Trans-cerebellar diameter/Abdominal Circumference (TCD/AC) ratio and femur length/mid-thigh circumference (FL/MTC) ratio in both normal and growth restricted fetuses

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Synopsis

Maternal DM is not associated with significant Doppler abnormalities. UA and MCA had low sensitivity in the prediction of adverse neonatal outcome.

Impact statement

What is already known on this subject?
Cerebellar diameter is the least affected parameter by intrauterine growth restriction; therefore TCD measurement is used in prediction of gestational age especially those with unknown last menstrual period. IUGR fetuses have decreased hepatic glycogen and subcutaneous fat stores which result in decreased AC, so AC is a sensitive parameter for prediction and diagnosis of fetal IUGR .

What do the results of this study add?
A significant correlation between TCD/AC ratio and EFW was found. Also, the correlation between the EFW with either MTC or FL/MTC ratio. However, the FL/MTC ratio was not significant.

What are the implications of these findings for clinical practice and/or further research?
TCD/AC and FL/MTC ratios are good, easy to perform and reliable predictors of IUGR.

Abstract

IUGR defined as fetal weight below the 10th percentile for gestational age. In Egypt it affects about 12.1% of cases with singleton pregnancy. Sonographic assessment of fetal growth for estimation of fetal weight (EFW) and diagnosis of intrauterine growth restriction (IUGR) is a common practice in obstetrics, providing valuable information for timing and planning the mode of delivery and management of labor.

Objectives: to compare TCD/AC ratio and FL/MTC in both normal and growth restricted fetuses in third trimesters.

Patient and methods : This prospective case-control study including 60 pregnant female are included in the

study (30 normal control group and 30 patients with IUGR fetus) all are subjected to US assessment.

Results: Significant difference in TCD/AC and FL/MTC between the 2 studied groups.

Conclusion: TCD/AC and FL/MTC ratios are good, easy to perform and reliable predictors of IUGR.

Keywords: IUGR, mid-thigh circumference, trans-cerebellar diameter.

Introduction

The time-dependent alterations to the fetal body measures that take place during pregnancy are referred to as fetal growth [(1)]. Fetal weight that is less than the 10th percentile for gestational age is the most widely used criterion for growth restriction. In Egypt, 12.1% of cases of singleton gestation are impacted by IUGR [(2),(3)]. A proportionately tiny fetus with symmetrical IUGR is typically the result of early damages like chromosomal anomalies, early teratogenic exposure that led to cellular hypotrophy/hypoplasia, or a decrease in overall number of cells [(4)].

Abdominal circumference decreases more than head circumference in asymmetric IUGR. This is believed to be caused by the redirection of blood from non-vital organs (liver, abdominal viscera) to critical organs (heart, brain) as a result of decreasing placental blood supply [(5)]. Because IUGR has a wide range of core explanations, a thorough history, physical, ultrasound fetal examination, and placental examination are necessary to determine the proper diagnosis, initiate appropriate treatment, and recognize fetuses susceptible for unfavorable outcomes [(6)].

In obstetrics, sonographic measurement of fetal development is routinely used to estimate fetal weight (EFW) and diagnose intrauterine growth restriction (IUGR). This method yields important data for managing labor and scheduling the mode of delivery. The majority of fetal weight calculation formulas were first developed in the first half of the 1980s, and they made use of various combinations of specified fetal biometric characteristics, including femur length (FL), head circumference (HC), abdominal circumference (AC), and biparietal diameter (BPD). Regrettably, considerable intra- and inter-observer variability compromises the reliability of EFW, and many of the current formulas can be inaccurate, particularly when fetal weight is at an extreme [(7)].

Since cerebellar diameter is the factor that is least impacted by intrauterine growth restriction, TCD estimation is used to forecast gestational age, particularly in cases where the last menstrual period is unreported. Fetal IUGR is diagnosed and predicted by AC, a sensitive parameter due to reduced hepatic glycogen and subcutaneous fat storage in IUGR fetuses [(8)].

