Case Study

Prediction of Fetal Growth Restriction using Transcerebellar Diameter and Abdominal Circumference Ratio

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How to cite this article: Shazia Shad, Upma Saxena, Shreya S Kushwaha et. al. Prediction of Fetal Growth Restriction using Transcerebellar Diameter and Abdominal Circumference Ratio. Indian Journal of Public Health Research & Development 2023;14(4).

Abstract

Objective: To predict fetal growth restriction using transcerebellar diameter and abdominal circumference ratio (TCD/AC) in women with clinically diagnosed FGR.

Materials and Methods: A prospective observational cohort study was conducted on women >28 weeks of gestation with clinically diagnosed fetal growth restriction, at the Tertiary care centre. Total 120 women were enrolled ,over a period of 18 months ,from December 2020 to July 2022 .Biometry was performed using ultrasonography and transcerebellar diameter and abdominal circumference ratio (TCD/AC) and head circumference and abdominal circumference ratio (HC/AC) were calculated. All women were followed up till delivery and fetomaternal outcome was recorded. After birth height, weight and ponderal index of the newborn were also noted. TCD/AC ratio was correlated with birth weight and ponderal index, for predicting FGR. TCD/AC ratio was also compared with routinely used HC/AC ratio for predicting FGR.

Statistical Analysis: The final analysis was done with the use of Statistical Package for Social Sciences (SPSS) software, IBM manufacturer, Chicago, USA, version 21.0®.

Results: A cut off value of TCD/AC >0.14 was found to have a sensitivity, specificity, PPV and NPV of 87.36%, 75.76%, 90.5% and 69.4% respectively with a diagnostic accuracy of 84.17%, in diagnosing FGR. There was a significant negative correlation between TCD/AC ratio with birth weight and ponderal index, with a correlation coefficient of 0.463 and 0.501 respectively. (p value < 0.001) TCD/AC was better predictor of fetal growth restriction with a diagnostic accuracy of 84.17% versus 40.83% with HC/AC. Significant positive correlation was observed between period of gestation (weeks) with transcerebellar diameter (mm),with correlation coefficient of 0.497 (p<0.001).

Conclusions: TCD/AC ratio is an effective gestational age independent parameter to predict FGR on ultrasonography, with better diagnostic accuracy than routinely used HC/AC. Hence it should be performed for all antenatal women clinically suspected to have FGR.

Keywords: Transcerebellar diameter, Abdominal Circumference, Fetal Growth Restriction, Head circumference, birth weight, Ponderal index.

Introduction

The term "fetal growth restriction" (FGR) implies failure of a fetus to meet its genetically determined growth potential due to fetal, placental or maternal factors.[1] The estimated incidence of fetal growth restriction is high (10%) but its recognition is low, as

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only 40% of these cases are identified during antenatal period.[2] A different set of clinical problem develops in infants of same weight but different gestational age, therefore identification of high risk newborns based on gestational age and weight is important.[3] Growth restricted fetus need to be identified antenatally because they have a high likelihood of intrapartum hypoxia, intrauterine death, low APGAR scores, meconium-stained liquor and neonatal mortality.[4] Besides these, growth restricted fetus have also reported long-term health problems, like risk of neurodevelopment disorders, endocrine and cardiovascular diseases.[5] Early detection of FGR is useful in deciding frequency of antenatal surveillance and timing of delivery.[6,7] Timely delivery of such infants leads to improved outcomes by fourfold reduction in morbidity and mortality.[8] It is also an important factor in stillbirth prevention strategies, as up to 30% of stillbirths are associated with FGR.[9]

Third trimester growth scan with Doppler is used for fetal weight determination and to classify fetuses that are small for gestational age (SGA), which is defined as an estimated fetal weight (EFW) <10th percentile.[10]

The cerebellum due to brain sparing effect is relatively resistant to hypoxia.[5] So transcerebellar diameter (TCD) is least affected by growth restriction. The abdominal circumference (AC) on the other hand correlates directly with liver size which is maximally affected by fetal malnutrition. Therefore TCD/AC ratio which utilizes the least and most affected fetal biometric parameter, is a very sensitive method of detecting fetal growth restriction. [2,11]

Several nomograms for the transcerebellar diameter to abdominal circumference ratio indicate that, from around 21-22 weeks of gestation, in normal fetuses, the TCD/AC ratio is gestation-age independent and remains constant (median value 0.13). A study in growth restricted fetus reported that an asymmetric pattern defined as transcerebellar diameter to abdominal circumference ratio (TCD/AC) ratio >95th percentile with median value 0.15 in second trimester and 0.16 in the third trimester, is predictive of birthweight < 10th centile.

