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Fetal Transverse Cerebellar Diameter / Abdominal Circumference Ratio in Normal Pregnancy

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Abstract

Objective To determine the normal values of transverse cerebellar diameter (TCD)/abdominal circumference (AC) ratio during fetal period in Thai population.

Design Prospective descriptive study.

Setting Maharaj Nakorn Chiang Mai Hospital, Chiang Mai University

Methods Normal singleton pregnancies with certain date between 15 and 40 weeks' gestation were voluntarilly enrolled to undergo ultrasound examination without any specific indications. TCD and AC were measured for each gestational week and the TCD/AC ratio was calculated.

Results TCD/AC ratio was studied in 275 normal pregnancies. By analysis of 944 measurements for each parameter, this ratio was found to be constant and independent of menstrual age, with normal range (mean+2SD) of 13.705+2.016%. The median of the ratio was 13.64% (fifth and 95th percentiles of 11.659 and 15.709, respectively). The mean ratio is nearly the same as that of the western series.

Conclusion The normal TCD/AC ratio is gestational age-independent parameter, constant throughout pregnancy. The ratio obtained from the Thai study hopefully will be the baseline for the Thai population, especially in evaluation of fetal gr owth in case of uncertain gestataional age.

Key words: Ratio, transverse cerebellar diameter, abdominal circumference, pregnancy

Accurate antenatal diagnosis of intrauterine growth restriction (IUGR) could greatly decrease the high perinatal morbidity and mortality associated with this condition. Many different sonographic criteria for the diagnosis of IUGR have been proposed. Numerous investigators have measured a variety of fetal body measurements in an attempt to make an accurate ultrasonic diagnosis of the IUGR fetus. Abdominal circumference (AC) appeared to be the most sensitive to abnormalities of fetal growth.[1] The head/abdominal circumference, femur lenght/abdominal circumference ratio and fetal ponderal index have also been used, with some degree of accuracy, to detect impaired in utero growth. Fetal weight estimated from one or more of the BPD, femur length and abdominal circum ference measurements have also been used to recognize the IUGR fetus. Despite these multiple ultrasound methods, difficulty still exists in recognizing the IUGR

fetus antenatally. Based on the meta-analysis by Benson and coworkers,[2] none of those sonographic criterion allows a confident antenatal diagnosis of IUGR to be made. New criteria, or combinations of existing ones need to be further evaluated. Goldstein et al[3] developed a nomogram for TCD measurements in the second and third trimester of pregnancy. Subsequently, Reece et al[4] evaluated the TCD measurement in cases of impaired fetal growth and found that this measurement was not affected in their cases of growth restricted infants. Additionally, several investigators[5-8] found that have demonstrated that TCD/AC ratio is a date-independent parameter and is valuable in identifying babies with asymmetrical IUGR. The purpose of this study was to determine the normal values of transverse cerebellar diameter (TCD) / abdominal circumference (AC) ratio during fetal period in Thai population.

Patients and Methods

This prospective study consisted of 275 normal pregnant women attending the antenatal clinic at Maharaj Nakorn Chiang Mai Hospital between 15 and 40 weeks' gestation from May 1989 until July 1995. The subjects met the following criteria: (i) history of regular menstruation and knowledge of the exact date of the last menstrual period; (ii) singleton pregnancy without medical or obstetrical complication, no evidence of intrauterine growth restriction and congenital anomalies; and (iii) attending the antenatal clinic within the first trimester of pregnancy and menstrual age consistent with clinical estimation. Each patient was voluntarilly enrolled into the study without any specific indications.

The ultrasound scans were performed by the first two investigators, who had no prior clinical information about the patients, using a real-time, 3.5 MHz curvilinear scan (model SSD 650 and 680EX; Aloka, Tokyo, Japan). In addition to routine measurements (biparietal diameter, abdominal circumference, and femur length), a TCD measurement was obtained by the following method. The landmarks of the thalami, cavum septum pellucidum, and third ventricle were identified; then by slightly rotating the transducer below the thalamic plane, the posterior fossa was revealed with the characteristic butterfly-like appearance of the cerebellum. The AC was measured from a transaxial view of the abdomen at the level of the junction of the umbilical vein with the left portal vein. The measurements were made along the outer perimeter of the abdomen. The TCD/AC ratio was calculated by dividing the TCD by the AC and then multiplying by 100, as described by Campbell and assoicates.[7] The statistical analyses were carried out with computer and SPSS PC+ software.

