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Original Research Article

Efficacy of trans-cerebellar diameter/abdominal circumference ratio versus head circumference/abdominal circumference ratio in prediction of asymmetrical intrauterine growth retardation

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ABSTRACT

Background: Determination of gestational age is an important step of pregnancy management and foetal development evaluation in obstetrics. Any error in this gestational age estimation results in prematurity or post maturity and in case if the expected date of delivery is not known, there is high chance of perinatal mortality in the near outcome. Hence it is important in achieving an uneventful gestation to have a sensitive, specific and age independent obstetric biometric parameter that stays constant throughout the gestation. Trans-cerebellar diameters (TCD)/ abdominal circumference (AC) ratio are reliable, constant predictors to assess the gestational age and to evaluate fetal growth. Aim was to compare the accuracy of TCD/ AC ratio with head circumference (HC)/ AC ratio in predicting asymmetrical IUGR.
Methods: A prospective study was conducted over a period of one year on 100 clinically suspected IUGR pregnancies who were evaluated with BPD, HC, AC and FL along with TCD were measured for assessing the sonological gestational age. Two morphometric ratios-TCD/AC and HC/AC were calculated. Estimated fetal weight was calculated for all these pregnancies and its percentile was determined. Then those clinically suspected IUGR cases were followed up to delivery and post-delivery new Ballord score and CAN score (clinical assessment of nutritional status at birth) were calculated.
Results: In the present study, the sensitivity, specificity, PPV, NPV and DA were 83.93%, 65.91%, 75.81%, 76.32% and 76% respectively for TCD/AC ratio versus respectively for HC/AC ratio in predicting IUGR.
Conclusions: Both ratios were gestational age independent and can be used in detecting IUGR with good diagnostic accuracy. However, TCD/AC ratio had a better diagnostic validity and accuracy compared to HC/AC ratio in predicting asymmetric IUGR.

Keywords: Fetal cerebellum, Geatationl age, TCD/AC, Ultrasonography

INTRODUCTION

A healthy newborn is the goal of every expectant mother and her obstetrician. A fetus with an estimated weight below the 10th percentile for a given gestational age is considered to have fetal growth restriction (FGR) also called as intrauterine growth restriction (IUGR). It is estimated that the incidence of FGR is 3-10%. The growth potential of the fetus is dictated, on one hand by the fetal genome and on the other hand by the intrauterine environment. The intrauterine environment is under the influence of both maternal and placental factors.[1]

In order to prevent such mal occurrence during pregnancy clinicians has developed various methods for assessing the fetal growth in utero. Ideal and best investigation that is simple, reliable, accurate, non invasive and safe is prenatal ultrasonography. An accurate determination of gestational

age, identification of congenital anomalies, evaluation of fetal growth and assessment of fetal wellbeing and maturity are all possible due to availability of ultrasound.[2]

The most commonly used parameters to evaluate fetal growth are biparietal diameter (BPD), HC, AC and femur length (FL). Out of all these parameters best predictor of FGR is AC. But all these parameters can be correlated if the gestational age is accurately known. But uncertainty of the gestational age makes the differentiation between the appropriate for gestational age and the small for gestational age fetus difficult.[3]

Trans-cerebellar diameter (TCD) is the maximum transverse diameter of the fetal cerebellum. The fetal cerebellar hemispheres are located in the posterior cranial fossa which is resistant to the external pressure and growth deviations, thus making it a better indicator for the determination of gestational age.[4] Conversely, fetal AC is the earliest affected parameter in the process of impaired fetal growth. Thus, a ratio of TCD/AC which is gestational age independent is very useful in predicting IUGR. HC is another parameter which remains minimally affected by external pressure effects causing deformation of fetal head and by growth alterations. HC/AC ratio is another gestational age independent parameter which may be used in predicting IUGR.

Fetal cerebellum can be visualized as early as 10- 11 weeks by USG. From second trimester onwards, it grows with the linear correlation with gestational age.[5] This study was primarily planned to study the efficacy of TCD/ AC ratio and HC/ AC ratio in prediction of asymmetrical IUGR.

Aim

Aim of the study was to compare the accuracy of TCD/AC ratio with HC/AC ratio in predicting asymmetrical FGR.