In India, many women present to the hospital in third trimester with unknown gestational age and it is difficult to ascertain whether they are preterm or growth restricted. Hence this study was carried out to ascertain whether transcerebellar diameter to abdominal circumference ratio (TCD/AC) can be used to diagnose fetal growth restriction, with unknown period of gestation.

Methods

This prospective observational cohort study was conducted in Department of Obstetrics and Gynaecology, Department of Radiodiagnosis and Department of Pediatrics of a Tertiary care hospital over a period of 18 months from December 2020 to July 2022, after obtaining institutional ethics committee approval. A total of 120 women with singleton pregnancy in cephalic presentation and clinically diagnosed FGR at >28 weeks period of gestation with known LMP were recruited after informed consent. Women having BMI>35 kg/m2 , polyhydramnios, Type 2 diabetes mellitus or a fetus with gross congenital anomaly were excluded.

After history, examination and antenatal investigations, ultrasonography was performed for biometry and EFW using Toshiba's model SSA640 and various ratio like TCD/AC and HC/AC were also calculated.

The women were followed up until delivery, and neonates with birth weight <10th centile were grouped as Small for gestational Age (SGA), using international standards for size at birth. The babies were grouped as symmetric or asymmetric FGR based on Ponderal index which was calculated by multiplying weight (in gram) with 100 and dividing by the cube of length (in centimetres). Cut-off of Ponderal index for babies with asymmetrical FGR was taken as < 2. Maternal outcomes like emergency LSCS and preterm delivery and fetal outcomes like MSL, APGAR score at birth, NICU admission and mortality rates were recorded in the two groups which had TCD/AC ratio of >0.14 and ≤0.14 to see if this ratio can predict adverse perinatal outcomes in babies with FGR.

The data entry was done in the Microsoft EXCEL spreadsheet. The data normality was checked by using Kolmogorov-Smirnov test. The final analysis was done with the use of Statistical Package for

Social Sciences (SPSS) software, IBM manufacturer, Chicago, USA, version 21.0®.

Results

The present study conducted in the Department of Obstetrics and Gynecology, Radio diagnosis and Pediatrics over a period of 18 months, recruited a total of 120 women with clinically diagnosed FGR.

The mean age of study population was 24.37 years but there was no difference in the distribution of FGR between different age groups. The mean gestational age at diagnosis and at delivery was 35.79 weeks and 37.37 weeks, respectively. Majority (51.67%) of women in present study population were primigravida whereas only 31.67% were second gravida. On comparing the incidence of FGR babies in women with different BMI, women with lower BMI (<18.5 kg/m^2) had a higher incidence of FGR babies (82.53%) relative to those with BMI >30 kg/m^2 which had only 23.53% of FGR babies.(p value <0.001) TCD/AC at cut off point of >0.14 with AUC of 0.832 had sensitivity of 87.36% and specificity of 75.8% for predicting FGR. HC /AC at cut off point of >0.311 with AUC of 0.832 had sensitivity of 21.8% and specificity of 90.9% for predicting FGR. [Figure 1].

TCD/AC ratio also had a PPV and NPV of 90.50% and 69.4% respectively which was higher as compared to PPV and NPV of HC/AC ratio of 86.4% and 30.6% respectively. TCD/AC was better predictor of fetal growth restriction with a diagnostic accuracy of 84.17% versus 40.83% with HC/AC[Table 1].

There was a significant negative correlation between TCD/AC and birth weight with a correlation coefficient of 0.463.(p value <0.0001) A significant negative correlation was observed between TCD/AC ratio with ponderal index with correlation coefficient of 0.501(p value <0.0001) which helped in diagnosis of asymmetrical FGR [Table No.2] [Figure no. 2a,2b]. On comparing TCD and gestational age, there was a significant positive correlation between period of gestation (weeks) with transcerebellar diameter (mm) [Figure 1] with correlation coefficient of 0.497 (p value <0.001).

In terms of neonatal outcome, NICU admission rates in FGR and AGA were 34.94% and 16.67% respectively, which were significantly higher in FGR(p value=0.044) group. There was no significant difference in the two groups in terms of MSL, APGAR score, prematurity and Caesarean section rates[Table no.3]. One Intrauterine death and one neonatal death occurred and both had TCD/AC>0.14.

