

The Accuracy of Transcerebellar Diameter in Assessment of Gestational Age in Normal and Growth Restricted Fetuses and Diagnosis of Intrauterine Growth Restriction

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ABSTRACT

Background

In many pregnant women, it is very difficult to accurately assess the fetal gestation age, due to pregnancy on top of lactation or contraceptive method, unsure of date, irregular cycles, late booking and missing the dating scan. Therefore, we might have a wrong diagnosis of preterm or postterm pregnancy, which will affect the outcome of pregnancy.

Patients and methods: In our prospective study, we examined 70 normal pregnant women and 70 intrauterine growth restricted (IUGR) pregnancy cases after Ethical Committee approval and informed written consent, to assess the effectivity of transcerebellar diameter (TCD) in detection the age of gestation in normal pregnancy and IUGR cases in relation to other ultrasound parameters as biparietal diameter (BPD), head circumference (HC), femur length (FL), abdominal circumference (AC). In addition, TCD/AC ratio was assessed for its efficiency in diagnosing IUGR pregnancy if its value was above 95th percentile. **Results:** Our results showed no significant difference between the mean gestation age detected by TCD compared to the actual mean gestation age in normal as well as IUGR cases, in addition the TCD showed the highest diagnostic accuracy of 95% in detection of gestation age in IUGR within 2 weeks. TCD/AC ratio showed accuracy of 91.43% in diagnosis of IUGR if ratio above 95th percentile.

Conclusion: TCD is a very important parameter in diagnosis of IUGR cases and proper assessment of gestation age.

Keywords: TCD, gestation age, intrauterine growth retardation, BPD, HC, AC, FL, TCD/AC.

INTRODUCTION

The accurate assessment of gestational age is very important to achieve a good pregnancy outcome, inaccuracy might lead to adverse outcome, as preterm induction of labor, or postterm pregnancy, still birth and neonatal morbidity. The cerebellum position is in the posterior cranial fossa, it is separated from the pons and the medulla by the fourth ventricle^(1,2). Since the last decade, ultrasound parameter 'transcerebellar diameter (TCD)' has been assessed as a good predictor of gestational age in intrauterine growth retardation (IGUR) as well as normal pregnancy⁽³⁾. With ultrasound technology, we begin to see the fetal cerebellum by 12 weeks. The growth of the cerebellum is linear throughout the second trimester, however in the third trimester the growth curve is more flattened. Consequently, TCD measurements have been correlating with the gestational age up to 24 weeks, for example at 19 weeks, the TCD is around 19 mm⁽⁴⁾. Moreover, measurement of TCD is not affected much by growth restriction or acceleration⁽⁵⁾.

In third trimester, femur length together with other US parameters are used for the assessment of gestational age, FL has been diagnosed to show margin of error 2.5 - 3.1 weeks from the actual gestational age⁽⁶⁾. Also, the biparietal diameter (BPD) was proven to show margin of error of 3 – 4 weeks. Transcerebellar diameter (TCD) represents an independent biometric parameter as it is not affected by change in the shape of the skull because of the surrounding occipital bone and petrous ridge⁽⁵⁾.

Intrauterine growth retardation (IUGR) is caused mostly by alteration of blood flow through the placenta. Proper ultrasound assessment of gestational age in cases of IUGR reduces the mortality rates by 60%. In most cases of IUGR, due to the redistribution process of the

cardiac output, the brain will remain unaffected in a process known as brain sparing, therefore the cerebellar growth will be within normal range and consequently the TCD in prediction of gestation age⁽⁷⁾.

PATIENTS AND METHODS

Ethical approve

This study was only started after being approved by the Ethics Board of Cairo University. An informed written consent was taken from each participant in the study. This work has been carried out in accordance with the code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans⁽⁸⁾.

Study protocol

A total of 140 pregnant women were assessed in a prospective study done over 3 years (2017-2019) in Cairo University Hospital by 2-dimensional ultrasound. Examinations were performed with the patient lying in the dorsal supine position. 2D ultrasound was done and whole fetal measurements and liquor volume was checked. In 70 cases, singleton pregnant women, who were sure of dates, pregnant in second or third trimester of gestation, calculated by LMP or dating scan and diagnosed with intrauterine growth restriction were included. The other 70 cases were pregnant in 2nd or 3rd trimester with normal singleton pregnancy, sure of dates by LMP or dating scan. Exclusion criteria were: multiple pregnancy, congenital anomalies, unsure of dates and intrauterine fetal death (IUFD). IUGR was diagnosed either clinically through measuring the fundal height less by 4 cm than what was expected, and confirmed by

ultrasound where estimated weight below the 10th percentile for its gestational age⁽⁹⁾.

