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In order to find the best regression equation between gestational age and ultrasonic cerebellar diameter, a study was undertaken among 225 pregnant women attending Maharaj Nakorn Chiang Mai's routine antenatal clinic during September 1, 1989 to August 31, 1990. All subjects were of a certain gestational age and met the set criterias 944 ultrasonic measurements were prospectively done from 15 to 40 weeks gestations, with an average of four per subject. The most suitable regression equation was obtained by regression analysis. Mathematical modeling of the data demonstrated that the curvillinear relationship between cerebellar diameter and gestational age was an optimal model ($r^* \alpha 0.9489$ $p = 0.0000$).

In addition, a nomogram of cerebellar diameters and gestational ages were also constructed.

Key words : cerebellar diameter, ultrasound, gestational age.

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ได้ทำการศึกษาหาความสัมพันธ์ระหว่างอายุครรภ์ (GA) กับเส้นผ่าศูนย์กลางของ cerebellum (CD) ซึ่งวัดด้วยคลื่นเสียงความถี่สูง โดยได้ทำการตรวจวัด 944 ครั้งในสตรีตั้งครรภ์ปกติที่ทราบอายุครรภ์แน่นอน 225 คน ระหว่างอายุครรภ์ 15-40 สัปดาห์ (โดยเฉลี่ย 4 ครั้งต่อคน) นำค่าเส้นผ่าศูนย์กลางที่ได้ทั้งหมดมาหาค่ามัชฌิมเลขคณิต และค่าเบี่ยงเบนมาตรฐานของแต่ละอายุครรภ์ พบว่าเส้นผ่าศูนย์กลาง cerebellum และอายุครรภ์มีความสัมพันธ์กันแบบโพลีโนเมียลกำลังสาม ($r^2 = 0.9489$, $p = 0.0000$)

นอกจากนี้ยังได้สร้างตารางค่า cerebellar diameter ของแต่ละอายุครรภ์ที่ระดับเปอร์เซนไทล์ 10, 25, 50, 75 และ 95 ขึ้นด้วย

One of the major concern in obstetrics management is an exact gestational age especially in the high risk group. The menstrual history is frequently unreliable. At present, ultrasonography has significantly improved the evaluation of foetal age by foetal biometry. The measurement of foetal head[1], body[2] and long bones[3,4]as routinely used have some limitations. Foetal cerebellum can be easily demonstrated sonographically and its diameter can be measured accordingly. This parameter may play an important role for foetal age evaluation.[5,6]

Previous studies reported interference of accuracy of cerebellar diameter measurement by conditions that change the foetal head shape such as breech presentation, oligohydramnios, twins, etc. when compared with biparietal diameter and also in intrauterine growth retarded foetus. This measurement (diameter) thus was of little concern and scarcely studied. According to the basic concept, human embryo has a certain pattern of development and the foetal brain should have a normal pattern of growth. Any deviation from norm may indicated pathological conditions. Like other parts, if the cerebellum could not be demonstrated by the early second trimester, This points to possible foetal central nervous system anomalies such as Dandy-Walker syndrome, type II Arnold-Chiari malformation. We then put our focus on the foetal cerebellum and base our report on 944 ultrasonographic measurement of this region.

The purpose of this study is to determine the normal relation between cerebellar diameter and gestational age (± S.D.) and to serve as a basis for further studies in which pregnancy at risk for congenital malformation or growth alteration can be assessed.

Patients and methods

A prospective study of ultrasonography was conducted in a population of normal, pregnant women who attended the antenatal clinic of Maharaj Nakorn Chiang Mai Hospital who fulfilled all the following criteria (1) exact last menstrual period, that could be confirmed by bimanual examination on the first visit (< 14 weeks) (2) regular menstrual cycle (at least 3 cycles before pregnancy), (3) Age less than 35 years old, (4) height at least 145 centrimeters, (5) singleton, (6) have no medical complication. The measurements were obtained by placing the electronic calipers of the ultrasound machines at the outer to outer margins of the cerebellum. All examinations were performed by two of the authors (Wanapirak C., Tongsong T.) who did not know the gestational age of patients, using an Aloka SD 630 or SD 650 linear array real time B-scanner with a 3.5 mHz transducer. Patients were excluded if there were foetal malformations. The collected data were in a stored computer and subsequently analyzed.