Table 1: Comparison of TCD/AC ratio and HC/AC ratio for predicting fetalgrowth restriction

Variables	TCD/AC	HC/AC
Area under the ROC curve (AUC)	0.832	0.543
Standard Error	0.0409	0.0572
95% Confidence interval	0.753 to 0.894	0.450 to 0.634
P value	<0.0001	0.4521
Cut off	>0.14	>0.311
Sensitivity(95% CI)	87.36%(78.5-93.5%)	21.84%(13.7-32.0%)
Specificity(95% CI)	75.76%(57.7-88.9%)	90.91%(75.7-98.1%)
PPV(95% CI)	90.5%(82.1-95.8%)	86.4%(65.1-97.1%)
NPV(95% CI)	69.4%(51.9-83.7%)	30.6% (21.7-40.7%)
Diagnostic accuracy	84.17%	40.83%

Table 2: Correlation between TCD/AC ratio with birth weight and Ponderal index

Parameter	TCD/AC≤0.14 (AGA) (N=36) n(%)	TCD/AC>0.14 (FGR) (N=84) n(%)	P value	Correlational coefficient
Birth weight				
<10th centile	11(30.56)	76(90.48)	<0.0001	
>10th centile	25(69.44)	8(9.52)		-0.463
Ponderal Index				
<2 (asymmetrical FGR)	9(25)	71(84.52)	<0.0001	-0.501
≥2 (non FGR)	27(75)	13(15.48)		

Table 3: Correlation between TCD/AC ratio and Fetomaternal outcome

Parameter	TCD/AC≤0.14 (AGA) (N=36) n(%)	TCD/AC>0.14 (FGR) (N=84) n(%)	P value
Mode of delivery			0.157
Emergency LSCS	7(19.4)	27 (32.14)	
Vaginal delivery	29(80.5)	57(67.86)	
Preterm delivery			0.258
Yes	6(16.67)	22(26.19)	
No	30(83.33)	62(73.81)	
APGAR score at 1 min			0.075
<7	14(38.89)	47(56.63)	
≥7	22(61.11)	36(43.37)	
APGAR score at 5min			0.096
<7	9(25)	34 (40.96)	
≥7	27(75)	49 (59.04)	
NICU admission			0.044
Yes	6(16.67)	29 (39.94)	
No	30(83.33)	54 (65.06)	
MSL at birth			0.830
Yes	8(22.22)	17(20.48)	
No	28(77.78)	66(79.52)	

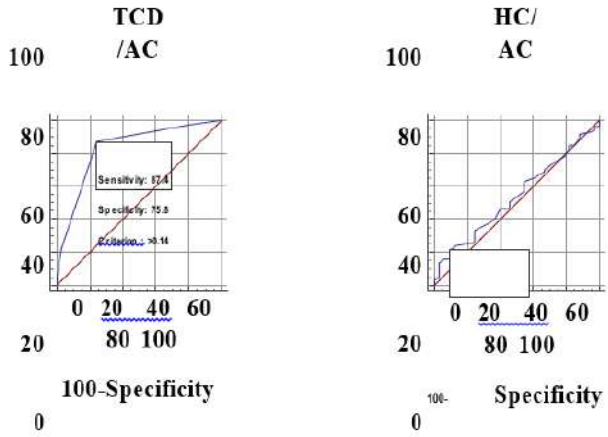
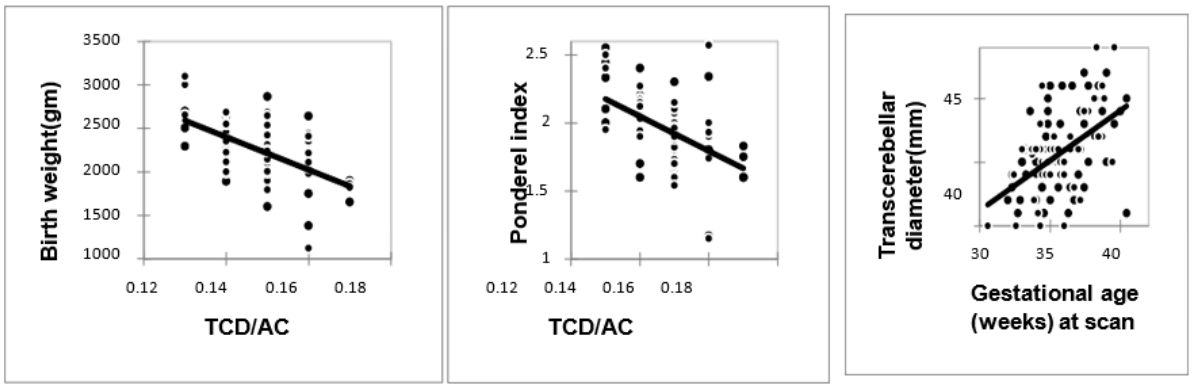


