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Fetal Transverse Cerebellar Diameter Measurement for Prediction of Gestational Age in Pregnant Sudanese Ladies

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Abstract-This study was carried out to evaluate whether Transverse Cerebellar Diameter (TCD) in singleton gestations can serve as a reliable predictor of gestational age (GA) in fetuses in the second and third trimester of pregnancy. A prospective study was carried out with 50 pregnant ladies, GA ranging from 15 to 37 weeks (estimation of mean GA was 26.8 ± 6.8 weeks), with a single fetus. TCD measurement by ultrasound was used for each fetus. Correlations between fetal TCD and GA were determined for the whole sample. Mean TCD was 28.6 ± 7.5 mm in 15-37 weeks of gestation. Regression analysis indicates a significant relationship between TCD and GA; correlation coefficient (r) = 0.94 and $p < 0.001$. Fetal TCD by ultrasound could be a predictive biometric parameter of GA in the last two trimesters of a pregnancy.

Keywords-Fetal Transverse Cerebellar Diameter (TCD); Gestational age (GA); Ultrasound

I. INTRODUCTION

Prediction of gestational age (GA) based on sonographic fetal parameters is perhaps the cornerstone in modern obstetrics and continues to remain an important component in the management of pregnancies with fetuses who have growth disturbances. The transverse cerebellar diameter (TCD) serves as a reliable predictor of GA in the fetus and is a standard against which aberrations in other fetal parameters can be compared, especially when the GA cannot be determined by the date of the last menstrual period or an early pregnancy scan [1-3].

A variety of sonographic fetal parameters have been shown to correlate well with GA. Identification of aberrant growth as well as growth disturbances across the spectrum of GA in both healthy fetuses and those with genetic abnormalities will be helpful for optimal fetal surveillance. TCD is one such fetal parameter that has remained consistently superior in predicting GA in both singleton and twin gestations [4-6].

Two studies evidence an association between the dimensions of the fetal cerebellum, especially the TCD and GA [7, 8]. Furthermore, it has been shown that this association is not influenced by alterations in the growth of the fetus, such as macrosomia or restricted intrauterine growth [9]. Also this association is not affected by changes in the shape of the cranial vault due to extrinsic pressure as occurring in dolichocephalism or brachycephalism. Besides, it does not undergo modifications due to the insinuation of the cephalic pole in the mother's pelvis at the end of pregnancy if anomalous presentations, oligohydramnios or multiple pregnancies occur [4, 10, and 11]. Such factors could influence other measurements such as bi-parietal diameter (BPD) and cephalic circumference (CC) [9, 12]. Therefore, it is important to study the correlation between fetal TCD and pregnancy age addressing longer and earlier gestational periods.

This study was carried out to evaluate whether TCD in singleton gestations can serve as a reliable predictor of GA in fetuses in the second and third trimester of pregnancy.

II. METHODS

A. Selection and Description of Participants

A prospective, cross sectional study was carried out at fifty pregnant ladies seeking ultrasound for antenatal care between 15 to 37 weeks of pregnancy. This study was conducted in the ultrasound clinic of the College of Medical Radiological Science at Sudan University of Science and Technology (SUST), Khartoum, Sudan, in between December 2011 to January 2013.

Excluded pregnant ladies were: smokers (any amount); heavy drinkers (more than seven doses of alcoholic beverage per day), illicit drugs users; those with chronic illnesses, clinical complications in the current pregnancy such as arterial hypertension, diabetes mellitus or fetal structural anomalies diagnosed during the ultrasound exams [13].

After the nature of the exam was fully explained, informed consent was obtained from both the consecutively enrolled outpatient and the Radiology Department. Prior to samples scanning, a formal approval was obtained from Ethics and Scientific Committee of College of Medical Radiologic Science.

B. Ultrasound Equipment

Ultrasound examinations were performed on the high-resolution general electric (GE) ultrasound medical system, logic 5 expert ultrasound unit equipped with a 3.75 MHz convex probe, model 2302650 with serial number of 1028924YM7, manufactured date of April 2005 and made by the Yokogawa medical system, Ltd. 7-127 Asahigaoka 4-chome Hino-shi Tokyo, Japan and generally adopted as the standard for obstetric examinations.

