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BIOMETRIC PARAMETER IN ESTIMATION OF THE GESTATIONAL AGE AMONG IUGR: A ULTRASOUND BASED STUDY

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ABSTRACT

The cerebellum is well protected in the fetal head and it is the last organ to be affected by a decrease in blood flow. The cerebellum, as a part of the brain, was spared along with the rest of brain in asphyxiated primates. The report revealed that in the present of acute asphyxia, cerebellar blood flow remains unchanged as a consequence of redistribution of cardiac output. In the human fetus, cerebellar growth may be least affected by intrauterine growth retardation (IUGR), and the measurement of the TCD appears to be the most reliable biometric parameter in predicting true gestational age. A study was done on the pregnant women between 15 to 40 weeks who presented to our department for ultrasound examination over a period of one year. All pregnant women were evaluated with complete history, clinical examination and ultrasonography. The disparity in gestational age in between the predicted by transverse cerebellar diameter and that predicted by the remaining biometric parameters was consistently greater than 2.5 weeks that is greater than 2SD above the mean. Additionally the measurements of BPD, AC and FL were well below normal range for the gestational age in most of the cases. Transcerebellar diameter is an added advantage in causes of IUGR pregnancies as it correlates well with the gestational age as compared to other growth parameters .TCD can also be used as a single growth parameter to predict the gestational age using the various formulas obtained and nomograms both in normal and IUGR pregnancies.

INTRODUCTION

Use of ultrasonography has significantly improved the evaluation of fetal growth and development and has permitted prenatal diagnosis of a variety of congenital malformations. Campbell et al in (1968) studied fetal cephalometry in the second trimester pregnancy and demonstrated that by using combined A and B scan technique, the fetal head can be measured from 13th week of pregnancy [1].

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Binholz J.C (1982) studied the new born cerebellar size both in full term and in preterm babies. A cross sectional area measurement of the central portion of the vermis correlates strongly with gestational age according to him. It was also suggested that the central vermian area was decreased in "small for date" babies, new born infants, but was normal in "large for date" subjects and he proposed that the ultrasonic cerebellar parameters as an additiona1 measurement for fetal growth [2]. Mcleary et al (1984) studied the measurement of transcerebellar diameter with ultrasonography of 225 normal fetuses ranging from 15 to 39 weeks of gestational age and were followed closely with the BPD. He proposed

that the transcerebellar diameter is very useful in estimating the fetal age particularly in conditions where BPD is difficult to estimate [3].

Smith P.A et al studying the fetal cerebellum in second trimester of pregnancy described a technique for measuring TCD and AP diameter of the cisterna magna in the same plane between 14 and 32 weeks of gestation. He also proposed nomograms for measurements of the gestational age and showed that there was a good correlation between them.

Goldstein I et al in (1987) investigated the posterior fossa of the fetus by ultrasonography and confirmed the capability of the ultrasound to demonstrate the anatomy of the fetal posterior fossa. The vermis, the cisterna magna and the cerebellar hemispheres could be demonstrated easily. They also proposed a systematic approach to pre-natal ultrasound examination of the posterior fossa. They suggested that the fetal transcerebellar diameter in utero between 17 and 40 weeks of gestation is more useful indication of accurate gestational age, particularly in case of Dolichocephaly and Brachycephaly and also facilitates the antenatal detection of the congenital disorders [4]. Objective of study is to evaluate the role of cerebellar measurement as a biometric parameter in estimation of the gestational age and to know whether cerebellar growth is independent of IUGR

METHODOLOGY

The main source of data for this study were pregnant women in second and third trimester presented to the Department of Radio Diagnosis, Medical College Hospital And Research Centre. A study was done on the pregnant women between 15 to 40 weeks who presented to our department for ultrasound examination over a period of one year.

All pregnant women were evaluated with complete history, clinical examination and ultrasonography.

Ultrasonographic examination was done using following machines:

1. Toshiba nemio.
2. Esaote Megas

Inclusion criteria:

- Non anomalous and non-malformed Singletone pregnant women who are in between 15 to 40 weeks of gestation.

Exclusion criteria:

- Multiple pregnancies
- Complicated pregnancy.
- First trimester pregnancy

RESULTS

In IUGR pregnancies the gestational age was correlated to TCD and various ultrasonic parameters including BPD, FL, AC and HC (table 9). There was a very good correlation between gestational age and TCD (R^2 – 0.85). But the correlation was not that strong between gestational age and other parameters including BPD (R^2 = 0.92), FL (R^2 = 0.83), AC (R^2 = 0.90) and HC (R^2 = 0.95).