Transcerebellar diameter was measured by transverse view of fetal brain at the level of the posterior fossa and visualization of midline thalamus, cerebellar hemisphere and cisterna magna. Measurement was obtained by placing on screen calipers at the outer edge of cerebellum⁽¹⁰⁾. Biparietal diameter (BPD) was measured in transverse plane at the level of thalami from the outer table of proximal skull border to the inner table of distal skull border^(11,12). Head circumference (HC) was measured at the transverse plane of the head at a level bisecting thalami in the midline, with the cavum septum pellucidum anteriorly and equidistant from the temporoparietal bones, the measurement was done along the outer perimeter of the head^(9,13). Abdominal circumference (AC) was measured in the trans axial view of the abdomen. The AC was measured at the level of the fetal stomach, and the umbilical portion of the left portal vein. The AC was measured at the outer aspect of the fetal soft tissues through tracing the outer perimeter of the AC^(9,14). The femur length (FL) was measured at the level of the appearance of the proximal femoral epiphysis together with the distal femoral epiphysis and the calipers were placed from blunt end to blunt end parallel to the shaft^(6,15). TCD/AC ratio was studied in relation with gestational age for the diagnosis of IUGR if the ratio is more or equal to 95th percentile according to centile chart established by **Singhakom et al.**⁽¹⁶⁾.

Statistical analysis

Data were coded and entered using the Statistical Package for the Social Sciences version 25. Data were summarized using mean, standard deviation in quantitative data and using frequency (count) and relative frequency (percentage) for categorical data. Standard diagnostic indices (specificity, sensitivity, positive predictive value (PPV), negative predictive value (NPV), and the diagnostic odds ratio (DOR) were calculated as described by **Galen**⁽¹⁷⁾. Comparing the gestation age detected by US parameters and the true GA was done using paired t test⁽¹⁸⁾ in both normal and IUGR patients. Regarding the comparison of the categorical data, we performed Chi square (χ^2) test and Fisher's exact test. P value less than 0.05, was classified as statistically significant⁽¹⁹⁾.

RESULTS

The majority of patients in our study belonged to the age group 20 to 32 years (65%) with minimum 17 years and maximum 40 years. In our study also 40 patients out of 140 were primigravida (28%) and 100 patients were multigravida (72%).

There was no significant difference between the sensitivity of TCD within 1 and 2 weeks between normal and IUGR cases. On the other hand, the sensitivity of the BPD, HC, FL, AC showed significant statistical difference between normal and IUGR cases within 1 and 2 weeks (Table 1).

Table 1: Sensitivity (accuracy frequency) of detection of gestation age by TCD, BPD, HC, FL and AC within 1 and 2 weeks in both normal and IUGR patients

			Normal (70)		IUGR (70)		P value
			Count	%	Count	%	
TCD	Within 2 weeks	Accurate	67	95.71%	66	94.29%	0.785
		Not accurate	3	4.29%	4	5.71%	
	Within 1 week	Accurate	63	90%	62	88.57%	0.99
		Not accurate	7	10%	8	11.43%	
BPD	Within 2 weeks	Accurate	66	94.29%	21	30%	<0.001
		Not accurate	4	5.71%	49	70%	
	Within 1 week	Accurate	56	80%	2	2.86%	<0.001
		Not accurate	14	20%	68	97.14%	
HC	Within 2 weeks	Accurate	66	94.29%	3	4.29%	<0.001
		Not accurate	4	5.71%	67	95.71%	
	Within 1 week	Accurate	53	75.71%	0	0%	<0.001
		Not accurate	17	24.29%	70	100%	
FL	Within 2 weeks	Accurate	67	95.71%	12	17.14%	<0.001
		Not accurate	3	4.29%	58	82.86%	
	Within 1 week	accurate	61	87.14%	0	0%	<0.001
		Not accurate	9	12.86%	70	100%	
AC	Within 2 weeks	accurate	66	94.29%	2	2.86%	<0.001
		Not accurate	4	5.71%	68	97.14%	
	Within 1 week	accurate	52	74.29%	0	0%	<0.001
		Not accurate	18	25.71%	70	100%	

TCD (transcerebellar diameter) BPD (biparietal diameter) HC (head circumference) FL (femur length) AC(abdominal circumference) IUGR(intra-uterine growth restriction)

Comparison between mean actual gestation age in normal pregnancy patients and in IUGR fetuses and mean gestation age detected by different ultrasound parameters is in table 2 and 3, respectively. Regarding normal pregnancy cases, no significant difference upon comparing mean actual gestation age in normal pregnancy patients and mean gestation age detected by TCD as well as FL. However, significant difference was found between mean actual gestation age in normal pregnancy patients and mean gestation age detected by BPD, HC as well as AC.