The suggested technique in the current study for the determination of fetal soft tissue mass was a linear estimation of the tissue above the outer surface of the fetal femur, which serves as an intuitive and straightforward way to assess the volume of fat and muscular mass of the fetal thigh. This strategy was motivated by the fact that body weight can be calculated using using both of height as well as lean and fat mass [(9)].

The current research investigation compares the TCD/AC ratio and FL/MTC ratio in the third trimester of growth-restricted and normal fetuses to see if there is any relationship between them and estimated fetal weight (EFW). Assess the potential application of FL/MTC ratio and TCD/AC ratio in IUGR screening and diagnosis.

Patients and Methods

This is prospective case-control clinical study. It was approved by Tanta University hospital ethical committee. This study conducted on pregnant women admitted to Tanta University Hospital in period of May 2023

till December 2023.

Groups of the patients:

Sixty singleton pregnant females in 3rd trimester were enrolled in the study and divided to 2 groups:

Group I (control group) included 30 pregnant females with normally growing fetuses.

Group II: included 30 pregnant females with growth restricted fetuses. This growth restricted fetus is diagnosed by fetal weight below the 10th percentile for gestational age.

Any unexpected risk during the study will be cleared to the participants and the ethical committee.

Study Design:

All demographic data of enrolled patients were collected, including age, gestational age, gravidity, parity. Fetal wellbeing, and estimated fetal body weight EFBW are also assessed.

All the patients are subjected to US assessment of fetal parameter:
1- Biparietal diameter (BPD)
2- Head circumference (HC)
3- Abdominal circumference (AC)
4- Femur length (FL)
5-The transverse cerebellar diameter (TCD)
6- Mid-thigh circumference (MTC) (calipers are placed on the outer margin of the skin and the outer margin of the femur shaft)

Also the three ratio (HC) / (AC), TCD/AC and FL/MTC were calculated and compared in both groups.

The privacy of patients and confidentiality of data collected are guaranteed.

Statistical methods

The data were analyzed using SPSS version 26, USA. The tests used were mean, standard deviation and P value. P value less than 0.05 was considered significant.

Results

A total of 60 patients were recruited in this study. In the group 1

Only 30 pregnant female with normal fetal weight are included. In group 2 the pregnant female with diagnosed IUGR fetus are recruited.

The enrolled patients in both group were similar regarding baseline demographic characteristics including age, parity and gestational age at time of examination (Table 1). There is no difference in age gravidity and parity in both groups and P value were (0.099, 0.378, 0.365 respectively). The mean duration of pregnancy was the same whatever the method of calculation either by LMP or by US. But There was significant difference between both groups (P= 0.004) as regard to EFW.

Table (1): Demographic and clinical data:

	Group I		Group II		T	P
	range	Mean ± SD	range	Mean ± SD		
Age (in years	19-36	28.35± 4.524	22-33	27.17 ± 3.142	2.769	0.099 NS
Gravidity	1-3	1.70 ± 0.72	1-3	1.82 ± 0.75	0.782	0.378 NS
Parity	0-2	0.70 ± 0.70	0-2	0.82 ± 0.75	0.788	0.365 NS
Gest. age by LMP	26-40	31.9 ± 4.05	26-38	31.8 ± 4.27	0.082	0.998 NS
Gest. age by US	25-38.2	31.77 ± 3.7	21-38	30.01 ± 4.99	0.088	0.130 NS
EFBW (gram)	824-3740	1992.7±801.30	340-2457	1510.03±990.11	8.616	0.004*

LMP: last menstrual period US: ultrasound NS: non-significant EFBW: estimated fetal body weight

When the fetal parameters were compared between two groups as shown in Table 2 all the parameters of the fetuses in group 2 were less than that of group. There was significant difference between both groups as regard to BPD (P= 0.001), HC (P=0.002), AC (P=0.002) and MTC(P=0.001) with non-significant FL=(p=0.052),and TCD(P=0.061).