Table 1. Correlation that is R^2 and P value GA with BPD, FL, AC, HC and TCD in IUGR pregnancies

Parameters compared	R^2	p-value
GA vs BPD	0.92	0.0001
GA versus FL	0.83	0.001
GA versus AC	0.90	0.001
GA versus HC	0.95	0.001
GA versus TCD	0.85	0.001

Table 2. IUGR pregnancies whose ultrasonic measurements, when compared with nomogram derived from normal pregnancies, was less than 5th percentile for the gestational age

	Less than 5th percentile	Within normal range	p-value
BPD	18	2	0.0001 TCD Vs BPD, FL, AC, HC
FL	18	2	
HC	20	0	
AC	20	0	
TCD	3	17	

The ultrasonic measurements in the IUGR pregnancies were compared with nomograms derived from measurements in normal pregnancies (tables 5-8). It showed that in 17 out of 20 patients the TCD measurements were with in the 5th percentile and only in 3 patients it was less than 5th percentile. BPD & FL were less than 5th persentile in 18 out of 20 patients and AC, HC measurements were less than 5th percentile in all the 20 patients. This difference was statistically significant (P = 0.0001), that is TCD measurements were within the normal range in significantly higher number of patients than other ultrasonic measurements. Eighty healthy pregnant women underwent routine ultrasonographic examinations and the measurements obtained as described

above. The sonographic visualization of fetal cerebellum was present as early as 14 to 15 weeks of gestation. The characteristic image of the cerebellum by ultrasonography appears as two lobules on either side of the midline located in the posterior cranial fossa. In this study the cerebellum was seen in all examination, however, before the late third trimester measurements of the transverse cerebellar diameter are easier to perform.

A statistically significant curvilinear relationship was found between the transverse cerebellaer diameter and the gestational age (R^2 = 0.95; p=0.0001), the biparietal diameter (R^2 = 0.98; P=0.0001), the femur length (R^2 = 0.97; P=0.0001) the abdominal circumference (R^2 = 0.99; P=0.0001) and the head circumference (R^2 = 0.98; P = 0.0001). A nomogram comparing the transverse cerebellar diameter with the gestational age and the biparietal diamete , fumur length, AC & HC, is outlined in table 5-8. The pattern of growth of the cerebellum measured by the transverse cerebellar diameter follows a second-degree polynomial, similar to the growth of biparietal diameter femur length, HC & AC. The equations for the transverse cerebellar diameter aginst gestational age, biparietal diameter, femur length, HC and AC are described in the respective graphs.

Twenty pregnant women suspected of IUGR underwent diagnostic ultrasonography. The gestational ages of these pregnancies ranged from 28 to 40 weeks. In all 20 patients in whom the diagnosis of IUGR was made, the transverse cerebellar correlated with the gestational age as predicted with the last menstrual period and it remained within the range of normal for the gestational age. The remaining biometric parameter predicted was much lower for the gestational age. The disparity in gestational age in between the predicted by transverse cerebellar diameter and that predicted by the remaining biometric parameters was consistently greater than 2.5 weeks that is greater than 2SD above the mean. Additionally the measurements of BPD, AC and FL were well below normal range for the gestational age in most of the cases.

DISCUSSION

In our study we have found a good correlation between BPD and gestational age. The estimated gestational age by measuring BPD in the second trimester and early third trimester was more consistent where as it varied in the late third trimester. In the late third trimester alteration in the shape was found due to moulding in most of the cases. Though the fetal femoral length was found to be one of the accurate measurements and many tables were published correlating femur length either with BPD or with the gestational age. Many potential sources of error were found in the technique. The proximal and distal epiphyseal cartilages are not ossified and should be excluded from the measurement. Infrequently a hyper echoic distal femoral point is also imaged but this is a non-osseous extension that continues from the distal end of diaphysis. If included in the femur length ,could falsely over estimate by as much as 3 weeks.

In general most of the observers consider femur measurement as accurate as BPD in the estimation of gestational age of the fetus. So it is being used routinely along with BPD to predict the fetal age particularly when the head is in a difficult position and compared with other parameters [5].