As for IUGR pregnancy cases, no significant difference upon comparing mean actual gestation age and mean gestation age detected by TCD. On the other hand, high significant difference with P value <0.001 was found between mean actual gestation age in IUGR pregnancy patients and mean gestation age detected by BPD, HC, FL and AC.

Table (2): Comparison between mean actual gestation age in normal pregnancy patients and mean gestation age detected by each ultrasound parameter using paired T test

	Normal		P-value compared to actual GA
	Mean in days	Standard Deviation	
Actual Gestation age (GA)	197.34	52.06	----
TCD GA	195.59	51.04	0.264
BPD GA	195.73	52.23	0.026
HC GA	195.04	48.31	0.005
FL GA	197.96	54.90	0.360
AC GA	194.79	50.03	0.003

Table (3): Comparison between mean actual gestation age in IUGR patients and mean gestation age detected by each ultrasound parameter using paired T test

	IUGR		P-value compared to actual GA
	Mean in days	Standard Deviation	
Actual Gestation age (GA)	254.11	19.40	----
TCD GA	253.30	18.80	0.176
BPD GA	232.21	23.51	<0.001
HC GA	222.66	22.71	<0.001
FL GA	228.74	24.62	<0.001
AC GA	222.40	23.20	<0.001

Diagnostic accuracy tests, as described by Galen⁽¹⁷⁾, (specificity, sensitivity, positive predictive value (PPV), negative predictive value (NPV), and the diagnostic odds ratio (DOR) were calculated for different ultrasound parameters (TCD, BPD, HC, FL, AC) for accurate

assessment of gestation age within 2 weeks in IUGR pregnancy. In addition, diagnostic accuracy tests of TCD/AC ratio for diagnosis of IUGR if above 95TH percentile were calculated as well. TCD showed the highest accuracy (95%), while the sensitivity, specificity, PPV, NPV and DOR were 94.29%, 95.71%, 95.65%, 94.37% and 366.67 respectively. As for the accuracy of the BPD it was 62.14%, regarding, the sensitivity, specificity, PPV, NPV and DOR they were 30%, 94.29%, 84%, 57.39% and 7.09 respectively. Regarding the HC, the accuracy was 49.29%, furthermore, the sensitivity, specificity, PPV, NPV and DOR were 4.29%, 94.29%, 42.86%, 49.62% and 0.74 respectively. Concerning the accuracy of the FL, it was 56.43%, on the other hand, the sensitivity, specificity, PPV, NPV and DOR were 17.14%, 95.71%, 80%, 53.60% and 4.60, respectively. The accuracy of the AC was 48.57%, in addition, the sensitivity, specificity, PPV, NPV and DOR were 2.86%, 94.29%, 33.33%, 49.25% and 0.49, respectively. The TCD/AC showed an accuracy of 91.43%, moreover, the sensitivity, specificity, PPV, NPV and DOR were 97.14%, 85.71%, 87.18%, 96.77% and 226.67, respectively.

DISCUSSION

The accurate assessment of the gestation age is very important step in the antenatal care especially in high risk pregnancy where the fetus is small for gestation age or growth restricted. Scott and Usher⁽²⁰⁾ reported that the death rate was nearly 8 times higher than in total study population when birth weight was below the 10th percentile. Among the various clinical criteria, LMP in a women with regular cycles and sure of her date can be used to assess the gestation age. 1st trimesteric dating scan is the best method for assessment age. The BPD, HC, AC and FL ultrasound parameters are used for gestational age assessment. However, these parameters have margin of error particularly in growth restricted pregnancies. As the pregnancy advances the accuracy of prediction of gestational age with the US parameters decreases⁽⁶⁾. TCD has been assessed by several studies in correlation with other parameters for gestation age assessment in 2nd and 3rd trimesters^(6,10). Moreover, in IUGR cases, TCD has shown higher accuracy in detection of gestation age. In addition, TCD/AC percentile ratio has been studied for its accuracy of diagnosis of IUGR⁽⁷⁾.

In our study, we examined 70 normal pregnant women and 70 IUGR pregnancy cases to assess the accuracy of TCD in detection of gestation age in normal pregnancy and IUGR cases. Furthermore, TCD/AC ratio was assessed for its efficiency in diagnosing IUGR pregnancy if its value was above 95th percentile.

Reece *et al.*⁽²¹⁾ were the first to suggest the use of fetal transcerebellar diameter as an assessment tool for the gestation age, after investigating the posterior cranial fossa with the ultrasound. This was in accordance with

our study, which presented results confirming that TCD could be used as an accurate indicator for gestation age assessment during 2nd and 3rd trimesters.