Printing facility issued through the ultrasound digital graphic printer, 100 V; 1.5 A; and 50/60 Hz, with the serial number of 3-619-GBI-01 and made by Sony Corporation- Japan.

C. Ultrasound Technique

The GA assessment was based on an early pregnancy scan (< 14 weeks GA) or by certain dates (date of last menstrual period) if no antenatal scan was available. Dates were considered certain if it was recorded as such in the maternal notes.

Fetal TCD was measured using the method described by Goldestein et al. to locate the cerebellum in the posterior fossa by means of rotation of the transducer to approximately 30° from the plane that identifies the thalamus, the cavity of the septum pellucidum, third ventricle and cistern magna, positioning the calipers on the outer margins of the cerebellar hemispheres [10].

A single TCD measurement was used for each fetus studied. The measurement of TCD was obtained by placing electronic calipers at the outer margins of the cerebellum. The landmarks of the thalami, cavum, septumpellucidum and third ventricle were identified thereby slightly rotating the transducer below the thalamicplane. The posterior fossa is revealed with the characteristic butterfly like appearance of cerebellum. In all cases cerebellum was seen as two lobules on either side of the midline in the posterior cranial fossa. TCD measurement was taken in the coronal plane. The widest diameter of the cerebellum was measured (Fig. 1). The measurements were validated by the senior neonatal ultrasonologist.

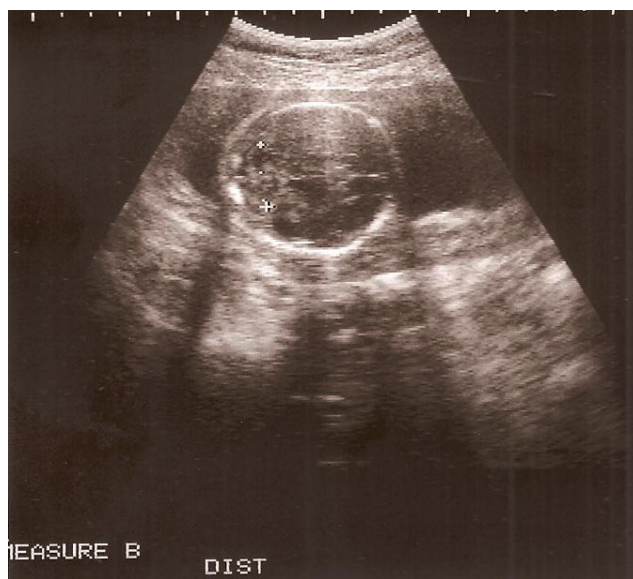


Fig. 1 Sonogram of the posterior fossa demonstrating the measurement of the transverse cerebellar diameter.

D. Statistical Study

Correlations between fetal TCD and GA were determined for the whole sample and each gender separately. Statistical analysis was performed using Microsoft Excel Software and the standard Statistical Package for the Social Sciences (SPSS Inc., Chicago, IL, USA) version 15 for windows.

III. RESULTS

The retrospective dataset consisted of 50 singleton gestations admitted to the ultrasound clinic that had their TCD measured at a GA ranging from 15 to 37 weeks of pregnancy.

The mean $\pm$ SD GA was 26.8 ± 6.8 weeks; the fetal gender was identified and confirmed in the postnatal period of 33 males and 17 females.

Most pregnant ladies (53%) were less than 24 years old and (85%) had eleven or more years of schooling. Fifty-five (55%) of the ladies participating in the study had no previous children and only (6%) had four or more previous children as displayed in Table I.