Ultrasound appearance of cerebellum

Ultrasound appearance of the fetal cerebellum has a characteristic appearance that changes gradually in shape and echogenicity with advancing gestational age. Based on its shape, it has been graded into 3 types-grade-I (Figure 1 A) with eyeglasses at 12-16 weeks, grade-II (Figure 1 B) with dumbbell at 16-18 weeks and grade-III (Figure 1 C) with fan shape during third trimester and early postnatal life. These images show the gradual increase in echogenicity-from hypoechoic to slightly echoic finally to homogeneously hyperechoic in third trimester.

Cerebellar view

This view is clearly obtained by rotating the tranducer in the axial plane centered on the thalamus to show the cerebellar hemispheres. This view clearly depicts the cerebellum, cistern magna, the cavum septi pellucid and frequently, the anterior horns of the lateral ventricles.

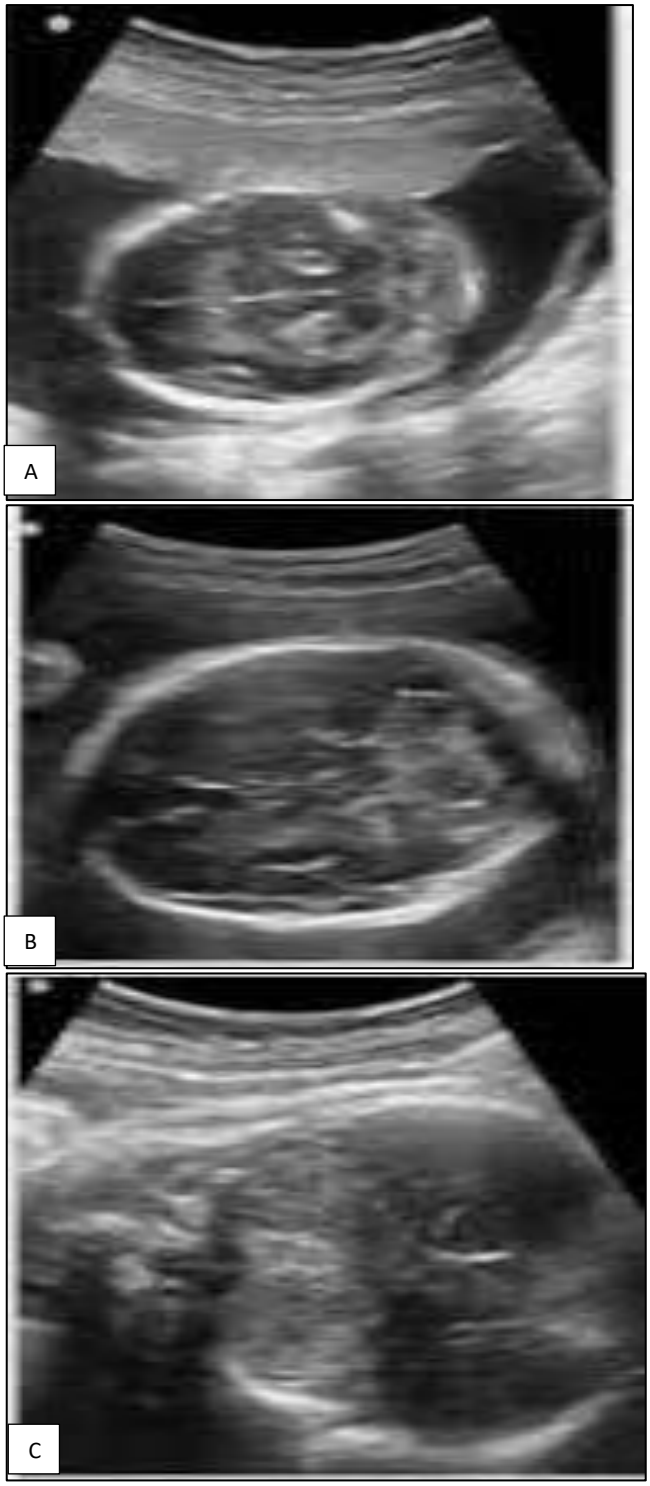

Figure 1 (A-C): Grade I cerebellum-transcerebellar US view at 21 weeks gestation. Cerebellar hemispheres are cystic and show "a pair of eyeglasses" appearance. Grade II cerebellum-transcerebellar US view at 31 weeks gestation. Cerebellar hemispheres are oval and echogenic with "dumbbell-like" outline and the vermis has developed and grade III cerebellum-transcerebellar US view at 35 weeks gestation. Cerebellar hemispheres show "fan" shape and the whole cerebellum is homogeneously echogenic.

