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ORIGINAL ARTICLE

Ultrasound Assessment of Fetal Transcerebellar Diameter to Abdominal Circumference Ratio (Tcd/Ac) and to Femur Length Ratio (Tcd/Fl) in Detection of IUGR

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Abstract

Background: **Modern obstetrics requires the Predicting of gestational age (GA) depending on sonographic fetus characteristics, and it is still a crucial part of managing pregnancies. It has been shown that a number of fetal sonographic characteristics correlate favorably with GA. One such fetal measure that has regularly performed better in determining GA is transcerebellar diameter (TCD).**

Patients and methods: **Hundred pregnant women with a confirmed last menstrual period participated in this retrospective research at the obstetrics and gynecology department of Al-Azhar University. They were separated into two groups: Between March 2021 and March 2021, pregnant women in (Group I) with typically developing fetuses and (Group II) with fetuses beyond 20 weeks of gestation with growth restrictions were included.**

Results: **In terms of TCD, there was a statistically negligible variation between Groups A and B, indicating that it was unaffected by changes in fetal development, making TCD a metric that is independent of age ($P = 0.07$). Although there was a substantial variation across the two groups under study for TCD/AC and TCD/FL ratio, ($P < 0.05$).**

Conclusion: **The prenatal TCD in IUGR babies was less impacted than the fetal HC, indicating that cerebellar growth has been preserved preferentially over other cranial structures. In order to identify aberrant fetal growth, the TCD/AC ratio proved useful. Since this ratio is GA independent, it may be used even when the GA is unclear.**

Keywords: Femoral length, Growth restriction, TCD/AC ratio, Transcerebellar diameter, Ultrasound

1. Introduction

Prenatal growth is defined as variations in the fetus's body size that occur throughout pregnancy and alter with time. Numerous metrics rapidly change as pregnancy progresses, particularly in the first and second trimesters, and must be compared to typical values for people of that age.[1]

Fetal development is objectively tracked throughout pregnancy by examination. In order to detect fetal growth, the gestational age (GA) is computed depending on certain fetal measures and contrasted with the gestational period. When fetal parameters are measured, GA accuracy is at its highest in the 1st trimester and decreases as fetus age increases in the 2nd and 3rd trimesters.[2]

The most frequent word used to indicate how far along a pregnancy is throughout pregnancy is GA. By taking measures of the biparietal diameter (BPD), head circumference (HC), abdomen circumference (AC), and femur length (FL) throughout the second and third trimesters, GA may be estimated. The transverse cerebellar diameter (TCD) may act as a reliable gauge of the fetus's GA and as a benchmark for other fetal parameter abnormalities.[3]

A significant risk factor for prenatal illness and death is intrauterine growth retardation (IUGR), and its early detection is helpful in determining

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the incidence of antenatal surveillance, the best time to deliver the baby, and prompt neonatal care to prevent prenatal death and morbidity. The majority of the IUGR detecting parameters rely on GA. A GA-independent measure is the transcerebellar diameter to abdominal circumference ratio (TCD/AC). Isolated femur length loss may be a symptom of IUGR caused by uteroplacental inadequacy.[4]

Ultrasonography (USG) is the gold benchmark for determining fetus development. BPD, HC, AC, and FL are the most often utilized growth measures. These metrics, however, rely on GA, which reduces their usefulness at extremes of growth. The FL to AC ratio (FL/AC) and TCD/AC have been described as age-independent development markers in a number of investigations.[5]

The cerebellum is the occipital bone and the thick petrous ridges that surround the posterior cranial fossa shield it from pressure and inhibit growth abnormalities and deformity. The size of the cerebellum has a linear connection with GA and may be seen utilizing a sonographic approach as soon as the 10th or 11th week after pregnancy.[6]

The TCD accuracy ranges from 0 to 2 days between weeks 22 and 28, 5 days between weeks 29 and 36, and 9 days between weeks 37 and 38 of actual conception.[7] TCD/AC is stable from 14 to 42 weeks, with various investigations' cutoff ratios varying from 15.4 to 15.98.[8]

