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Accuracy of Transcerebellar Diameter to Abdominal circumference ratio in diagnosis of Asymmetric Intrauterine Growth Restriction after 28 weeks of gestation

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ORIGINAL ARTICLE

Accuracy of Transcerebellar Diameter to Abdominal Circumference Ratio in Diagnosis of Asymmetric Intrauterine Growth Restriction After 28 Weeks of Gestation

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Abstract

Background: **A fetus whose estimated weight is below the 10th percentile for its gestational age (GA) is the most often utilized definition of IUGR. A newborn with asymmetric growth limitation will have a smaller abdomen than the head. Gestational age affects several of the factors for IUGR identification. An important metric that is independent of gestational age is the transcerebellar diameter to abdominal circumference ratio (TCD/AC). Both the volume of the subcutaneous plane and the size of the liver are reflected by AC.**

Aim: **To measure fetus growth restriction and to choose a cut-off value for TCD/AC to evaluate the reliability of TCD/AC in the identification of Asymmetric IUGR.**

Subject and methods: **100 pregnant women after 28 weeks of gestation, 50 of them with IUGR fetus (estimated fetus weight <10th percentile for the age) as the study group and 50 of them with fetuses of normal fetal weight regarding to gestational age as the control group.**

Results: **When compared to the control group, there was a considerable rise in the cases group's FBG, TCD, TCD/AC ratio, and UA R index. When compared to the control group, there was a considerable decrease in AC, fetal weight, and amniotic fluid in the case group. TCD/AC and asymmetric IUGR showed a strong relationship and linkage.**

Conclusion: **TCD/AC and HC/AC, two morphometric ratios that were GA independently measures, may both be used to accurately diagnose IUGR. When predicting asymmetric IUGR, TCD/AC ratio outperformed HC/AC ratio in terms of diagnostic validity and accuracy.**

Keywords: Abdominal circumference (AC), Intrauterine growth restriction (IUGR), Transcerebellar diameter (TCD)

1. Introduction

One of the most important factors contributing to perinatal morbidity and death in both the index and future pregnancies is intrauterine growth restriction (IUGR), a diagnosis that is often made in obstetrics.[1]

The baby whose predicted weight is less the 10th percentile for its GA and who is identified when there is a delay of greater than two weeks in a serial ultrasound evaluation of fetus GA is the most common definition of IUGR.[2]

The frequency of IUGR in the general population is between 5 and 8%. After preterm, it is the second leading cause of perinatal death.[3]

Fetal growth limitation is seen in two major ways. Infants that have symmetric growth limitation throughout the first or early 2nd trimester of gestation. About 20%−30% of children with IUGR exhibit this proportionate lack of development,

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which is brought on by diminished fetal cellular proliferation across all organs. However, if the rate of development slows down in the last trimester, a newborn will have asymmetric growth restriction, which causes their abdomen to be smaller than their head. This head-sparing phenomenon accounts for ~70%–80% of all IUGR cases.[4]

Prediction of IUGR with prompt treatment choices is of the utmost significance due to the high frequency of IUGR and its poor detection, which increases perinatal morbidity and death. A correct date early in pregnancy is crucial for an IUGR diagnosis. The gold standard for measuring fetal growth and amniotic fluid content is ultrasound biometry.[5]

The robust bones that make up the posterior cranial fossa, including the petrous temporal and occipital bones, provide the cerebellum with excellent protection, making it more resistant to external pressure than the parietal bones. Due to the brain-sparing phenomenon, which maintains the brain's blood supply at the cost of the systemic flow, it is generally resistant to hypoxia.[5]

On the other hand, AC represents both the volume of the subcutaneous plane and the size of the liver, which is related to the level of fetus's malnutrition. As a result, AC forecasts growth restriction better than BPD or FL.[6]

The study's objectives were to investigate the precision of TCD/AC in detecting asymmetric IUGR and to establish a cut-off value for the evaluation of fetal growth restriction.

2. Patients and methods

One hundred pregnant women after 28 weeks of gestation, 50 of them with IUGR fetuses (estimated fetus weight <10th percentile for the age) as the study group and 50 of them with fetuses of normal fetal weight regarding to gestational age as the control group.