Results

Two hundred and thirty-seven pregnant women underwent an ultrasound examination for the study, from 1 May 1989 to 30 November 1990. Twelve subjects were excluded because eight cases had growth alteration and four cases had foetal anomalies (gastroschisis, omphalocele, ventriculomegaly and hydrops fetalis). The cerebellar diameters were measured in 995 examinations in the remaining 225 women, but 51 examinations were unsuccessful due to maternal obestiy, occiput posterior position and deeply engaged of foetal head. The average age of the subjects was 25.9 years old. Their occupations were mainly agriculture (74.3%) and 61.8% were primigravida. The characteristic image of the cerebellum by ultrasonography appears as two lobules on either side of the midline located in the posterior cranial fossa (Fig I). The mean and standard deviation of cerebellar diameter were shown on table I and figure 2.

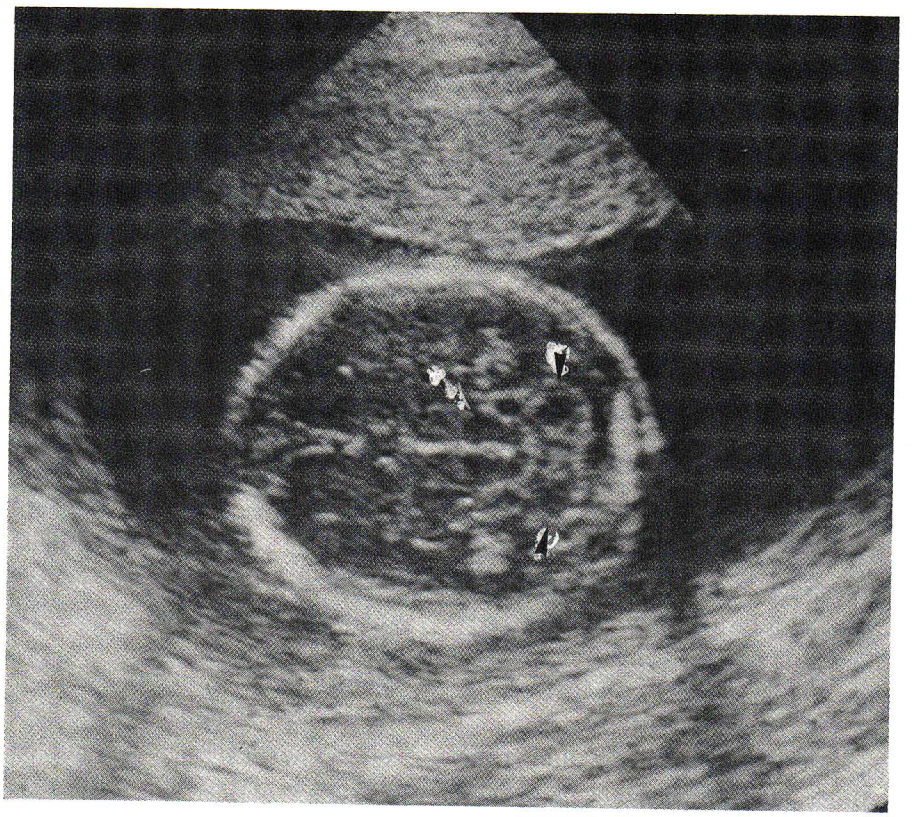

Figure 1. Sonographic visualization of the fetal cerebellum.