Preeclampsia-eclampsia (up to 4%), a significant cause of maternal and neonatal morbidity and death, complicates around 9% of all conceptions.[9]

Gestational hypertension is now seen as either a distinct illness affecting related organs or a distinct degree of the same underlying problem (de novo hypertension after mid-pregnancy without proteinuria). The latter theory contends that gestational hypertension is just a moderate or initial phase of preeclampsia, maybe occurring before renal dysfunction and consequent proteinuria.[10]

A considerable percentage of newborn children are affected by intrauterine growth restriction (IUGR), which is evidenced by short for GA (SGA) of various reasons, mostly in underdeveloped nations. Based on a comparable placental condition defined as aberrant implantation and marked by inability of trophoblasts to differentiate, invade, and remodel the spiral arteries, certain types of IUGR have been etiologically connected to preeclampsia & gestational hypertension. The idea that gestational hypertension, preeclampsia, and IUGR related to placental insufficiency all have identical causes but distinct clinical symptoms is supported by these parallels.[11]

The study's objective was to identify IUGR utilizing the ratio of TCD to abdomen circumference (TCD/AC) and the ratio of TCD to femur length.

2. Patients and methods

This was retrospective research that had consecutive pregnant women with known last menstrual period between March 2021 and March 2022 at the obstetrics and gynecology department, Al-Azhar University. The study participants were divided into 2 groups: **Group (A):** 50 pregnant women with healthy, developing fetuses. **Group (B):** 50 pregnant women with growth-restricted fetuses older than 20 weeks were enrolled.

All women with Normal pregnancies of Singleton live fetus of 15- and 40- weeks' conception, confirmed date of last period, Pregnant women with gestational hypertension, pregnant women with cumulative ultrasound age (CUA) and clinically suspected IUGR. Exclusion criteria were congenital malformation, prior history of abnormal babies, stillbirths, and women with sickle cell hemoglobinopathy, diabetes mellitus.

All participants were subjected to General examination of vital signs and signs of underlying disease, US measurement of fetal biometry at weeks 20, 28 and 32. Prospectively, TCD diameter measures were taken by positioning the ultrasound device on screen calipers at the cerebellum's periphery.

Abdominal circumference (AC) is determined at the junction of the umbilical vein and left portal vein, which appears as a J-shaped anechoic structure, and the fetal stomach are measured along the outside of the skin line on a true transverse plane. The renal and umbilical cord entry shouldn't be visible, and the transverse portion should be round rather than oval.

Femur length (FL) was determined at the most horizontal and perpendicular to the ultrasound beam feasible position. Only the length of the ossified diaphysis was measured. The epiphysis was excluded from the measure. To view the posterior acoustic shadow, the whole length of the femur was preserved on a single screen. The detection of any abnormalities or growth retardation produced estimated findings.

Utilizing SPSS version 21, data input, processing, and statistical analysis were completed (The Social Sciences Statistical Package).

3. Results

Age, height, weight, and BMI did not significantly vary between the two groups researched (Table 1).

Table 1. Demographic information for the two groups analyzed (N = 100).

Parameters	Group A (N = 50)	Group B (N = 50)	P value
Age (years)			
Range	18–39	18–38	0.074
Mean ± SD	28.36 ± 4.81	25.52 ± 4.43	
Height (m)			
Range	1.4–1.8	1.2–1.6	0.098
Mean ± SD	1.68 ± 0.11	1.58 ± 0.13	
Weight (kg)			
Range	45.5–96.0	46–96.0	0.287
Mean ± SD	65.8 ± 15.68	66.66 ± 15.68	
BMI (kg/m^2)			
Range	17–31	16.5–32	0.103
Mean ± SD	23.74 ± 5.57	24.4 ± 5.4	

In GA by LMP and GA by U/S, there was no substantial variation across the two groups. (Table 2).

When it came to AC and FL, there was a statistically substantial variation between the two study groups, but not when it came to TCD (Table 3).

In terms of TCD, there is a statistically negligible variation between Groups A and B, indicating that it is unaffected by changes in fetal development, making TCD a metric that is independent of age ($P = 0.07$). Although there was a substantial variation across the two groups under study for TCD/AC and TCD/FL ratio, (Table 4).

