Obstetrics and Gynecology

Transcerebellar Diameter to Abdominal Circumference Ratio in Assessment of Normal Fetal Growth

Ahmed Samir Hamid shaaban, [1] MSc, Ismael Talat El Garhy, [1] MD, Ehab Hasanin Mohammed, [1] MD.

* Corresponding Author:
Ahmed Samir Hamid shaaban
dr.ahmedsamir5615@gmail.com

[1]Obstetrics and Gynecology Department, Faculty of Medicine, Al-Azhar University.

ABSTRACT

Background: Intrauterine growth restriction (IUGR) and its early detection were correlated with a high risk of perinatal mortality and morbidity and management are helpful in decreasing the neonatal risks. Transcerebellar diameter to abdominal circumference ratio becomes a gestational age-independent parameter, which may be helpful for early detection of IUGR.

Aim of the study: Study the accuracy of transcerebellar diameter/ abdominal circumference ratio (TCD/AC ratio) for the evaluation of normal fetal development.

Patients and Methods: Our Prospective observatory research included 500 women with uncomplicated pregnancy attending the outpatient clinic of Al Azhar university hospitals for routine antenatal care. Routine ultrasound parameters were measured as well as transcerebellar diameter. In all patients, the TCD/AC ratio was also determined.

Results: Our study concluded that difference in TCD/AC ratio between patients with IUGR vs. patients with no IUGR is statistically significant with p-value <0.001. TCD/AC had a good diagnostic value in 18-34 weeks gestational age groups with Best cutoff value on TCD/AC ratio of >13 this cutoff value with 99.03 % sensitivity and 83.45 % specificity, 58.0 with a positive predictive value, and 99.7 with a negative predictive value.

Conclusion: TCD/AC ratio seems to become an age-independent constant parameter and a comparatively good IUGR indicator in gestational age groups of 18-34 weeks which may be helpful for early identification of fetal intrauterine growth retardation (IUGR).

Keywords: *Transcerebellar diameter, TCD/AC ratio, growth restriction..*

INTRODUCTION

For providing adequate obstetric and neonatal care, precise estimation of gestational age (GA) is essential; including management of diseases through pregnancy with medications which may be considered unsafe during the first trimester, diagnosis of growth restriction or intrauterine growth retardation and post-term pregnancy (≥42 weeks of gestation), Provision of preterm labor antenatal corticosteroids and decisions about whether to administer or withhold intensive care to severely premature babies, which depends mainly on accurate gestational age estimation .[1]

Growth-restricted fetuses need to be recognized by obstetricians because this fetal condition is correlated with substantial perinatal mortality and morbidity. In fetal, neonatal, and adult life, IUGR can have substantial consequences. [2] IUGR raises the likelihood of intrapartum asphyxia, preterm birth and complications correlated with preterm birth include

but are not limited to, intraventricular hemorrhage, necrotizing enterocolitis and respiratory distress syndrome. Increased occurrence of low Apgar scores, umbilical cord pH lower than 7.0, requirement for intubation, seizures, sepsis and neonatal mortality was also observed in these babies.[3] Increased perinatal mortality and morbidity due to a higher likelihood of intrauterine fetal demise (IUFD) and an increased rate of iatrogenic premature birth was correlated with IUGR.[4]

To evaluate fetal growth, independent parameters for pregnancy age are also required. The maximum transverse diameter of the fetal cerebellum is the transcerebellar diameter (TCD). In the posterior cranial fossa, which resists external pressure and development deviations, the fetal cerebellar hemispheres are found.[5] Owing to the brain sparing phenomenon that contributes to sustained blood flow to the brain at the expense of systemic supply, it is

relatively resistant to hypoxia.[6] It can also be utilized as a tool to help evaluate gestational age in third trimester.[7,8] In comparison, the first impacted factor in the process of impaired fetal development is fetal abdominal circumference (AC). Therefore a TCD/AC ratio that becomes independent of pregnancy age is very helpful in forecasting IUGR.