Naseem *et al.*⁽¹²⁾ performed a study on 228 normal patients comparing TCD and BPD accuracy in third trimester and concluded that TCD was more accurate parameter for assessment of gestation age in third trimester than BPD. In another study done by **Naseem *et al.***⁽⁶⁾ on 327 patients pregnant in their third trimester, comparing TCD with FL showed that TCD was more effective than the FL regarding gestation age assessment in 3rd trimester. While in our study, regarding the 70 normal cases, both the TCD and FL showed similar high accuracy in assessment of gestational age in normal pregnancy and no significant difference was found upon comparing the mean actual gestational age with the mean gestation age detected by TCD and FL. On the other hand, significant difference was found in case of BPD, HC, AC.

Bhimaro *et al.*⁽²²⁾, studied 50 suspected IUGR pregnant women, to assess the accuracy of TCD/AC ratio in prediction of IUGR and compared it to HC/AC. The TCD/AC sensitivity appeared to be 88%. While specificity was 93.5%. Regarding PPV, NPV and diagnostic accuracy, the results were 77.1%, 96.3% and 92.4% respectively. Luckily enough, the sensitivity, specificity, PPV, NPV and accuracy were 97.14%, 85.71%, 87.18%, 96.77% and 91.43% respectively in our study.

Agrawal *et al.*⁽²³⁾, studied 100 pregnant women with suspected risk of IUGR to assess the accuracy of TCD/AC in diagnosis of IUGR. The accuracy reached 80 % of the cases and they concluded that the TCD/AC ratio was fairly accurate in detection growth restriction even at early gestational age. Similarly, in our study the accuracy of TCD/AC ratio in the diagnosis of IUGR if above 95th percentile reached 91%.

Ravindernath *et al.*⁽²⁴⁾, studied 100 pregnant women, where 80 were normal and 20 were suspected IUGR, to assess the accuracy of TCD in detection of gestation age. They found out that TCD was unaffected by intrauterine growth restriction and showed better correlation than other parameters with gestation age. Fortunately, we agreed with their results when we proved that the TCD was more accurate for assessment of gestational age than the other parameters in IUGR cases.

Mourya *et al.*⁽⁷⁾, studied 80 pregnant women with suspected IUGR to assess the accuracy of TCD/AC in prediction of IUGR. They found out that TCD/AC sensitivity was 81.25%, specificity was 62.50%, the PPV was 89.65% and NPV was 45.45%. They agreed with our study that TCD/AC ratio is a reliable parameter for diagnosis of IUGR.

Ismail *et al.*⁽²⁵⁾, studied a total of 77 pregnant women with risk of IUGR to assess the accuracy of

TCD/AC in the diagnosis of IUGR. They found out that TCD/AC sensitivity was 93.5% and specificity was 87%, the positive predictive value was 82.9%, negative predictive value was 95.2%, and diagnostic accuracy was 89.6%. In our study, we had a bigger sample size of 140 pregnant women and the diagnostic accuracy tests for TCD/AC ratio for accurate diagnosis of IUGR showed sensitivity, specificity, PPV, NPV and accuracy were 97.14%, 85.71%, 87.18%, 96.77% and 91.43% respectively.

Dashottar *et al.*⁽²⁶⁾, studied 200 pregnant women to assess the effectiveness of TCD in proper detection of gestation age in normal as well as IUGR cases. Similar to our study, they found no significant difference between mean actual gestation age and mean gestation age detected by TCD in both normal and IUGR cases. However, other parameters as BPD, AC and FL showed statistical significant difference in normal as well as IUGR cases, which was slightly different from our study, that we agreed with all the results, except that in normal cases there was no significant differences in mean actual gestation age and mean gestation age detected by the TCD as well as the FL.

CONCLUSION

This study is important especially in our country as many of our patients attend the hospitals without medical records or previous antenatal care visits especially in low socioeconomic conditions, not remembering their LMP or their estimated date of delivery (EDD) which makes it very difficult for the physician to accurately assess the gestational age of the fetus especially in cases of IUGR. In this study, we can conclude that TCD is a very accurate, useful and reliable parameter for detection of age of gestation in 2nd and 3rd trimesters of normal pregnancy. In addition, TCD is highly accurate for detection of gestation age in IUGR suspected pregnancies. Furthermore, TCD/AC ratio is highly precise for the diagnosis of IUGR if above 95TH percentile. Therefore, we recommend the measurement of TCD as a routine parameter for assessment of gestation age. We would advise in the future doing a bigger study on a bigger sample size, for example a multi-center study, in order to target bigger population, as it might not be easy to find a lot of confirmed IUGR cases, which would be the main limitation.

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Conflict of Interests

We, all authors, declare no conflict of interest by any mean in this study

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