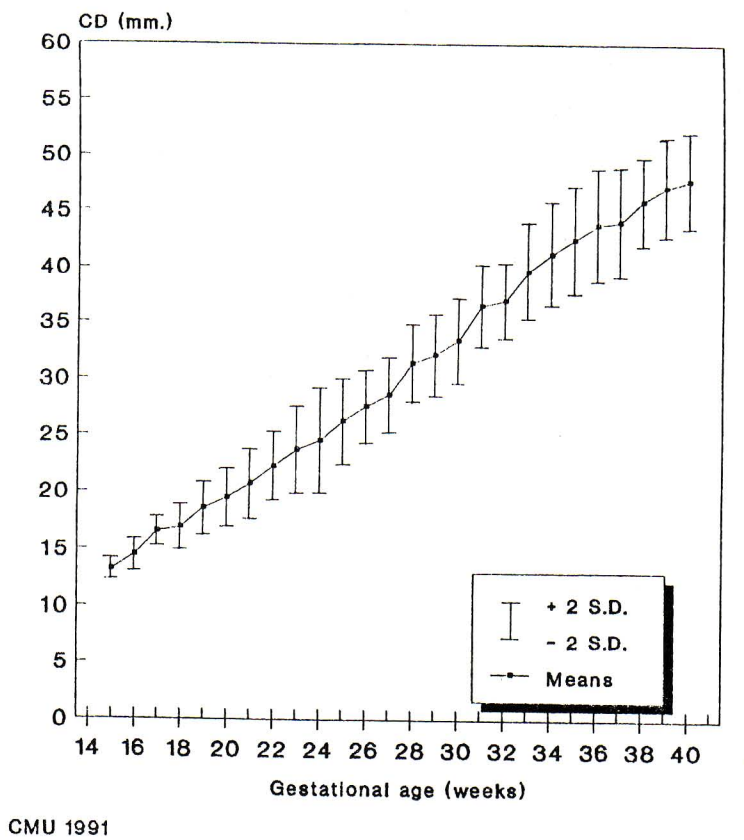

Figure 2. Mean and + 2 standard deviation of CD.

Table 1. Means and Standard divation of cerebellar diameter each week.

Gestational age (weeks)	N*	Mean (mm.)	S.D.**	S.E.***
15	30	13.23	0.94	0.17
16	30	14.50	0.41	0.26
17	34	16.53	1.24	0.21
18	32	16.91	1.96	0.35
19	39	18.54	2.32	0.37
20	39	19.46	2.51	0.40
21	39	20.69	3.03	0.48
22	36	22.22	2.99	0.50
23	35	23.69	3.83	0.65
24	36	24.50	4.61	0.77
25	34	26.21	3.79	0.65
26	33	27.49	3.24	0.56
27	38	28.53	3.33	0.54
28	36	31.38	3.44	0.57
29	39	32.08	3.65	0.58
30	38	33.34	3.83	0.62
31	46	36.50	3.68	0.54
32	39	36.95	3.42	0.55
33	36	39.61	4.31	0.72
34	39	41.10	4.56	0.73
35	37	42.35	4.75	0.78
36	34	43.97	4.99	0.86
37	47	43.72	4.84	0.71
38	35	45.71	3.89	0.66
39	32	47.00	4.47	0.79
40	31	47.61	4.25	0.76
Total	944			

* N = Number of cases ** S.D. = Standard deviation *** S.E. = Standard error

A statistically signiticant curvilinear relationship was found between the transverse cerebellar diameter and gestational age as illustrated by the equation

$$GA = 5.42146 + 0.73059(CD) + 0.00436(CD)^2 - 0.00011997\ (CD)^2$$

($R^2 = 0.906681$, $P = 0.0000$, $SE = 2.24089$)

$$CD = 21.01465 - 2.04193(GA) + 0.12744(GA)^2 - 0.0014887(GA)^{(3)}$$

($R^2 = 0.9489$, $SE = 3.63741$, $P = 0.0000$)

A nomogram of transverse cerebellar diameters and gestational ages is outlined in Table II.

Table 2. A nomogram of the transverse cerebeelar diameter (m.m.) according to percentile distribution.

G.A.*	study group					Goldstein study*				
(weeks)	10	25	50	75	90	10	25	50	75	90
15	12	13	13	14	14	10	12	14	15	16
16	12.5	14	15	16	16	14	16	16	16	17
17	15	16	17	17	18	16	17	17	18	18
18	15	16	17	17	20	17	18	18	19	19
19	17	17	18	19	23	18	18	19	19	22
20	17	18	19	20	22	18	19	20	20	22
21	19	19	20	22	23	19	20	22	23	24
22	20	21	22	22.5	24	21	23	23	24	24
23	21	22	23	24	29	22	23	24	25	26
24	21	22	24	26	30	22	24	25	27	28
25	23	24	25	27	30	23	21.5	28	28	29
26	23	25	28	29	31	25	28	29	30	32
27	25	26	28.5	31	32	26	28.5	30	31	32
28	27	30	31.5	33	36	27	30	31	32	34
29	26	30	32	34	36	29	32	34	36	38
30	29	31	34	35	38	31	32	35	37	40
31	31	34	37	39	41	32	35	38	39	43
32	33	35	37	39	42	33	36	38	40	42
33	34	37	39	42	45	32	36	40	43	44
34	36	37	41	44	47	33	38	40	41	44
35	38	40	42	45	47	31	37	40.5	43	47
36	37	36	44	48	50	36	29	43	42	55
37	38	40	43	47	50	37	37	45	52	55
38	41	42	46	49	51	40	40	48.5	52	55
39	44	45	48	49.5	52	52	52	52	55	55

