

Predicting Fetal Intrauterine Growth Retardation by Using Reference Centile Charts for the Ratio of Fetal Transverse Cerebellar Diameter to Abdominal Circumference in a Thai Population

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ABSTRACT

Objective: To predict fetal intrauterine growth retardation (IUGR) by using the centile chart for the ratio of transverse cerebellar diameter to abdominal circumference (TCD/AC) throughout pregnancy from 13-40 weeks.

Methods: A total of 643 pregnant women were recruited in this study. The exclusion criteria of 643 normal pregnant women were uncertain date of last menstrual period, multiple pregnancies, fetal abnormalities and maternal conditions which could affect fetal growth. The known 20 small IUGR infants were also tested. Transverse cerebellar diameter and abdominal circumference of all the subjects were measured out by gestational age. The approximately equal numbers of fetuses were measured at each week of gestation. The mean and standard deviation of TCD/AC ratio is estimated at each week of gestation. In addition the 5th, 10th, 50th, 90th and 95th percentiles were calculated at each week of gestation.

Results: Of 643 pregnant women, 149 (23.1%) were scanned before 20 weeks of gestation and 286 (44.5%) were scanned between 20 and 30 weeks of gestation. The last group was rechecked after 30 weeks of gestation. TCD/AC ratio slowly declined from early pregnancy until about 20 weeks then remained stable. After 30 weeks of gestation it started to decline again. A TCD/AC ratio greater than the 90th centile was present in 80% (16/20) known small for gestational age (SGA) infants. (SGA has not been defined).

Conclusion: The normal reference value of TCD/AC ratio in Thai fetus was shown in this study. The TCD/AC ratio is a stable, gestational age independent parameter during 20-30 weeks of gestation that may be useful in the early detection of fetal intrauterine growth retardation (IUGR).

Keywords: IUGR, reference centile chart, TCD/AC ratio, Thai fetus

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Fetal biometry by ultrasound assessment has become the major method of both reassuring gestational age and monitoring fetal growth and development. Many fetal parameters can be measured with ultrasonography and have been correlated with gestational age. The most frequently used biometric parameters include the fetal biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC), and femur length (FL). Those parameters are

limited for clinical usefulness in establishing gestational age in late pregnancy or in assessing fetal growth in uncertain dated pregnancies. This was explained by the increasing biologic variability in advancing gestational age. To determine the abnormal fetal growth, serial ultrasonographic evaluation in the third trimester is required for appropriated fetal surveillance and intervention.

The cerebellum is a suprasegmental portion of the brain located within the cranial posterior fossa. The fetal cerebellum can be visualized sonographically as early as 10 weeks of gestation. From the second trimester, it grows rapidly with a linear relationship pattern

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correlating with gestational age. However, as the pregnancy advances, the growth curve of the cerebellum tends to flatten, showing a slower rate of evaluation. Since the cerebellum is located inside the posterior fossa and is surrounded by the dense, petrous ridges and the occipital bone, it should be able to withstand deformation by extrinsic pressure better than the parietal bone. The transverse cerebellar diameter (TCD) can better predict gestational age in cases in which there are variations of the fetal head shape such as dolichocephaly and brachycephaly or even when the fetus is in a direct occiput posterior position.^{1,2}

To assess fetal growth by using a gestational age an independent method is useful in assessing the pregnant women with uncertain date. The FL/AC ratio is a gestational age independent method for assessing fetal growth but there is limitation using in only asymmetrical IUGR.³ The TCD/AC ratio is also independent of gestational age and may be useful in assessing fetal growth in pregnancies with unknown dating.⁴ Unfortunately, there is no standard reference of TCD/AC for Thai fetuses. Therefore, we designed this study to establish the reference ranges of transverse cerebellar diameter/abdominal circumference throughout pregnancy from 13-40 weeks of gestation in order to use these indices in clinical management of Thai patients. The model in a group of known SGA infants is also tested.

MATERIALS AND METHODS

This study was approved by the Ethics Committee at Faculty of Medicine Siriraj Hospital, Mahidol University.

This study included two separate groups of patients and was designed as a cross sectional study. The first group was uncomplicated pregnancy that will be described later. The second group, from neonatal records reviewed, was 20 SGA infants who had been delivered at Siriraj Hospital.

We recruited 643 pregnant women in the first group between 13 and 40 weeks of gestation, and attended the antenatal clinic at Siriraj Hospital. The inclusion criteria were pregnant women who had previous regular menstrual period to current pregnancy and uterine size at that time of examination was compatible with menstrual age. Exclusion criteria were as follow:

1. Uncertain date of last menstrual period
2. Maternal conditions which may affect fetal growth e.g., diabetes mellitus, hypertension, etc.
3. Multiple pregnancies
4. Fetal or neonatal malformation or abnormal karyotype of fetus detected by ultrasonography or genetic diagnosis.