Results

A total of 1102 measurements of TCD/AC ratio obtained from 290 pregnant Thai women. Fifteen subjects were excluded because having growth alteration (10 cases) and major fetal anomalies (5 cases). The TCD/AC were determined in 1048 examinations in the remaining 275 women, but 64 examinations (34 for TCD and 37 for AC) were unsuccessful due to maternal obesity, occiput posterior position, oligohydramnios, and deeply engaged of fetal head. Therefore, the analysis consisted of 944 measurements. The average age of the subjects was 25.7 years. Their occupations were mainly agriculture (74.3%) and 61.8% were primigravida. The mean TCD/AC ratio and standard deviation for each gestational week are calculated as shown in table I and figure 1. Additionally, 5th, 50th and 95th percentiles are also shown in table 1.

Strong correlation existed between gestational age and transcerebellar diameter (R^2=0.95), between gestational age and AC (R^2=0.97), and between TCD and AC (R^2=0.96). The TCD/AC ratio was normally distributed with a mean +2SD of 13.705+2.016%. The 5th, 50th and 95th percentiles were 11.659, 13.640 and 15.709 % respectively. The TCD/AC ratio remained constant throughout pregnancy with respect to gestational age. (R^2=0.0069).

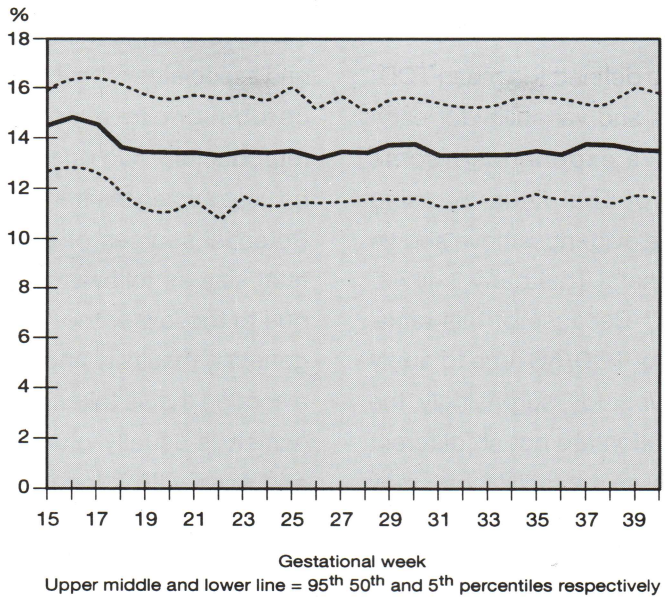


Figure 1. Nomogram of TCD/AC ratio distribution: TCD/AC ratio of the 5th, 50th, and 95th percentiles for each gestational week is relatively constant.

Table 1. TCD/AC Percentiles Throughout Pregnancy

Gestational Age (weeks)	No. of Exams	Means	SD	5th percentile	50th percentile	95th percentile
15	31	14.67	0.86	12.76	14.57	16.08
16	32	14.76	0.91	12.87	14.83	16.43
17	40	14.35	0.84	12.67	14.55	16.45
18	33	14.00	1.03	11.91	13.65	16.26
19	35	13.41	1.12	11.14	13.48	15.67
20	38	13.36	1.11	11.09	13.44	15.56
21	33	13.49	0.98	11.55	13.45	15.75
22	34	13.39	1.26	10.79	13.35	15.65
23	35	13.51	0.89	11.74	13.45	15.70
24	39	13.61	1.16	11.29	13.41	15.54
25	35	13.28	0.94	11.48	13.50	16.06
26	38	13.29	0.92	11.46	13.24	15.20
27	40	13.66	1.11	11.47	13.48	15.77
28	39	13.38	0.90	11.63	13.46	15.10
29	39	13.54	0.93	11.63	13.74	15.58
30	35	13.75	1.05	11.66	13.79	15.68
31	36	13.40	1.04	11.39	13.37	15.49
32	39	13.49	1.02	11.36	13.42	15.33
33	40	13.62	0.92	11.63	13.42	15.33
34	41	13.59	0.99	11.57	13.39	15.59
35	42	13.39	1.00	11.81	13.53	15.70
36	39	13.64	1.01	11.56	13.41	15.66
37	43	13.73	1.02	11.62	13.80	15.37
38	30	13.70	1.11	11.49	13.77	15.52
39	29	13.89	1.04	11.76	13.58	16.05
40	29	13.90	1.05	11.80	13.55	15.91
Total	**944**	**13.705**	**1.008**	**11.659**	**13.640**	**15.709**