PATIENTS AND METHODS

This study was done at Al Azhar University Hospitals Obstetrics & Gynecology Department from August 1st, 2018 to February 1st, 2020. Patients were selected from outpatient clinic. It is a Prospective observational study. Included 500 pregnant ladies with periods of pregnancy among 18 and 34 weeks. After receiving approval from the Ethical Committee of the Faculty of Medicine, Department of Obstetrics and Gynecology, Al Azhar University . All women solicited for enrollment and given informed written consent.

All patients selected for our study underwent the following conditions: complete history taking include age, history of any medical disorders, and history of any previous operations. Clinical examination including height, weight, gait, vital signs, chest, heart examination and limb examination. Verification of gestational age by the last menstrual cycle prior to 20 weeks of pregnancy and/or ultrasound verification of gestational age by ways of 1st trimester crown rump length measurement. The Voluson E6 system is the ultrasound unit used in this research (Voluson Expert, General Electric Medical Systems, Milwaukee, WI). Either 3 or 5 MHz abdominal transducers have been attached to the system. A trained obstetric sonologist, blinded to gestational age, and a patient id number, inspected every fetus only once. Biometric fetal parameters were measured, such as head circumference, biparietal diameter, transverse cerebellar diameter, abdominal circumference and length of the femur. The cerebellum has been situated in the posterior fossa and visualized at the BPD level by minor posterior and inferior transducer rotations. As specified by Goldstein et al., electronic calipers were used to calculate the TCD in an outer to outer fashion.[9] Abdominal circumference (AC) was measured by the cross-section (as circular as possible) of the fetal abdomen; the umbilical vein was visualized at the portal sinus level; the stomach bubble was visualized; the kidneys were not noticeable. The AC was calculated directly by ellipse calipers on the outside surface of the skin line.[10] The TCD/AC ratio was measured by dividing the TCD by AC and then multiplying it by 100.[11] The research was carried out in the usual way, typically brief, usually lasting around or less than 15 mins, with close attention provided to obtaining a setting suited to create the best image possible. In order to mitigate the error obtained from the caliper method, image magnification has been attempted.

Criteria for inclusion: Pregnant ladies with singleton uncomplicated pregnancy before 20 weeks of pregnancy at gestational age.

Criteria for exclusion: Women with multiple gestation, history of metabolic disease, any maternal medical conditions complicating pregnancy (hypertension, diabetes mellitus, renal disease, cardiac conditions, etc.), fetal congenital anomalies were excluded .

Outcome: pulation specific transcerebellar diameter/abdominal circumference ratio (TCD/AC ratio) for the evaluation of natural fetal development in women who attend Al Azhar University hospitals. Investigate other TCD based ratios for evaluation of natural fetal development. Investigate sensitivity, specificity and predictive value of TCD/AC ratio in evaluation of natural fetal development.

Statistical Methods: Using the statistical software SPSS (statistical package for social science version 26.00), all statistical calculations were performed, at 0.05, 0.01 and 0.001 likelihood levels 18. Non-parametric quantitative data distribution was conducted using the Mann Whitney variance analysis to compare two groups, and three groups were compared using the Kruskal Wallis test. The best cut-off point with its sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and area under curve (AUC) has been evaluated by the receiver operating characteristic curve (ROC) using Medcalc (version 15.80). The confidence interval became set at 95% and the accepted error margin became set at 5%. The p-value at the level of >0.05 was deemed to be non-significant (NS), significant at the <0.05, 0.01 level, and extremely significant at the <0.001 level.[12]

RESULTS

Variable		
Age (years)	Range	20.0-35.0
	Mean ±SD	29.32±4.90
Height (m)	Range	1.5-1.8
	Mean ±SD	1.68±0.11
Weight (kg)	Range	46.5-96.0
	Mean ±SD	66.66±15.68
BMI (kg/m2)	Range	16.5-32.9
	Mean ±SD	23.74±5.57
Gestational age by LMP (days)	Range	126-238
	Mean ±SD	195.89±45.90
Gestational age by LMP (weeks)	Range	18-34
	Mean ±SD	24.49±5.60
Gestational age by US (days)	Range	127-245
	Mean ±SD	192.24±37.01
Gestational age by US (weeks)	Range	18.1-34.9
	Mean ±SD	27.49±5.86

Table 1: Descriptive statistics for the whole study cohort (gestational age 18-34 weeks): Numerical variables (N=500).

shaaban et al – TCD/AC ratio in Assessment of Normal Fetal Growth.