Inclusion criteria: Reliable menstrual history (sure of dates), singletons, non-anomalous pregnancies at 28 weeks of gestation, and a verified GA before 20 weeks of gestation (by using an ultrasound to confirm the gestational age using the CRL measure during the first trimester and a confirmed last menstrual cycle or both).

Exclusion criteria: Moderate to severe polyhydramnios, multiple pregnancies, abnormal pregnancies, not sure of dates (unknown LMP), symmetrical IUGR and failure to visualize the posterior fossa.

Doppler measurements of umbilical cord blood flow: The 4D color Doppler image volumes were captured using an ultrasound machine with a 2.0–5.0 MHz probe. By observing a free loop of the umbilical cord in the lateral-elevational imaging plane, the probe's location and tilt angle were changed. The c-entire surface's intersection with the two arteries and one vein of the umbilical cord with acceptable margins was where the orientation of the probe was maintained. The c-surface was placed as near to the focal depth as feasible, which was typically 6.5 cm but might vary from 5.0 to 8.0 cm depending on where the cord was located.

Computerized Cardiotocography (CTG): A computerized system was used. The 998.4-kHz ultrasonic bursts produced by the ultrasound probe repeat at a frequency of 3.2 kHz. A high-frequency amplifier with a gain of 120 was used to amplify the received echo. Finally, the signal was band-pass filtered and demodulated (100–500 Hz). Every pulse on the CTG monitor was compared to the one after it using an autocorrelation control. At 200 Hz, the Doppler signal was captured (time sampling window: 5 ms). With a minimum FHR of 50 bpm, the autocorrelation function (ACF) was calculated across a window of 1.2 s. A FHR value in bpm was then generated after a peak detection algorithm extracted the cardiac period from the ACF. Every 250 ms, the CTG system updates the FHR value. Every 2.5 s, the PC reads 10 consecutive data from the buffer and calculates the real FHR by averaging ten values.

Cases were assessed with a 3.5 MHz frequency ultrasound scanner and BPD; AC and FL were measured to calculate the expected fetal weight, and its percentile was determined. 3.5 MHz allowed for better visualization of the fetus.

Cerebellar View: obtained by turning the transducer in an axial direction with the thalamus as the center of rotation to reveal the cerebellar hemispheres. This image showed the cerebellum, cisterna magna, cavum septi pellucidi, and anterior horns of the lateral ventricles.

Transverse cerebellar diameter (TCD): TCD was calculated by applying calipers to the cerebellum's outer edges, which were seen in the previously described plane.

Head circumference (HC): The transducer was positioned perpendicular to the central axis of the skull to detect HC on an axial plane that passed across the thalami and cavum septum pellucidum. On this level, the cerebellar hemispheres were not discernible, but the cerebral hemispheres and calvaria seemed symmetric. With calipers, an ellipse was drawn around the calvarium's outside edges.

Abdominal Circumference (AC): The umbilical vein, portal sinus, and fetal stomach bubble were all present in the axial plane where the AC was recorded. The skin's surface is where the calipers should be.

TCD/AC Ratio: The robust bones that make up the posterior cranial fossa, including the petrous temporal and occipital bones, provide the cerebellum with excellent protection. As a result, compared to the parietal bones, it can withstand external pressure better.

Both the volume of the subcutaneous plane and the size of the liver were represented by AC. So, compared to BPD or FL, AC forecasted growth restriction more correctly. However, the AC often had the most observed variability among the four fundamental ultrasonic parameters. The fact that AC was more severely impacted by growth disruptions than the other fundamental factors was one explanation for this. To predict asymmetrical IUGR, a morphometric ratio of TCD/AC was utilized.

HC/AC Ratio: This ratio was utilized to further detect asymmetric IUGR babies by contrasting the brain, the organ most conserved in the starving baby, with the liver, the organ most damaged.

