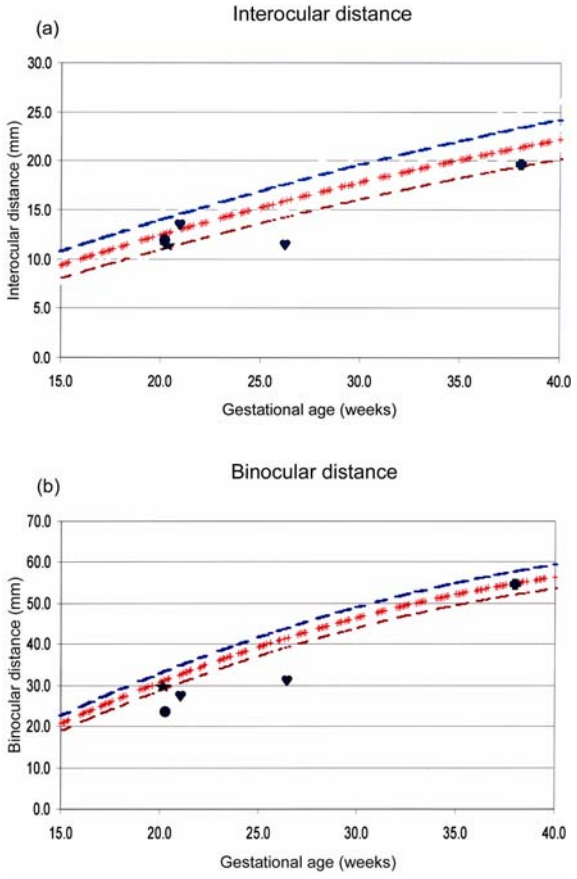

Fig. 3 Relationship between fetal interorbital distance (a), and binocular distance (b) and GA showing the 10th, 50th, and 90th centiles. Results of five abnormal fetuses are plotted (✚: Dandy Walker syndrome, ●: trisomy 13, ♥: trisomy 18, ★: trisomy 21)

could be used as an adjunct to estimating menstrual age[4]. However, it was a nonlinear model. The present found a linear model in this study. The difference may be from the difference in sample size and GA of the study group. Jeanty et al established nomograms for only fetal binocular distance[5]. Rosati et al[1] and Guariglia et al[2] constructed reference value of fetal IOD and BOD in early pregnancy (10-16 weeks) and found a linear model. In the present study, the authors constructed both fetal IOD and BOD in 15-40 weeks and found a linear model.

The authors found shortening in IOD and BOD in some cases of fetal aneuploidy. Due to the small number of abnormal cases in the present series, further study of IOD and BOD in fetuses at risk for hypertelorism and hypotelorism should be conducted.

In conclusion, the present study provides data on normal IOD and BOD. The nomograms might be helpful in the detection of fetal hypertelorism and hypotelorism.

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ระยะห่างของเบ้าตาของทารกในครรภ์ปกติ

กัญจน์พรรณ สุคนธ์พันธุ์, วรพงศ์ ภู่พงศ์

วัตถุประสงค์: *เพื่อสร้างค่าปกติของระยะห่างของเบ้าตาของทารกในครรภ์ (ระยะห่างชนิด interocular และ binocular) และดูความสัมพันธ์ระหว่างอายุครรภ์กับระยะห่างของเบ้าตาของทารกในครรภ์*

วัสดุและวิธีการ: *มีหญิงตั้งครรภ์ปกติจำนวน 602 คนที่มีอายุครรภ์ 15-40 สัปดาห์เข้าร่วมโครงการศึกษา การวัดระยะห่างของเบ้าตาของทารกในครรภ์ (ระยะห่างชนิด interocular และ binocular) ได้วัดเพิ่มเติมจากการตรวจอัลตราซาวด์เพื่อหาค่าอื่น ๆ ของทารกในครรภ์ และนำค่าของระยะห่างของเบ้าตาของทารกในครรภ์ (ระยะห่าง ชนิด interocular และ binocular) มาหาความสัมพันธ์กับอายุครรภ์*

ผลการศึกษา: *จากจำนวนการวัด 595 ครั้งที่นำมาวิเคราะห์ พบความสัมพันธ์เชิงเส้นตรงของอายุครรภ์กับระยะห่างของเบ้าตาชนิด interocular ($y = 2.304 \pm 0.510 \times GA$, $R^2 = 0.887$; $p < 0.0001$) และชนิด binocular ($y = 2.590 \pm 1.420 \times GA$, $R^2 = 0.953$; $p < 0.0001$) นอกจากนี้ยังพบความสัมพันธ์เชิงเส้นตรงของความกว้างของศีรษะของทารกในครรภ์ (BPD) กับระยะห่างของเบ้าตาชนิด interocular ($y = 2.854 + 0.203 \times BPD$, $R^2 = 0.888$; $p < 0.0001$) และชนิด binocular distance ($y = 3.893 + 0.568 \times BPD$, $R^2 = 0.965$; $p < 0.0001$)*

สรุป: *การศึกษานี้แสดงให้เห็นถึงค่าปกติของระยะห่างของเบ้าตาของทารกในครรภ์ ทั้งระยะห่าง interocular และ binocular ซึ่งข้อมูลนี้อาจจะมีประโยชน์ในการช่วยค้นหาภาวะระยะห่างของเบ้าตาของทารกในครรภ์ที่มากเกิน หรือน้อยเกินไป*