In our study we have found that there is a good correlation between femur length and the gestational age. Hadlock and co-workers [6] decided to combine several measurements in the hope of increasing gestational age accuracy. They took the means of gestational age from 2-4 multiple parameters has an accuracy of $\pm$ 2.3 to $\pm$ 2.4 weeks after 30 gestational weeks.

The above discussion concludes about the uncertainty in the estimation of gestational age, which is further amplified in cases of fetal growth retardation, which are further hampered by lack of precise estimation of gestational age, leading to difficulty in determining whether a fetus is truly growth retarded, constitutionally small for age or appropriately grown, but with incorrect gestational age. To solve this dilemma estimation of gestational by transcerbellar diameter has been found to be of much advantage.

Pilu et al [7] investigated the ultrasonography of the posterior fossa of the fetus and confirmed the capability of ultrasound to demonstrate the anatomy of the fetal posterior fossa. The cerebellar hemispheres, vermis and the cisterna magna could be easily demonstrated. They also proposed a systematic approach to prenatal ultrasound examination of the posterior fossa. They suggested that fetal transcerebellar diameter in utero between 17 and 40 weeks of gestation is more useful indication of accurate gestational age, particularly in case of dolichocephaly and brachycephaly and also facilitates the antenatal detection of congenital disorders.

Micovic et al [8] studies the growth of the cerebellum in normal pregnant women and stated that TCD may be practically applied in the gestational age measurement particularly in cases where it is difficult or impossible to measure BPD and in cases where it is unstable due to head moulding, since the cerebellum in not liable to changes particularly inform.

Behrman et al [9] studied the regional distribution of blood flow to term primate fetal brain in both control and asphyxiated animals. They found that the blood flow to the cerebellum was significantly higher than that to the cerebral cortex in the control group and in asphyxiated group, although cortical blood flow decreased, blood flow to the cerebellum remained unchanged. In light of these remarkable findings one has to presume the haemo-dynamic adjustments observed under experimental conditions are operative in the human fetus and are important in the preservation of normal cerebellar growth in serve fetal growth retardation. Albert Reece et al [10] studied on nineteen pregnant women with a clinical

suspicion of intrauterine growth retardation and with gestational age. Multiple biometric parameters were obtained including the transverse cerebellar diameter. A prenatal diagnosis of intrauterine growth retardation was made in all cases based on the transverse cerebellar diameter being consistently correlated with gestational age as predicted by the last menstrual period, whereas most of the other measurements were consistently discrepant by more than 2.5 weeks and the estimated fetal weight of all fetuses was equal to or less than the tenth percentile for the gestational age. They suggested that the growth of transverse cerebellar diameter is unaffected by intrauterine growth retardation. William. J. Meyer et al [11] prospectively evaluated the accuracy of a gestational age independent method of detecting abnormal growth by transverse cerebellar diameter/abdominal circumference ratio and compared this with standard utlrasonographic methods of growth assessment. They concluded that the fetal TCD/AC ratio is an accurate gestational age independent method of identifying the small of gestational age but not the large for gestational age infant.

Lyndon et al [12] obtained transverse cerebellar diameter in 44 small for gestational age fetuses between 27-42 weeks. The cerebellar diameter was normal in 12 (27.3) between 1 – 2 SD's, below the mean for gestational age in six (13.6%) and greater than 2 SD's below the mean in 26(59.1%). Hence they concluded that transverse cerebellar diameter couldn't be used to assess gestational age in those fetuses suspected of being small for gestational age. The results of our study provide normative data of fetal cerebellar growth throughout gestation and demonstrates that the TCD remained unaffected by fetal growth retardation, whereas most biometric parameters measured sonographically were significantly affected by the overall growth retardation process.

A linear relationship was found during the second trimester between the growth of the cerebellum measured in mms and the gestational age in weeks. The established normal measurements of the transverse cerebellar diameter thought out pregnancy can be used as a standard against which deviation in growth or malformations may be compared and is comparable with other parameters like BPD, FL, HC and AC. Utility of the transverse cerebellar diameter may serve as a reliable indicator to estimate gestational age in cases of fetal growth retardation.

CONCLUSION

Transcerebellar diameter is the better parameter for gestational age assessment than BPD and FL as it is not fraught with the problems in the measurement commonly encountered in BPD and FL due to its easily identifiable landmarks.

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CONFLICT OF INTEREST: Nil

STATEMENT OF HUMAN AND ANIMAL RIGHTS

All procedures performed in human participants were in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. This article does not contain any studies with animals performed by any of the authors.

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