Transverse cerebellar diameter and abdominal circumference of all the subjects were measured at randomly assigned gestational ages so that approximately equal number of fetuses were measured at each week of gestation. All ultrasonographic examinations were performed with a Toshiba (ECC CEE, SSA-340A) ultrasound machine with a 3.5 MHz convex transducer. Electronic calipers were used and all measurements were obtained in centimeters and each fetus was included only once. The cerebellum was identified in the posterior fossa and measured in an outer to outer fashion. The abdominal circumference was obtained

from a transaxial view at the level of the junction of the umbilical vein and left portal vein. The mean and standard deviation of TCD/AC ratio is estimated at each week of gestation. In addition the 5th, 10th, 50th, 90th and 95th percentiles were calculated at each week of gestation as well.

The second group was from neonatal records reviewed and 20 IUGR infants were selected. Infants were recruited if they had had a fetal ultrasonographic examination within 1 week of delivery. The measurements included TCA and AC. Gestational age was determined by the Ballard scoring system. 5 A birth weight less than 10 percentile was defined as IUGR. TCD/AC ratio was defined as abnormal if it was greater than that for the 90th percentile for gestational age.

RESULTS

A total of 643 pregnant women were entered in this study. The number of fetuses measured at each week of gestation is shown in Table 1. Fig 1. shows a scatter plot of fetal transverse cerebellar diameter (TCD)/abdominal circumference (AC) ratio in pregnancy. Reference centiles were calculated from the estimated means and standard deviations (SDs) at each week of gestation. It could be noted that TCD/AC ratio slowly declined from early pregnancy until about 20 weeks then remained stable. After 30 weeks of gestation it started to decline again. Reference centiles of TCD/AC ratio were created for each gestational age. The results are shown in Table 2.

TABLE 1. Number of fetuses measured at each week of gestation.

Gestational age (weeks)	Number of fetuses	Percent
13	9	1.4
14	21	3.3
15	27	4.2
16	27	4.2
17	19	3.0
18	23	3.6
19	23	3.6
20	29	4.5
21	29	4.5
22	25	3.9
23	24	3.7
24	28	4.4
25	24	3.7
26	23	3.6
27	36	5.6
28	26	4.0
29	23	3.6
30	19	3.0
31	27	4.2
32	27	4.2
33	23	3.6
34	30	4.7
35	18	2.8
36	34	5.3
37	20	3.1
38	15	2.3
39	11	1.7
40	3	0.5
Total	643	100.0

TABLE 2. Fitted centiles of Thai fetal TCD/AC ratio.

Gestational age (weeks)	Mean	SD	Percentiles				
			5	10	50	90	95
13	16.36	1.18	14.81	14.81	16.31	18.39	18.39
14	15.85	1.09	13.26	14.67	16.08	17.38	17.92
15	15.28	1.32	13.19	13.61	15.20	16.81	18.58
16	14.60	0.92	12.80	13.24	14.53	16.07	16.38
17	14.13	1.05	11.85	12.98	14.06	15.69	15.98
18	14.07	0.81	12.88	13.03	13.92	15.47	16.01
19	14.04	0.77	12.28	13.06	14.04	15.08	15.58
20	13.34	0.75	11.85	12.10	13.38	14.38	14.60
21	13.54	0.83	12.31	12.46	13.38	14.86	15.31
22	13.39	0.95	11.88	12.13	13.38	14.71	14.80
23	13.13	0.84	11.36	11.87	13.15	14.27	14.58
24	13.27	0.81	11.75	12.34	13.06	14.70	14.80
25	13.53	0.63	12.54	12.68	13.62	14.53	14.84
26	13.33	0.75	11.60	12.31	13.35	14.49	14.71
27	13.12	0.81	11.31	12.45	13.03	14.30	14.91
28	13.28	0.74	11.83	12.25	13.32	14.28	14.70
29	13.26	1.02	11.36	11.51	13.28	14.68	14.85
30	12.82	1.34	10.09	11.07	12.90	14.65	15.18
31	13.27	0.96	11.98	12.10	13.08	14.45	15.43
32	13.21	1.14	11.58	11.81	13.20	15.04	15.23
33	12.81	1.09	11.09	11.22	12.93	14.12	14.51
34	12.55	0.77	11.29	11.64	12.47	13.58	14.05
35	12.50	1.13	10.62	10.95	12.71	13.96	15.53
36	12.16	1.03	10.44	10.68	12.22	13.51	14.02
37	12.25	0.79	11.18	11.24	12.06	13.39	13.66
38	12.05	1.16	10.63	10.68	11.68	13.96	14.10
39	11.88	0.99	10.59	10.64	11.84	13.87	14.08
40	12.07	1.40	11.04	11.04	11.51	13.66	13.66

SD, standard deviation

The TCD/AC ratio was abnormal in 16 out of 20 (80%) of the IUGR infants. The mean body weight was $1,674 \pm 250$ grams. The mean TCD/AC ratio in this group was $17.5 \pm 0.94\%$ (range, 15.9 – 19.1%). The mean gestational age was 35.6 ± 1.2 weeks (range 33-37 weeks). Using the two-sample t-test for analysis, the mean TCD/AC ratio was significantly higher in the IUGR infants than in the normal group ($P < 0.0001$). (Table 3)

DISCUSSION

IUGR is caused mostly by asphyxia or reduced utero-placental blood flow. The blood flow shifts mainly to the central parts including brain, heart and adrenal glands.⁶ There was a study that in acute asphyxia, cerebellar blood flow remained unchanged as a consequence of redistribution of cardiac output.⁷ In human, cerebellar growth may be least affected by IUGR, therefore TCD measurement is mostly accurate in the predicting of gestational age.⁸ IUGR fetuses have decreased hepatic glycogen and subcutaneous fat stores which results in decreased AC. Therefore the AC is sensitive to predict fetal IUGR.⁹ The TCD/AC ratio is the least affected biometric parameter and could be a sensitive method of detecting asymmetrical IUGR at any gestational age.