2.1. Statistical analysis

SPSS version 23 was used for data processing, data checking, data entry, and data analysis. The findings of this investigation were analyzed using the following statistical techniques. The data were presented as mean ± standard deviation (SD) for quantitative factors and as number and proportion for qualitative data.

3. Results

Table 1.

Both weight and BMI substantially enhanced between controls and patients. The two groups did not substantially vary in terms of age, height, parity, or GA Table 2.

There were significant increase in TCD, TCD/AC ratio and UA R index in cases group compared with controls. There was significant decrease in AC, fetal weight and Amniotic fluid in cases group compared with controls Table 3.

There was substantial connection between TCD/AC and asymmetric IUG Table 4.

There was substantial connection between TCD/AC and asymmetric IUGR ($P < 0.0001$) Table 5.

A TCD/AC cut-off value of 0.1501 have a sensitivity and specificity of 96% and 64% respectively for prediction of asymmetric IUGR with high significance ($P < 0.0001$).

4. Discussion

Accurate gestational age (GA) estimation is necessary for providing adequate obstetric and neonatal care. This includes managing diseases during pregnancy with drugs that might be deemed risky during the 1st trimester, diagnosing growth restrictions or IUGR, and providing preterm labor antenatal corticosteroids and making decisions about whether to give or withhold intensive care to the baby.[7]

The purpose of the research was to evaluate TCD/AC precision in detecting asymmetric IUGR.

There was significant increase in both weight and BMI in controls compared with cases. There was no substantial variation between the two groups as regard age, height, parity and GA.

Hamid *et al.*[8] sought to investigate the reliability of the TCD/AC ratio for the assessment of typical fetal growing. In their research, 500 Egyptian women with simple, typical pregnancies who went to the prenatal clinic for a routine scan had mean

Table 1. Patients basal characteristics in both groups.

Parameters	Cases	Controls	*P* value
Age (Years)			
Mean ± SD	29.8 ± 8.34	28.54 ± 5.93	0.3862
Median (RANGE)	30 (17–42)	29 (19–39)	
Weight (kg)			
Mean ± SD	84.08 ± 12.67	88.8 ± 7.21	0.0242*
Median (RANGE)	82.5 (63–108)	88 (72–106)	
Height (m)			
Mean ± SD	1.61 ± 0.05	1.62 ± 0.04	0.1455
Median (RANGE)	1.6 (1.53–1.7)	1.62 (1.5–1.7)	
BMI (kg/m2)			
Mean ± SD	32.41 ± 3.64	33.81 ± 2.14	0.0212*
Median (RANGE)	31.56 (25.32–39.67)	33.46 (29.38–39.52)	
Parity			
Mean ± SD	1.5 ± 1.52	1.74 ± 1.05	0.359
Median (RANGE)	1 (0–5)	2 (0–4)	
Gestational age (Week)			
Mean ± SD	33.86 ± 3	33.1 ± 2.48	0.1711
Median (RANGE)	34.5 (28–39)	33 (28–39)	

*$P < 0.05$ significant.

Table 2. Anthropometric and Doppler evaluation.

Parameters	Cases	Controls	*P* value
TCD			
Mean ± SD	4.79 ± 0.56	4.48 ± 0.51	0.0056*
Median (RANGE)	4.8 (3.9–5.8)	4.4 (3.6–5.6)	
AC			
Mean ± SD	27.64 ± 3.34	29.14 ± 2.52	0.0133*
Median (RANGE)	27.9 (22.3–34.7)	29 (24–35.2)	
TCD/AC			
Mean ± SD	0.17 ± 0.01	0.15 ± 0.01	<0.0001*
Median (RANGE)	0.1737 (0.131–0.191)	0.1547 (0.1387–0.1655)	
Fetal weight (g)			
Mean ± SD	1666.4 ± 467.59	2201.4 ± 563.69	<0.0001*
Median (RANGE)	1740 (810–2380)	2150 (1100–3400)	
Amniotic fluid (DVP)			
Mean ± SD	5.89 ± 1.48	7.54 ± 1.7	<0.0001*
Median (RANGE)	5.75 (3.1–9)	7.5 (4.8–10.5)	
UA doppler (R Index)			
Mean ± SD	0.7 ± 0.06	0.68 ± 0.04	0.0123*
Median (RANGE)	0.715 (0.58–0.82)	0.675 (0.59–0.77)	

*$P < 0.05$ significant.