Obstetrics and
Gynecology

Variable		
BPD (cm)	Range	3.7-8.9
	Mean ±SD	6.43±2.07
HC (cm)	Range	13.1-32.4
	Mean ±SD	28.89±8.40
AC (cm)	Range	11-33.6
	Mean ±SD	22.94±5.01
FL (cm)	Range	2.7-7.1
	Mean ±SD	5.33±1.35
TCD (cm)	Range	1.6-4
	Mean ±SD	3.07±1.36
TCD/AC ratio	Range	8.54-16.87
	Mean ±SD	12.10±2.20
TCD/BPD ratio	Range	22-53.43
	Mean ±SD	39.50±9.81
TCD/HC ratio	Range	4.76-15.6
	Mean ±SD	9.90±3.07
TCD/FL ratio	Range	34.9-77.9
	Mean ±SD	45.79±12.64
EFW (g)	Range	190-2648
	Mean ±SD	1175.86±579.87

**Table 2:** Descriptive statistics for the whole study cohort's biometry (gestational age 18-34 weeks): Numerical variables (N=500).

Variable		Frequency	Percent
Parity	P0	182	36.40%
	P1	168	33.60%
	P2	126	25.20%
	P3	18	3.60%
	P4	6	1.20%
Previous CS	No previous CS	342	68.40%
	Previous CS	158	31.60%
Previous abortion	Nil	438	87.60%
	Once	52	10.40%
	Twice	10	2.00%
IUGR	No IUGR	415	83.00%
	IUGR	85	17.00%

Table 3: Descriptive statistics for the whole study cohort (gestational age 18-34 weeks): Categorical variables.

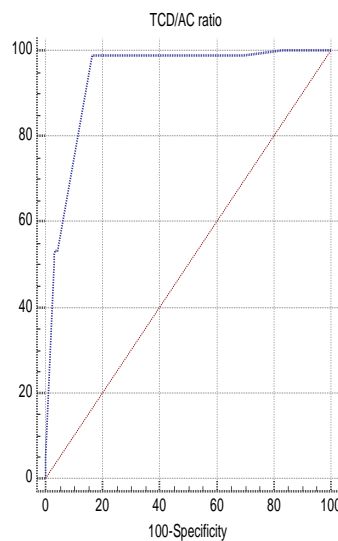| Variable		No IUGR N= 415	IUGR N= 85	p-value
		Median (IQR)	Median (IQR)	
Gestational age 18-34 weeks	TCD (cm)	3.97 (2.40-3.90)	3.01 (2.30-3.90)	**<0.001 HS**
	TCD/AC ratio	11.00 (9.87-13)	16.00 (12.-17.0)	**<0.001 HS**
	TCD/BPD ratio	45.00 (29.0-47.00)	44.1 (27.0-50.00)	0. 340 ns
	TCD/HC ratio	10 (7 -13)	9 (8-10.0)	0.081 ns
	TCD/FL ratio	40.00 (36.1 -60)	36 (34.9 -38)	**<0.001 HS**