With the best cutoff rate on TCD/AC ratios of >14, this cutoff value has 92% sensitivity and 85% specificity, 86% with a PPV, and 91.3% with a NPV. TCD/AC seems to have a strong predictive value in 18–32 weeks GA groups. TCD/FL also has the best cutoff value of >34, which has a sensitivity of 84%, a specificity of 79%, a PPV of 80%, and a NPV of 87.7%. (Table 5), and Fig. 1.

4. Discussion

A variety of sizes and circumferences, including the BPD, FL, HC, and AC, have been investigated for their relationship to the real GA.[12]

One of the most trustworthy ultrasonography growth markers has been the TCD. It was demonstrated that the TCD is a trustworthy metric that strongly correlates with GA.[13]

Table 2. Gestational age of the 2 studied groups.

Parameters	Group A (N = 50)	Group B (N = 50)	P value
Gestational age by LMP (Weeks)			
Range	18–34	18–34	0.375
Mean ± SD	24.5 ± 5.60	24 ± 5.50	
Gestational age by US (Weeks)			
Range	18.4–35	18.7–34.5	0.464
Mean ± SD	27 ± 5.6	27.5 ± 5.8	

Table 3. Fetal biometry of the studied groups.

Parameters	Group A (N = 50)	Group B (N = 50)	P value
AC (cm)			
Range	12–34.8	11–33.6	**<0.001***
Mean ± SD	29.2 ± 3.9	25.6 ± 2.7	
FL (cm)			
Range	2.7–7.3	2.7–7.1	**0.020***
Mean ± SD	6.4 ± 0.8	6.1 ± 0.5	
TCD (cm)			
Median (IQR)	4 (2.40–4)	3 (2.30–3.90)	0.067
Mean ± SD	4.0 ± 0.5	3.07 ± 1.36	

The metric that is initially impacted by poor fetal growth is fetal AC. It is the single most accurate morphometric FGR marker.[14]

This study's objective was to evaluate the TCD measure's ability to identify IUGR utilizing the TCD to abdominal circumference ratio (TCD/AC) and the TCD to femur length ratio (TCD/Fl).

This investigation revealed that, in comparison to the HC, the cerebellar diameter was even less impacted, pointing to a preferred strategy for maintaining cerebellar development. These findings were in line with research on monkey models, which shows that blood flow to the cerebellum, brain stem, and midbrain was greater than to the cerebrum even within the brain.[15]

A study of **Nagaraju *et al.*,**[16] found that; The posterior cranial fossa, which has robust bone walls and is hence highly resistant to external compression, is where the TCD is measured. Additionally, the cerebellar development is preserved more favorably than other cerebral structures, as seen by the fact that it is less impacted than the head circumference.

The findings of this research showed the importance of the TCD/AC ratio's single cut-off value, which may help in the early detection of SGA newborns. As indicated in Table 4, the optimal TCD/AC ratio cut-off rate for predicting IUGR was 14%, with sensitivity, specificity, PPV, and NPV values of 92%, 85%, 86%, and 91.3%, respectively. In this research, it was discovered that the TCD/AC ratio had a very high sensitivity of 100% and specificity of 63.33%; when the ratio is above this number, IUGR may be diagnosed. Furthermore, TCD/FL

Table 4. Relation between TCD and fetal biometry.

Parameters	Group A (N = 50)	Group B (N = 50)	P value
TCD/AC ratio			
Median (IQR)	12 (10.08–16.16)	16 (14.2–18.3)	**<0.001***
Range	10.08–16.16	14.2–18.3	
Mean ± SD	14 ± 1.36	16 ± 0.97	
TCD/FL ratio			
Median (IQR)	40 (36.1–60)	36.5 (34.9–38)	**<0.001***
Range	36.1–60	34.9–38	
Mean ± SD	45.7 ± 12.6	36.9 ± 1.1	

Table 5. TCD/AC ratio and TCD/FL ratio sensitivity, specificity, and accuracy in the detection of IUGR.