Table 3. Correlation between TCD/AC and asymmetric IUGR.

R	*P* Value
0.751	<0.00001*

*$P < 0.05$ substantial.

(SD) ages of 29.32 (4.9) years, mean (SD) BMIs of 23.74 (5.57), and mean (SD) parities of 36.40% (PG), 34.6% (P1), 25.20% (P2), 3.60% (P3), and 1.20% (P4).

Bhimarao *et al.*[9] in identifying asymmetric IUGR at 20 weeks of gestation in order to assess the accuracy of TCD/AC with HC/AC. 50 pregnant women between the ages of 18 and 35 who had asymmetrical fetal IUGR were evaluated in the current research, with the majority of them (28%) falling into the 27- to 29-year-old age range. The GA in the bulk of these pregnancies, which made up 30% of the population, was between 34 and 36 weeks. Patients made up 70% of primigravidae.

The diastolic blood pressure increased substantially in the Cases group. Systolic blood pressure did not substantially vary between the two groups.

Cases group in FBG increased substantially. Between the two groups, there was no discernible change in hemoglobin levels.

There was substantial increase in TCD, TCD/AC ratio and UA R index in cases group compared with controls. There was substantial decrease in AC, fetal weight and Amniotic fluid in cases group compared with controls.

Agreed with **Dhumale *et al.* (2010),**[10] It was discovered that all GA groups had a statistically substantial variation in TCD/AC ratio between women with IUGR and those without IUGR, with a *P*-value of <0.001.

Hamid *et al.* (2020)[8] showed that the median TCD/AC ratio for the several gestational periods was determined to be: at 18–22 weeks, 10.98; at 23–26 weeks; at 27–30 weeks; and at 31–34 weeks. The

Table 4. Regression analysis was created between TCD/AC and asymmetric IUGR.

	Unstandardized coefficients		Standardized coefficients		*P* value
	B	Std. Error	Beta	t	
(Constant)	−4.11592	0.411385		−10.005	<0.00001*
TCD/AC	28.22399	2.507132	0.750948	11.25748	<0.00001*

*$P < 0.05$ substantial.

Table 5. ROC curve analysis between TCD/AC and asymmetric IUGR.

Cut-Off Value	Sensitivity	Specificity	PPV	NPV	Asymptotic 95% Confidence Interval		*P* value
					Lower bound	Upper bound	
0.1501	96%	64%	89%	75%	0.894848	1	<0.0001*

*$P < 0.05$ significant.

mean (SD) GA by Last menstrual period (LMP) was 24.49.

Eight instances with a TCD/AC ratio greater than 0.158, or beyond the 95th percentile, or two standard deviations over the mean value, were classified as asymmetric IUGR, in which only the AC was impacted as per research by **Malik *et al.***[11]

With a *P*-value of <0.001, it was discovered that the variation in TCD/AC ratio between those with IUGR and individuals without IUGR is substantial in all GA groups, also concurred **Dhumale *et al.***[10]

There was substantial connection between TCD/AC and asymmetric IUGR. There was significant association between TCD/AC and asymmetric IUGR.

Bhimarao *et al.*[9] showed that Due to its high predictive value (92.4%) and specificity (93.5%), TCD/AC ratio was utilized as an age-independent measure in the diagnosis of IUGR. The study's *P*-value is < 0.0001, which indicates that it is substantial.

Hill *et al.*[12] 675 females with healthy pregnancies between 14 and 42 weeks were used in the research to determine the standard curves for the AC/HC, AC/FL, and AC/TCD ratios. Comparing the ratios of the 34 fetuses with IUGR and the 28 macrosomic babies to the control group, it was discovered that the AC/TCD ratio was the most effective of the three ratios examined.