Table 4: Comparison of the TCD and related measures in patients with or without IUGR in whole cohort study group.
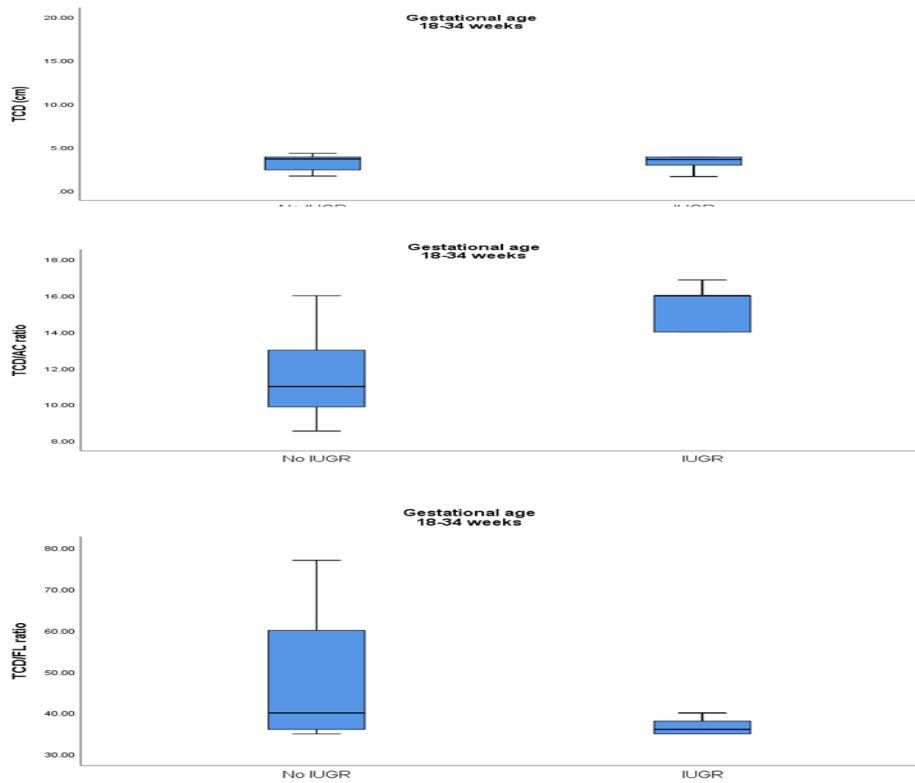
Fig 1: Shows a highly statistically significant variation among patients with IUGR and patients without IUGR according to TCD , TCD/AC ratio and TCD/FL ratio in whole cohort study group.

Cut off point	AUC	Sensitivity	Specificity	+PV	95% Cl	-PV	95% Cl	Z test	p value
TCD/AC ratio >13	0.937	99.03	83.45	58.0	50.3 - 65.3	99.7	98.5 - 100.0	40.65	<0.0001

Table 5: Receiver-operating characteristic (ROC) curve analysis at 18-34 weeks for differentiation among patients with or without IUGR.

Fig 2: Diagnosis of IUGR at 18-34 week using TCD/AC Ratio.

shaaban et al – TCD/AC ratio in Assessment of Normal Fetal Growth.

Obstetrics and Gynecology

DISCUSSION

A common and complex obstetric issue has been intrauterine growth restriction (IUGR). It is estimated that IUGR affects nearly 10-15% of women who are pregnant.[13] The perinatal rate for unscreened/ undetected SGA is 21.3 per 1,000 live births compared with 8.4 for screened/detected SGA (RCOG Guideline No. 31). Thus it is necessary to identify these fetuses, begin early antenatal surveillance and implement prompt obstetric measures to decrease perinatal mortality. Compared with SGA children, IUGR babies are reported to have an elevated risk of adverse short- and long-term effects.[3]

IUGR is often induced by asphyxia or decreased flow of utero-placental blood. The flow of blood primarily transfers to the central parts of the heart, brain, and adrenal glands (Loughna, 2006). There has been a research that cerebellar blood flow stayed constant in acute asphyxia as a result of cardiac output redistribution.[14] Cerebellar growth in humans is less influenced by IUGR, so measuring of TCD is mostly effective in predicting gestational age.[15] Hepatic glycogen and subcutaneous fat stocks have reduced in IUGR fetuses, resulting in reduced AC. Thus the AC has been sensitive for predicting fetal IUGR.[16] The TCD/AC ratio has been the biometric parameter that is the least impacted and might be a sensitive tool at any gestational age to detect asymmetric IUGR.