Cut off point	AUC	Sensitivity	Specificity	+PV	-PV	Accuracy
TCD/AC ratio > 14	0.805	92	85	86	91.3	88.5
TCD/FL ratio > 34	0.647	84	79	80	87.7	81.5

with best cutoff value > 34 with 84% sensitivity and 79% specificity, 80% with a PPV, and 87.7% with an NPV.

Our findings were in accordance with TCD/IUGR AC's prediction, according to **Nagaraju *et al.***[16] who revealed that TCD/AC ratio, an age-independent metric, had a cutoff value of ≥13.63 for the detection of FGR and had a sensitivity of 88%, specificity of 93.5%, when used to diagnose IUGR.

Khan *et al.*[17] engaged 30 high-risk patients with reliable GA and singleton pregnancies; it was discovered that elevated TCD/AC ratio was noticed in 15 of the 30 patients (50%) with a cutoff value of 16.03 for forecasting FGR, giving sensitivity and specificity of 77.78% and 83.34%, respectively, which was pretty close to what we discovered.

Sharma *et al.*[18] revealed that TCD/AC ratio was 98% sensitive in identifying asymmetrical IUGR, but only 71% sensitive in forecasting symmetrical IUGR. According to Olsen et al. (2010), 88 out of 122 asphyxiated babies had reduced cortical blood flow, while cerebellar blood flow was unaffected.

Nagaraju *et al.*[16] revealed that For IUGR fetuses, 80% of results were over the upper limit of the standard parameters. Rashid et al. (2018) pointed out that extreme growing restrictions (lower than the third percentile for birth weight) may be coupled with regular TCD/AC levels. Raised TCD/AC measures revealed the existence of fetal growing restrictions.

Uikey *et al.*[19] revealed that The sensitivity of the TCD/AC ratio is equal to 100%. This study's specificity was 80.25%, suggesting a high likelihood of a negative test among non-IUGR babies or a lesser likelihood of a non-IUGR baby being terminated too soon.

However, **Twomey *et al.***[20] revealed that, With a cut-off value of 176 and a percentage of 86 newborns having IUGR, the sensitivity of 73.26%, specificity of 80.25%, PPV of 79.75%. It is necessary to employ monograms particular to the Egyptian population since the TCD/AC ratios from our findings and those from other research may vary because of the varied demographic types.

A TCD/AC ratio over the 90th percent in late pregnancy was related with fetus growing restriction, according to the research criteria, which detected 80% of later IUGR cases at 30–36 weeks of