Marchand *et al.*[13] Analysis showed a significant positive monotonic connection between GA and the sonographic characteristics HC, FL, AC, BPD, and TCD. They showed that the associations between GA and the TCD/AC, FL/AC, and HC/AC ratios were not linear. While HC/AC had a negative correlation with GA between 20 and 40 weeks of pregnancy, FL/AC remained mostly steady throughout this time. At least one undulating curve was seen on the TCD/AC at 20 weeks of pregnancy.

In this study: A TCD/AC cut-off value of 0.1501 has 96% sensitivity, 64% specificity, with a positive predictive value (PPV) of 89% and a negative predictive value (NPV) of 75% for prediction of Asymmetric IUGR with high significance ($P < 0.0001$).

This agree with the investigation of Hamid *et al.*[8] revealed that With a TCD/AC ratio threshold of >13, this number has a sensitivity of 99.03% and a specificity of 83.45%, a PPV of 58.0 and an NPV of 99.7. TCD/AC seems to have a high diagnostic accuracy in groups 18–34 weeks GA.

And agreed with **Dhumale *et al.***[10] revealed that A relatively accurate indication of IUGR and an age-independent constant measure is the TCD/AC ratio in the GA group 18–34 weeks.

HC/AC ratio: In **Bhimarao *et al.***[9] research, HC/AC ratio exhibited a diagnostic accuracy of 90.4%, sensitivity of 84%, specificity of 92%, PPV of 72.4%, and NPV of 95.8% in predicting IUGR. Due to its high sensitivity (92%) and accuracy (90.4%), the HC/AC ratio was also utilized as an age-independent criterion in the diagnosis of IUGR. This study's *P*-value is 0.0001, which indicates that it is substantial.

Receiver operator curve (ROC) analysis on the multivariable model was carried out by **Marchand *et al.***[13] 0.950 and 0.965 were the areas under the curve. A higher HC was linked to a higher risk of SGA in the multivariate model (OR: 1.01; 95% CI 1.04–1.09; $P < 0.001$). Nevertheless, a reduced risk of SGA was linked to higher values for all other indicators (all OR 1; all $P < 0.001$). Similar outcomes were discovered for the FGR predicting.

It was discovered that both normal and growth-restricted babies had the same transcerebellar diameter. One of the most important methods for identifying pregnancy age in both healthy and growth-restricted babies is this measurement.[14]

The TCD cannot be utilized to accurately determine the GA of tiny fetuses, and the TCD/AC ratio cannot accurately determine whether or not fetuses are growing retarded fetuses in the event of IUGR since cerebellar size is lowered in response to the condition severity. TCD is a useful pregnancy age marker for embryos with asymmetric growth limitations as opposed to symmetric ones.[15]

In agreement with our results, Meyer *et al.* (1995)[16] When compared to other morphologic ratios, such as the HC/AC and FL/AC ratios, the fetus TCD/AC ratio was shown to be an accurate, GA independent tool for predicting the probability for GA with excellent diagnostic validity in a trial of 825 low-risk obstetric patients and 250 individuals with possible risks for growing delay ($n = 158$).

4.1. Limitations

Dependence on the operator for accurate measurement is one of the study's major drawbacks. One operator completed all of the measures for the current investigation, reducing inter-operator variability. We have reduced the potential for radiologist bias when assessing fetal biometric data by using a prospective research design. The thick shadowing in the posterior fossa during the third trimester is another technical obstacle that may prevent properly seeing the cerebellum.

4.2. Conclusion

TCD/AC and HC/AC, two morphometric ratios that were gestational age-independent measures, may both be used to accurately diagnose IUGR. When predicting asymmetric IUGR, TCD/AC ratio

outperformed HC/AC ratio in terms of diagnostic validity and accuracy. Our findings demonstrated that, as compared to controls, the cases group's FBG, TCD, TCD/AC ratio, and UA R index were significantly increased. Comparing the case group to the controls, there was a substantial drop in AC, fetal weight, and amniotic fluid. TCD/AC and asymmetric IUGR showed a strong connection and relationship.

Disclosure

The authors have no financial interest to declare in relation to the content of this article.

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Conflicts of interest

The authors declared that there were NO conflicts of Interest.

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