TABLE I MATERNAL CHARACTERISTICS

MATERNAL CHARACTERISTICS	N	%
AGE (YEARS)		
18-24	27	53.0
25-31	18	38.0
≥ 32	5	9.0
TOTAL	50	100.0
EDUCATION		
ILLITERACY	1	2.0
<11 YEARS	6	13.0
≥ 11 YEARS	43	85.0
TOTAL	50	100.0
PARITY		
0	28	55.0
1	6	12.0
2-3	13	27.0
≥ 4	3	6.0
TOTAL	50	100.0

A linear correlation was observed between fetal TCD and GA for the whole sample (correlation coefficient (r) = 0.94 and $p < 0.001$) as shown in (Fig. 2).

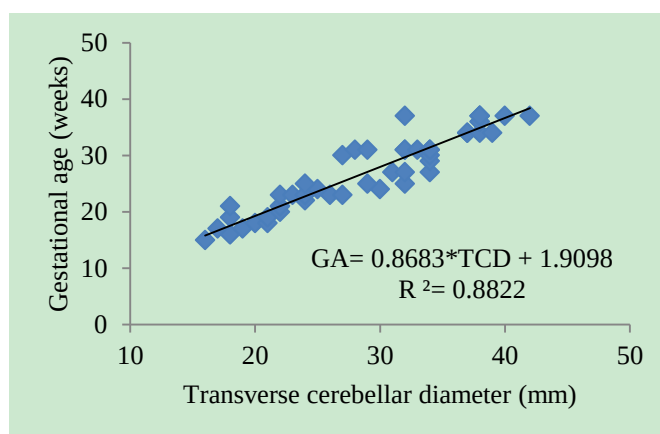


Fig. 2 Transverse cerebellar diameter (mm) according to gestational age (weeks). GA: gestational age and TCD: transverse cerebellar diameter.

IV. DISCUSSION

The determination of GA is important in obstetric for management of pregnancy and evaluation of fetal development. Higher perinatal mortality has been reported in patients whose expected date of delivery is not known. An error in the GA estimation can result in premature and postmaturity. Extremes of fetal growth contribute disproportionately to overall perinatal and infant morbidity and mortality [14]. Accurate gestational dating is of paramount importance and the cornerstone of management of pregnancies, especially those with fetuses who have growth disturbances (IUGR and large fetuses). Methods to date pregnancies should be simple and straight forward, irrespective of GA.

Fetal studies have demonstrated the close relationship between the TCD and GA with linear growth of the TCD during the second trimester [15, 16]. Data from the previous study confirmed that the TCD increases with GA in a linear fashion from 23 to 32 ± 6 weeks gestation when measurements are taken in the newborn infant [20]. In the present study we have shown that the TCD increases linearly from 15 to 37 weeks and correlates closely with GA (Fig. 2).

The measurement of TCD in the fetus continues to be a useful indicator for GA even in the presence of abnormal skull shapes fetal growth restriction multiple pregnancies and large-for-dates fetuses [1, 3, and 18-20]. Therefore, the TCD measurement of the fetus is resistant to these effects on other fetal measurements but in this study the excludes criteria used

limit these benefits thus it could be considered as limitation here, therefore future larger studies are required to corroborate our findings.

The results of this study and previously published studies on TCD from our institution are encouraging [4, 5]. However, it is likely that additional small improvements in accurate gestational dating can be achieved by incorporating the results of TCD with some combination of other fetal biometric parameters, including head circumference, biparietal diameter, and femur length. Nevertheless, the best combination of biometric measurements remains to be determined. Study data support the utilization of the same parameters of TCD for evaluation for males and females fetus GA after the 15th week. We must also observe the fact that no other ultrasound studies have yet been published about the period under the 15th gestational week. However, the behavior of cerebellar growth prior to the 15th week of pregnancy remains unknown through imaging methods.

V. CONCLUSION

There is a close relationship between TCD and GA (correlation coefficient (r) = 0.94 and $p < 0.001$), with TCD increases linearly from 15 to 40 weeks. Therefore, based on our findings and taking into account the present state of the art on this issue, the TCD fetal ultrasound could be a predictive biometric parameter of GA in the last two trimesters of a pregnancy. The present data offer the normal range of cerebral measurements throughout gestation. These values may allow intrauterine assessment of the development of the cerebellum as well as the posterior fossa.

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