Table (2): ultrasonic measurements:

Measurements (in cm)	Group (I)			Group (I)			Significance
	Range	Mean	S.D.	Range	Mean	S.D.	
Biparietal diameter (BPD)	6.50-9.67	8.05	0.93	4.94-9.48	7.34	1.38	**T = 10.824 P =0.001***
Head circumference (HC)	23.88-33.5	29.11	3.18	18.03-32.95	26.67	5.21	**T = 9.556 P =0.002***
Abdominal circumference(AC)	21.52-35.95	27.72	4.03	13.37-35.03	24.77	6.32	**T = 10.540 P = 0.002***
Femur length (FL)	4.44-7.50	6.06	0.91	3.60-7.44	5.92	1.23	**T = 10.512 P =0.052**
Transcerebellar diameter (TCD)	3.08-5.26	4.01	0.72	1.87-4.90	3.966	0.883	**T = 13.540 P = 0.061**
Mid-thigh circumference (MTC)	**8.49-16.52**	**11.96**	**2.26**	**5.11-13.02**	**9.13**	**2.45**	**T = 43.164 P < 0.001***

Table 3 shows that when the ration were estimated and compared in both groups all the three ratios show the same significant difference between both groups. The mean HC/AC was 1.048 in group 1and 1.099 in group 2(P=0.004). **As for TCD/AC the mean was 0.142, 0.151 respectively with P =0.023* (statistically significant). As such, Femur length to mid-thigh circumference ratio(FL/MTC) shows mean 0.515± 0.074 in group 1 0.632 ±0.224in group 2 with P < 0.001*(statistically significant).**

Table (3): HC/AC, TCD/AC, FL/MTC ratios:

Measurements	Group (I)			Group (I)			Significance
	Range	Mean	S.D.	Range	Mean	S.D.	
HC/AC	0.93-1.13	1.048	0.059	0.84-1.43	1.099	0.117	**T = 8.812 P = 0.004***
TCD/AC	0.12-0.16	0.142	0.012	0.14-0.18	0.151	0.001	**T = 3.570 P =0.023***
Femur length to mid-thigh circumference ratio (FL/MTC)	**0.40-0.70**	**0.515**	**0.074**	**0.32-1.40**	**0.632**	**0.224**	**T = 14.747 P < 0.001***

On studying table 4, the correlation between TCD/AC ratio and EFW was found. Also, the correlation between the EFW with either MTC or FL/MTC ratio. The MTC showed significant correlation but the ratio was not significant.

Table (4): correlation study:

Correlation between EFW with:	Group (I)	Group (II)
TCD/AC ratio	**R= 0.746** **P= 0.001***	R= 0.785 P= 0,001*
Thigh circumference	**R= 0.732** **P= 0.001***	R= 0.751 P= 0.001*
FL/MTC ratio	**R= 0.144** **P= 0.079^{NS}**	R= 0.239 P= 0.088^{NS}

Discussion

Intrauterine growth restriction (IUGR) has been a prevalent and intricate obstetric concern. It is believed that between 10% and 15% of pregnant women have IUGR. As opposed to 8.4 for screened/detected SGA (10), the perinatal rate for unscreened/undetected SGA is 21.3 per 1,000 live births. To reduce neonatal mortality, it is thus imperative to recognize these fetuses, initiate early antenatal surveillance, and promptly deploy obstetric procedures. It has been shown that IUGR babies are more likely to experience negative short- and long-term impacts than SGA children.(11)

Asphyxia or a reduction in the flow of utero-placental blood are common causes of IUGR. The heart, brain, and adrenal glands in the center get the majority of blood flow (7). A study found that the redistribution of cardiac output during acute hypoxia maintained steady cerebral blood flow. Since IUGR has less of an impact on cerebellar growth in human beings, TCD measurement is mostly useful in estimating gestational age. Reduced AC is the result of decreased hepatic glycogen and subcutaneous fat reserves in IUGR fetuses. So far, the AC has shown sensitivity in predicting IUGR in fetuses. As far as biometric parameters go, the TCD/AC ratio has shown to be the least impacted and could be a sensitive technique to identify asymmetric IUGR at any gestational age (12).