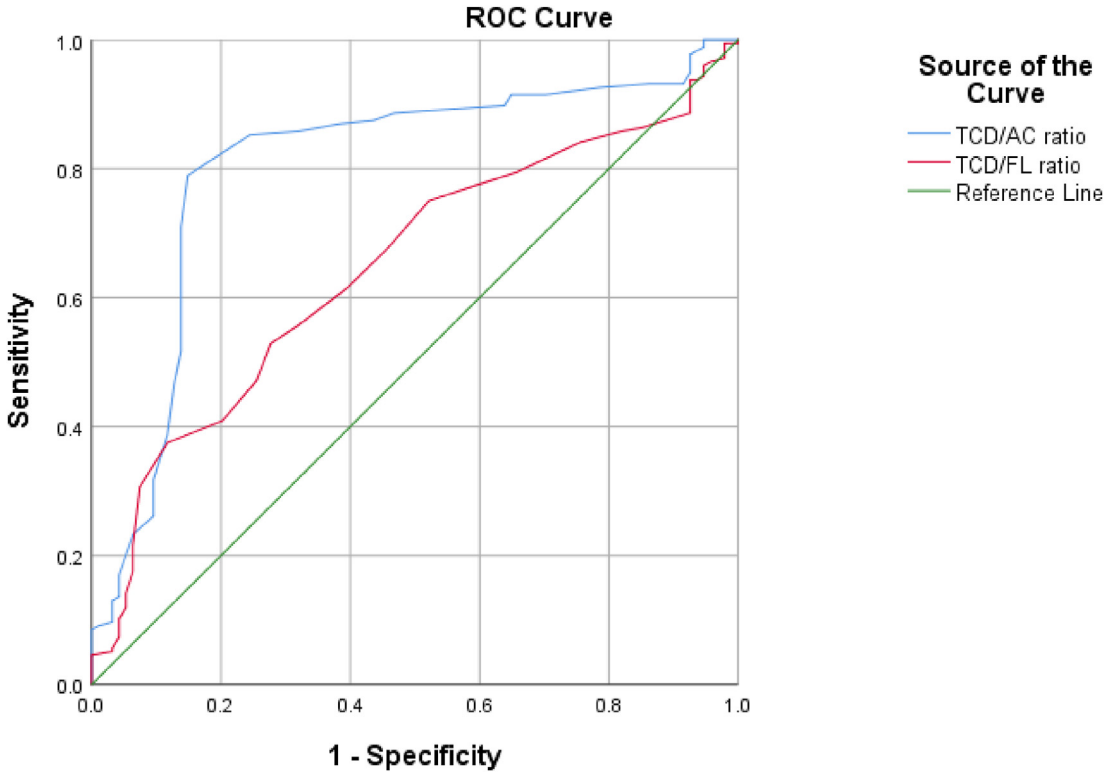

Fig. 1. Roc curve for sensitivity and specificity of for TCD/AC ratio and TCD/FL ratio in diagnosis of IUGR.

pregnancy. These results at 30–36 weeks are comparable to **Meyer *et al.*,**[21] for 87% of future SGA or IUGR newborns, a TCD/AC ratio higher than the 90th percent was reported. Likewise, **Haller *et al.*,**[22] revealed that a TCD/AC ratio over the 90th percent (15.5) for 80% of newborns later determined to have SGA or IUGR.

In the investigation of **Vinkesteijn *et al.*,**[23] For 80% of the growth-restricted fetuses, the TCD/AC rate was higher than the threshold value. Also, **Singhakom *et al.*,**[24] found that 80% of identified infants with SGA or IUGR had a TCD/AC ratio higher than the 90th percentile.

In a study of **Hussain *et al.*,**[8] The evaluation of standard fetal growth regarding the fetal TCD/AC ratio and to TCD/FL ratio revealed that TCD/AC takes into account both the least and most impacted growth features, making it an ideal parameter for IUGR identification even if only hypothetically. In their research, including 700 patients, **Meyer *et al.*,**[21] revealed that Between 14 and 40 weeks, there is a strong connection between TCD and AC.

Regarding TCD/FL, TCD and FL exhibit a significant association. The whole research population's TCD/FL is dispersed regularly, with a mean (± 2 SD) of 64.592 (± 7.996). This is in agreement with a 73.54 97th percentile score. The mean and standard deviations for subgroups between 18 and 40 weeks are still similar. The mean (± 2 SD) for CUA between 14 and 17 weeks is 67.2 (± 10.56). At this CUA range, values exhibit a greater degree of dispersion. TCD/FL usefulness as a metric for the identification and evaluation of the severity of IUGR must thus be further assessed in a broader population with the inclusion of participants with IUGR.

4.1. Study strength

It was a retrospective cohort study which considered the most accurate, informative, sensitive, and less subjected to bias. Assessors were blinded to each other's measurements. The two assessments were done in succession and the probe was removed in between. The investigators were blinded to each other's results.

4.2. Study limitation

Relatively small sample size regarding the accuracy of study outcomes.

4.3. Conclusion

The prenatal TCD in IUGR babies was less impacted than the fetal HC, indicating that cerebellar growth has been preserved preferentially over other cranial structures. In order to identify aberrant fetal growth, the TCD/AC ratio proved useful. Due to the fact that this ratio was GA independent, even when the GA was undetermined. An increase in the TCD/AC ratio over 14% was a sign of growth limitation and called for more research, such as fetal and placental velocimetry by Doppler ultrasonography.

Disclosure

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Authorship

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Conflicts of interest

The authors declared that there were no conflicts of Interest.

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