Discussion

In the present study, we defined the mean TCD/AC ratio and percentile ranks and variability for each gestational week. We have experienced some problems in the evaluation of Thai fetus by using western standard data. Some evidences have shown that the birthweight of a neonatal Thai baby is lower than the Caucasian ones.[9,10] Because of this racial factor, we need our own data of TCD/AC ratio to apply with our population. From our study, surprisingly, the values and pattern of distribution are not so different from those of western studies, so the racial factor may not influence the fetal abdominal growth. We found that the TCD/AC ratio remains fairly constant between 15-40 weeks' gestation. Thus, this ratio is independent of the gestational age of the fetus at the time of measurement. The variability of the ratio was also relatively stable throughout pregnancy.

To create a nomogram like this, the sample size calculated from the variability of the previous study,[5,6] requires about 20 measurements for each gestational week, so we believe that this large series can be effectively used as a standard one for application with our own population.

The fetal cerebellum is easily visualized in the posterior fossa from approximately 11 weeks onward.[3] In its location between the dense petrous ridges, the cerebellum is protected from external compressive forces that may distort the fetal cranium, as seen with breech presentation or oligohydramnios. In these circumstances, measurements of the BPD and HC will be less accurate predictors of gestational age. Because of its protected location, the correlation of TCD with gestational age is preserved in these cases and is better than that of the BPD and HC.[11] Generally, we had no problems in measuring TCD in early pregnancy. However, increasing difficulty with visualization of the cerebellum because of advancing gestational age may limit the clinical usefulness of the ratio in the late third trimester. We were not able to measure in about 3.2%, mostly in the third trimester. Occiput posterior position is the most common factor involved in poor visualization.

In this case, fetal acoustic stimulation may be useful to change the fetal position. Recently, Kokinas and associates[12] have shown that measurement of the cerebellum in a coronal view is accurate and reproducible. Coronal cerebellar measurements may be useful when the transverse view cannot be obtained. Potential sources of error in using the AC to predict fetal size as follows: 1) imaging from a plane that is due to too low or too high in the fetal abdomen which generally results in underestimation, 2) measuring from a section that is taken obliquely through the abdomen (which is usually characterized by an oval-shaped abdomen with a long segment of the umbilical vein) which will artificially increase the AC and, 3) using this measurement to predict age in pathological conditions such as growth restriction or macrosomia when the fetal abdomen is disproportionately small or large for age respectively.

In cases of IUGR caused by uteroplacental insufficiency, redistribution of fetal circulation occurs, thus preserving blood flow to the brain. Primate models have demonstrated that in the presence of acute asphyxia, cerebellar blood flow remains unchanged as a consequence of alterations of blood flow.[13] Moreover, it was shown that cortical blood flow of asphyxiated fetus is greatly diminished while cerebellar blood flow remains relatively constant. This suggests that even in a fetus with serious growth restriction, cerebellar growth impairment may not occur. In the human fetus, growth of the cerebellum may be least affected by IUGR, and measurement of the TCD appears to be the most reliable biometric parameter in predicting true gestational age.[4,14]

Depletion of hepatic glycogen and subcutaneous fat stores in IUGR fetuses lead to an early decrease in the fetal AC, making this parameter the earliest and most sensitive predictor of asymetrical IUGR. TCD/AC ratio, which utilizes both the least and the most affected fetal biometric parameters, should provide a very sensitive method of detecting asymmetrical and possibly symmetrical IUGR at any gestational age. This ratio may be especially useful in the evaluation of patients with poor antenatal care or unknown gestational dating, allowing for early clinical intervention in abnormal cases.

We hope that this baseline data of the TCD/AC ratio in normal pregnant Thai population is significant for diagnosis of IUGR, especially in case of uncertain gestational age. Based on the value of greater than 95th percentile, like previous report,[5,7] we suggest that values exceeding the 95th percentile of the TCD/AC ratio (>15.7%) should alert the physician for IUGR. Although this ratio should be sensitive in detecting the IUGR fetus, further studies are needed to assess prospectively the value of this ratio in diagnosis of IUGR and determine whether this ratio is more sensitive than current methods of predicting fetal growth abnormalities.

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