This study that included 500 Egyptian women with uncomplicated normal pregnancy who attended the antenatal clinic for routine scan with Mean (SD) of age was 29.32(4.9) years, as regards Mean (SD) of BMI were 23.74(5.57) and as regards the parity 36.40% were PG, 34.60% were P1, 25.20% were P2, 3.60% were P3 and 1.20% were P4., Mean (SD) gestational age by Last menstrual period (LMP) was 24.49, we have found that the average TCD/AC ratio for the various gestation periods was:

18-22 weeks	10.98
23-26 weeks	12.21
27-30 weeks:	12.58
31-34 weeks:	12.67

While Dhumale et al.[17]. who conducted a prospective observational research at the teaching hospital of KLE University, Belgaum on 434 obstetric patients 18-34 weeks of singleton pregnancy and confirmed gestational age similar to this study found that Mean for TCD/AC ratio for the various gestation periods was:

18-22 weeks	13.4
23-26 weeks	13.5
27-30 weeks:	13.6
31-34 weeks:	14.0

It was found that difference in TCD/AC ratio between patients with IUGR vs. patients with no IUGR are statistically significant in all gestational age groups with a p-value of <0.001, also agreed with Dhumale et al .

Our study showed that TCD/AC seems to have an excellent predictive value in 18-34 weeks gestational age groups with Best cutoff value on TCD/AC ratio of >13 this cutoff value with 99.03% sensitivity and 83.45 % specificity, 58.0 with a positive predictive value and 99.7 with a negative predictive value. That agreed by Dhumale et al. in which they stated that the TCD/AC ratio in the gestational age group 18-34 weeks is an age independent constant parameter and a comparatively good indicator of IUGR.

While in earlier studies Chawanpaiboon et al.[18] conducted on a total of 634 women who are pregnant among 13 and 40 weeks of pregnancy and attending the Siriraj hospital antenatal clinic, discovering that the TCD/AC ratio is a stable, gestational age independent parameter between 20-30 weeks of pregnancy which could be helpful in early diagnosis of fetal intrauterine growth retardation (IUGR) .

In our study difference in TCD between patients with IUGR vs. patients with no IUGR was statistically significant in all gestational age groups .

TCD is effective and accurate even at extremes of fetal growth in predicting GA.[19] It was found that the transcerebellar diameter among normal and growth-restricted fetuses was the same. This parameter can also be used as one of the significant methods for evaluating pregnancy age in normal and growth restricted fetuses.[20] Cerebellar size is decreased in the case of intrauterine growth retardation (IUGR) in relation to the seriousness of the disease and thus the TCD cannot be used to gain accurate info on the gestational age of small fetuses and the TCD/AC ratio cannot provide accurate data on whether or not fetuses are growth retarded fetuses.[21] For fetuses with asymmetric but not symmetric growth restriction, TCD is a helpful indicator of pregnancy age.[22]

CONCLUSION

This study concluded that difference in TCD/FL ratio between IUGR vs. patients with no IUGR is statistically significant in 18 -34 weeks gestational age groups difference in TCD/BPD and TCD/HC ratio between patients with IUGR vs. patients with no IUGR is statistically significant. As shown in the ROC curve comparisons for all gestational age groups TCD/AC ratio has good predictive value for discrimination between patients with IUGR and patients with no IUGR in gestational age group 18-34weeks compared to other TCD based ratios and all are statistically.

REFERENCES

1. Rijken MJ, Mulder EJ, Papageorghiou AT, et al. Quality of ultrasound biometry obtained by local health workers in a refugee camp on the Thai–Burmese border. *Ultrasound in Obstetrics & Gynecology.* 2012; 40(2):151-7.
2. Suhag A and Berghella V. Intrauterine Growth Restriction (IUGR): Etiology and Diagnosis. *Curr Obstet Gynecol Rep.* 2013; 2:102–11.

3. Von Beckerath A-K, Kollmann M, Rotky-Fast C, et al. Perinatal complications and long-term neurodevelopmental outcome of infants with intrauterine growth restriction. *American Journal of Obstetrics and Gynecology.* 2013; 208(2),130-1.

4. Alimena S, Nold C, Herson V, et al. Rates of intrauterine fetal demise and neonatal morbidity at term: determining optimal timing of delivery. *J Matern Fetal Neonatal Med.* 2017; 30(2):181-5.

5. Goel P, Singla M, Ghai R, et al. Transverse Cerebellar Diameter: A Marker for Estimation of Gestational Age. *J Anat Soc India.* 2010; 59(2):158–61.