The principal of this study is that trans-cerebellar diameter (TCD) is the factor that is least impacted by intrauterine growth restriction . In case if the pregnant patient is unsure of her LMP , we can use TCD to calculate the gestational age regardless of the fetal weight for age . In our study , there was no significant difference between appropriate for GA and SGA regarding TCD . We concluded that only TCD and FL was not different with EFW affection , thus more accurate for their specific gestational age. Conversely , AC is the most affected parameter in cases of FGR , A TCD/AC ratio will be affected (increased TCD/AC ratio) in all cases of FGR. This ratio may be used to confirm a diagnosis of FGR. And also there is a strong significant difference between MTC in normal fetuses compared to IUGR fetuses. The standard morphometric biometry of the fetus (HC, AC, FL, etc.) was also evaluated in relation to fetal growth.

As for TCD/AC the mean was 0.142, 0.151 respectively with P =0.023 (statistically significant). As such, Femur length to mid-thigh circumference ratio (FL/MTC) shows mean 0.515± 0.074 in group 1 0.632 ±0.224in group 2 with $P < 0.001$ which was also statistically significant.

In coincidence with our study, and according to Lees et al., the sensitivity of the TCD/AC ratio in predicting IUGR was only 71% in symmetrical IUGR but as high as 98% in asymmetrical IUGR. The theory that human cerebellar growth is comparatively refractory to prolonged low oxygen levels as a consequence of the brain sparing effect is supported by the fact that TCD is only slightly reduced in prenatal growth restriction. The optimal TCD/AC ratio threshold value for IUGR prediction was 13.75%, resulting in

100%, 63.33%, 73.17%, and 100% for sensitivity, specificity, positive predictive value, and negative predictive value, respectively (13).

The TCD/AC ratio and EFW showed a positive association in our investigation. According to Chawan et al., the mean TCD/AC ratio was substantially higher in the IUGR newborns than in the control group, and the TCD/AC ratio was aberrant in 16 out of 20 (80%) of the IUGR infants (10).

Our research demonstrates a statistically significant difference in MTC between IUGR and normal fetuses. The basis for this assessment stems from the need to obtain an accurate estimation of the fetal thigh's lean and fat mass in order to develop a unique formula for EFW. Furthermore The current study's objective was to assess the relationship between birth weight in normal and IUGR cases and this sonographic ratio (FL/MTC) metric.

Our opinion was supported by the findings of Scioscia et al., who demonstrated the potential of the linear measurement of MTC as a useful parameter for the sonographic evaluation of fetal growth and EFW. There were 388 singleton pregnancies in this study. They evaluated the accuracy of the mid-thigh soft-tissue density measurement (11). Additionally, as has been demonstrated by a number of studies, including those conducted by Brown et al., the use of subcutaneous fat tissue indicators (including MTC) in the future may offer a chance to identify and gauge the effects of various innovative therapies, such as the use of maternal amino acid infusions on the growth-restricted fetus (12,13).

This study had limitations. Despite we adopted the standard definition of SGA, the wide gestational age range (26-40 weeks) and the subsequent age-specific EFW the mean EFW in the normal group looked smaller (1992.7±801.30) but the range was (842-3740). We should have standardized a narrower gestational age range for proper comparison and analysis. However, multiple comparisons were done to confirm our results and to exclude other measures that may have the same impact on results as TCD & FL.

Conclusion

According to our research, MTC is a useful new metric for estimating birth weight and assessing fetal growth sonographically. This measurement is highly reproducible and simple to perform. Additionally, the TCD/AC and FL/MTC ratios are accurate, simple to use, and dependable indicators of IUGR.

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Conflicts of interest: Authors declared no conflicts of interest.

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comparisons were done to confirm our results STT was measured linearlyin the standard longitudinal section used for FLmeasurement5,6(Figure 1): after the appropriate sectionwas obtained, the image was frozen on the screen and thenmagnified. STT was then measured from the outer marginof the skin to the outer margin of the femur shaft, with thefemur lying parallel to the transducer. The measurementwas taken in the middle third of the fetal thigh, providingthat the greater and the lesser trochanters were turnedupwards. This section ensured the correct view of thelateral side of the femur (vastus lateralis, which is thelargest part of the quadriceps femoris). In each case, threesatisfactory images from different frozen images weremeasured (in mm to one decimal place) and the meanvalue was recorded.