* G.A. = Gestational age

Discussion

In the embryo, the cerebellum is formed from the dorsal part of the alar plates of the metencephalon and appear at the end of the fifth week as a swelling overriding the fourth ventricle. Subsequently, the cerebellar swellings enlarge and fuse in the midline at the twelfth week of gestation forming the vermis and the two lateral portions of the cerebellar hemispheres.[7] The cerebellum could then be visualised ultrasonographically from early second trimester onwards. Some limitations we encountered in recording include: 1. improper time for measurement 2. variation between the two ultrasonologists and 3. in the obese patient, 4. occiput posterior position and 5. deeply engaged foetal head.

We have established the normal measurement of the lateral transverse diameter through pregnancy and this correlated well with that of Reece's findings.[8] The study shows cerebellar growth to be in linear relationship with gestational age between 20-30 weeks and at about 17-20 weeks the value of cerebellar diameter (C.D.) in millimeters is approximately equal to the gestational age (G.A.) in weeks. We also established the equations that demonstrated relationship between gestational age and cerebellar diameter which may be useful for the determination of gestational age in certain group of patients including: 1. uncertain dates 2. those in whom the biparietal diameter may be affected: breech presentation, enlarged foetal head, dolichocephaly, oligohydramnios, twins, microcephaly, mild hydrocephalus etc. and 3. to confirm the gestation age with other parameters.

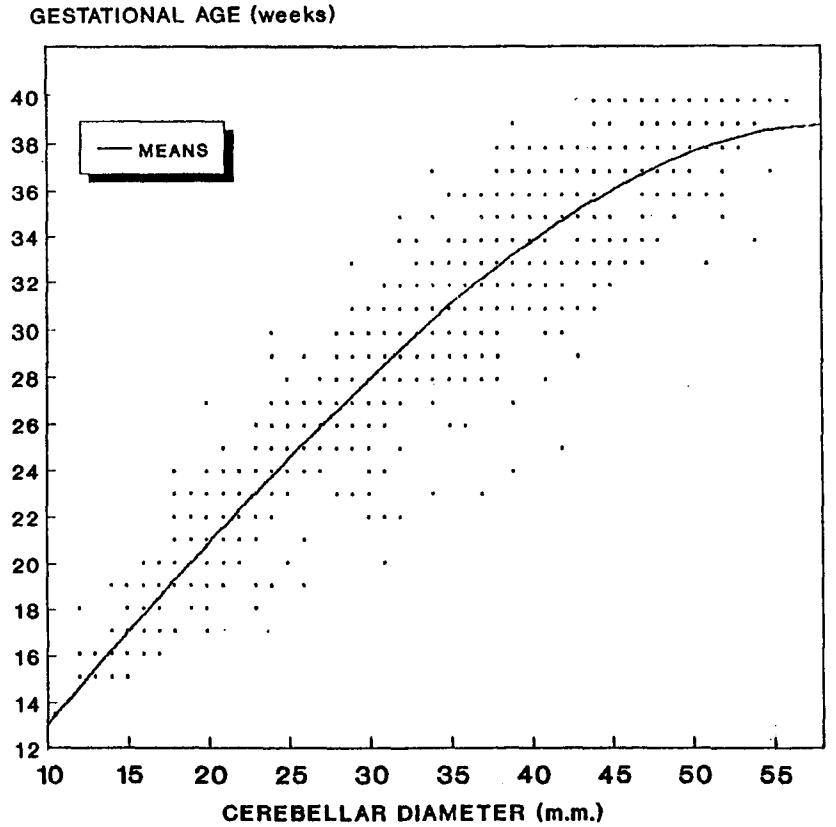

Figure 3. Scatter plot of transverse diameters (m.m.) against gestational age (weeks) shows curvilinear relationship.

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