6. Vinkensteijn AS, Mulder PG and Wladimiroff JW. Fetal transverse cerebellar diameter measurements in normal and reduced fetal growth. Ultrasound Obstet Gynecol. 2000;15(1):47–51.

7. Naseem F, Fatima N, Yasmeen S et al. Comparison Between Transcerebellar Diameter with Biparietal Diameter of Ultrasound for Gestational Age Measurement in Third Trimester of Pregnancy. Journal of the College of Physicians and Surgeons Pakistan 2013; 23 (5): 322-5.

8. Naseem, F., Ali, S., Basit, U, et al. assessment of gestational age; comparison between transcerebellar diameter versus femur length on ultrasound in third trimester of pregnancy. *Professional Med J.* 2014; 21(2): 412-7.

9. Haller H, Petrovic O and Rukavina B. Fetal transverse cerebellar diameter/abdominal circumference ratio in assessing fetal size. *Int J GynecObstet.* 1995; 50:159-63.

10. Salomon LJ, Alfirevic Z, Bilardo CM, et al. ISUOG practice guidelines: performance of first-trimester fetal ultrasound scan. *Ultrasound Obstet Gynecol.* 2013; 41:102.

11. Meyer WJ, Gauthier D, Ramakrishnan V, et al. Ultrasonographic detection of abnormal fetal growth with the gestational age: independent transverse cerebellar diameter to abdominal circumference ratio. *Am J Obstet Gynegol.* 1994; 171:1057-63.

12. Härdle, W. and Simar, L. Applied Multivariate Statistical Analysis. *2nd ed, Springer.* 2007; 420.

13. American College of Obstetricians and Gynecologists (ACOG). Intrauterine growth restriction. *Practice Bulletin no. 12, 2000, Washington DC. http://www.acog.org. Accessed* 25 Dec 2012.

14. Senat MV, Schwarzler P, Alcais A, et al. Longitudinal changes in the ductus venosus, cerebral transverse sinus and cardiotocogram in fetal growth restriction. *Ultrasound Obstet Gynecol.* 2000;16:19-24.

15. Vinkensteijn AS, Mulder PG and Wladimiroff JW. Fetal transverse cerebellar diameter measurements in normal and reduced fetal growth. Ultrasound Obstet Gynecol. 2000;15(1):47–51.

16. Blackwell SC, Moldenhauer J, Hassan SS, et al. Relationship between the sonographic pattern of intrauterine growth restriction and acidbase status at the time of cordocentesis. *Arch Gynecol Obstet* 2001; 264:191-3.

17. Dhumale H, Pujar YV, Shravage C. et al. Fetal transcerebellar diameter to Abdominal circumference ratio (TCD/AC) in the assessment of normal fetal growth. *Donald School Journal of Ultrasound in Obstetrics and Gynecology* 2010; 4(4):455-7.

18. Chawanpaiboon S, Kanokpongsakdi S, and Vantanasiri C. Predicting Fetal Intrauterine Growth Retardation by Using Reference Centile Charts for the Ratio of Fetal Transverse Cerebellar Diameter to Abdominal Circumference in a Thai Population. *Siriraj Med J* 2008; 60:316-9.

19. Martin R. Chavez, MD, Cande V. et al. Fetal Transcerebellar Diameter Measurement for Prediction of Gestational Age at the Extremes of Fetal Growth. *J Ultrasound Med.* 2007; 26:1167–71.

20. Ali SA and Khuwaja AB. Comparison of transcerebellar diameter in growth restricted and normal singleton fetuses for the assessment of gestational age: A case control study. *El Mednifico journal.* 2014, 2(3):200-4.

21. Snijders RJ, Johnson S, Sebire NJ, et al. First-trimester ultrasound screening for chromosomal defects. Ultrasound Obstet Gynecol 1996; 7 : 216–26.

22. Lee AC, Mullany LC, Ladhani K, et al. Validity of newborn clinical assessment to determine gestational age in Bangladesh. *Pediatrics.* 2016; 138(1): 20153303.