The fetal cerebellum is located at the posterior fossa and can be seen easily from 11 weeks of gestation.¹⁰ Its location is prevented from external compressive effect including fetal malposition, breech presenta-

TABLE 3. Details for 20 small for gestational age (SGA).

SGA infants (number)	Body weight (grams)	Gestational age at delivery (weeks)	Mean TCD/AC ratio
1	1,250	34	17.6
2	1,280	34	16.9
3	1,320	34	16.8
4	1,360	35	17.2
5	1,396	35	15.9
6	1,420	36	18.6
7	1,440	34	17.9
8	1,516	33	17.4
9	1,625	36	18.0
10	1,650	37	16.5
11	1,764	36	17.2
12	1,820	36	18.2
13	1,880	36	18.5
14	1,904	37	19.1
15	1,955	37	16.9
16	1,990	36	15.9
17	1,070	36	16.8
18	2,189	37	18.2
19	2,260	36	18.7
20	2,398	37	18.6

tion or oligohydramnios.

The data was collected in a cross-sectional fashion, measuring all the ratios for each fetus, specifically for the purpose of the study. The date of measurement was randomly assigned to each woman, so that approxi-

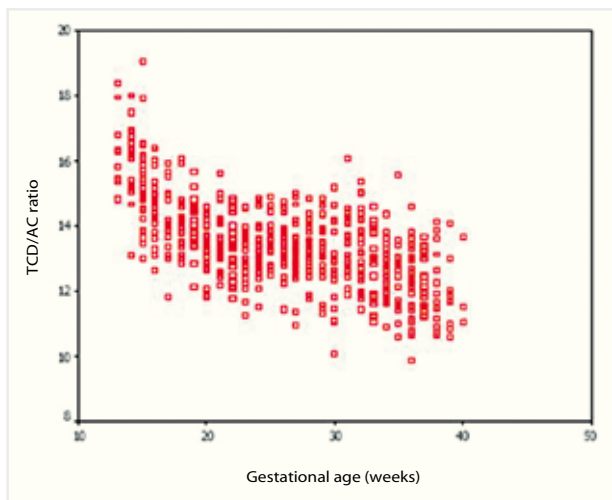


Fig 1. Fetal transverse cerebellar diameter (TCD) /and abdominal circumference (AC) ratio according to gestational age was shown.

mately the same number of fetuses was measured at each week of gestation. However there were limited numbers of fetus at early pregnancy and near term. Normal reference values for TCD/AC ratio have been studied by many investigators. Some investigators have found a high predictive value of TCD/AC ratio in predicting a fetus with intrauterine growth restriction. At the time of this study, there is no standard reference chart of TCD/AC ratio for Thai fetuses. The findings from this study will help identification and assessment of fetuses and create possibility for early intervention and therapy to prevent fetal morbidity and mortality.

IUGR is usually suspected from a discrepancy between uterine size and gestational age. Therefore, the predictive accuracy of clinical parameters for diagnosis of IUGR is poor. The diagnosis needs to be more precise and an objective measure employed to assess the fetus with suspected IUGR. All existing evidence points to ultrasound as this objective modality. Ultrasound parameters for diagnosis of IUGR, AC appears to give the highest accuracy [84-100%].⁶ However, AC can be used for the diagnosis of IUGR only in the case of a known accurate date.

Cabbad et al found that 22 out of 23 asymmetrically growth-impaired fetuses had a TCD lower than expected but within the normal range suggesting this measurement is useful for estimating gestational age in these cases.¹ Currently, it has been shown that the TCD/AC ratio is date-independent. The ratio is constant throughout the second and third trimester of normal pregnancy. In a fetus with IUGR, AC is obviously affected, but TCD is not, resulting in an increased

TCD/AC ratio. Therefore, an increased TCD/AC ratio can theoretically predict IUGR at any gestation age, even in the condition of an uncertain date. To date there have been only a few reports regarding the efficacy of TCD/AC ratio in predicting IUGR and each consisted of only a small-number of fetuses with IUGR.¹¹

The result of this retrospective study was the ratio was abnormal in 80% of known IUGR infants, therefore the TCD/AC ratio may be very sensitive for IUGR fetuses. The limitation of its usefulness is the difficulty in measuring TCD in the late third trimester. Future studies will be needed to assess for evaluating the symmetrical IUGR.

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