Figure 1: Receiver operating characteristic curve of TCD/AC and HC/AC ratio forpredicting fetal growth restriction.



(a) (b) (c)

Figure 2(a,b): Correlation of TCD/AC ratio with birth weight and Ponderal index

(c): Correlation of Transcerebellar diameter (mm) with gestational age

Discussion

The biometric parameters routinely used for estimation of gestational age - BPD, HC, AC and FL are influenced by fetal growth and external compressive forces.[13] For TCD cerebellum is measured which lies in the posterior cranial fossa, surrounded by the dense petrous ridges and occipital bone so it can withstand deformation by extrinsic pressure better than the parietal bones and hence is lesser affected than head circumference.[14]

In the present study, there was a positive correlation between transcerebellar diameter (in mm) and gestational age (weeks) with a correlation coefficient of 0.497. Similar earlier study also found a positive correlation between TCD and gestational age with correlation coefficient of 0.972.[15] Another cross sectional study on 500 women concluded that TCD had significant correlation with GA in normal (R2 = 0.979) and FGR pregnancies (R2 = 0.942).[16]

Previous study on 100 women between 15-28 weeks was in concordance to the present study and showed TCD to have highest correlation with gestational age compared to other biometric parameters with r-value of 0.982 at 29-40 weeks.[17] A prospective study on 100 pregnant women in concordance demonstrated ,strong correlation between gestational age and TCD with correlational coefficient 0.862 at 20-22 weeks and 0.803 at 32-34 weeks.[18]

In the present study, the mean TCD/AC ratio was 0.15 and a value >0.14 was found to have a sensitivity of 87.36%, specificity of 75.76%, PPV of 90.5% and NPV of 69.4% with a diagnostic accuracy of 84.17% ,in diagnosing FGR. Previous group of authors also found similar cut off for TCD/AC ratio where among

15 neonates with FGR, the mean TCD/AC ratio was 14.17 ± 0.89 at early gestation and 15.61 ± 1.18 at late gestation.[19] A study on 473 women in concordance with present study showed TCD/AC ratio >14.73 was associated with small for gestational age due to maternal placental syndromes.[20]

A recent study of 2022 also concluded that TCD/AC is an age independent parameter that remains constant at any gestational age with a mean TCD/AC ratio of 0.13 with sensitivity, specificity, PPV, NPV and diagnostic accuracy for diagnosing FGR of 88%, 93.5%, 77.1%, 96.3% and 92.4% respectively. [12] Another study on a group of 285 women found TCD/AC ratio to have a sensitivity, specificity, PPV and NPV of 77.1%, 97.2%, 79.4% and 96.8% respectively in predicting FGR with overall diagnostic accuracy of 95% which was in concordance with the present study.[15]Another study on a group of 500 women showed that TCD/AC ratio had 99.03% sensitivity and 83.45% specificity, in predicting FGR.[21]

When the babies diagnosed as FGR by TCD/AC ratio were correlated with birth weight, 90.48% of them had low birth weight (0.14 was worse than with TCD/AC ratio< 0.14, but difference was not significant (p value >0.05).

However, limitation of the present study was large interobserver variability in calculating transcerebellar diameter and abdominal circumference and difficulty in measurement of transcerebellar diameter due to calvarial shadow. Also, the study had a small study population for comparing maternal and fetal outcomes.

Conclusion

TCD is reliable for determining gestational age in third trimester of gestation. At a cut off value of >0.14, TCD/AC had overall better diagnostic accuracy (84.17% vs 40.83%) than HC/AC ratio in predicting FGR. Hence, we recommend that the TCD/AC ratio should be routinely used while performing USG as it is a good predictor of fetal growth restriction and can also be used in women with unknown period of gestation as it is gestational age independent.

Source of funding: Self

Conflict of Interest: No

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