TCD

It is measured by placing callipers on the outer margins of cerebellum visualised in the above-mentioned plane.

HC

It is measured on the axial plan transversing thalami and cavum septum pellucidum with the transducer perpendicular to the central axis of the head. The cerebral hemispheres and calvaria should appear asymmetric and the cerebellar hemispheres should not be visible on this plane. The ellipse must be drawn with callipers around the outer aspects of the calvarium (Figure 2).

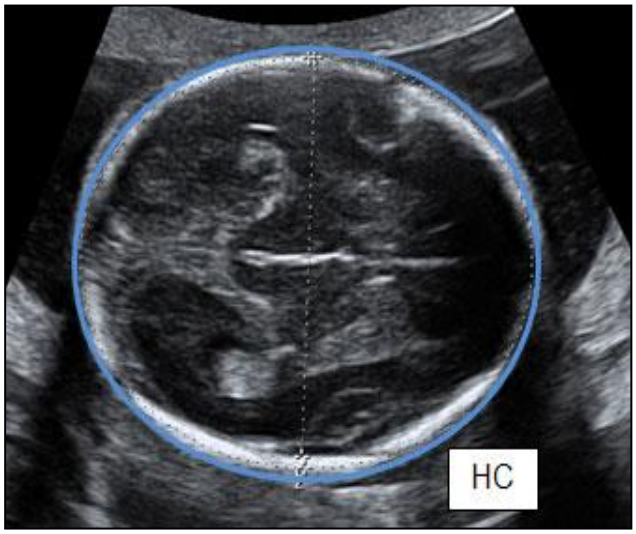

Figure 2: HC measurement.

AC

AC is measured on axial plane containing fetal stomach bubble, umbilical vein and portal sinus. The callipers should be on the skin surface (Figure 3).

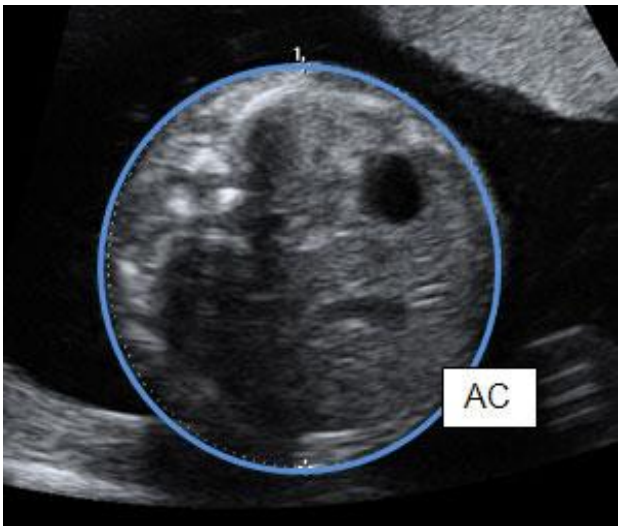

Figure 3: AC measurement.

TCD/AC ratio

The cerebellum is located in the posterior cranial fossa well protected within the strong bones (petrous temporal and occipital bones) forming it, thus withstanding the extrinsic pressure better than the parietal bones.[6] It is relatively resistant to hypoxia due to brain sparing phenomenon leading to maintained blood supply to brain at the cost of systemic supply.[7] AC reflects the size of the liver (which correlates with the degree of fetal malnutrition) as well as the volume of subcutaneous plane. Therefore, AC predicts growth restriction more accurately than either BPD or FL.[8] However, of the four basic ultrasound measurements the AC generally had the largest reported variability. This is partly attributed to the fact that AC is more acutely affected by growth disturbances than the other basic parameters.[9] Hence, a morphometric ratio of the TCD/AC can be used to the predict asymmetrical IUGR.

HC/AC ratio

This ratio compares the preserved organ in the malnourished fetus, the brain, with the most compromised, the liver and is of significant value in identifying asymmetric IUGR fetuses.

METHODS

A prospective study consisting of 200 antenatal women in two groups (100 as control and 100 as clinically suspected IUGR) was conducted in government Raja Mirasudhar hospital, Thanjvur medical college, Thanjavur during the period of January 2018-December 2018 (12 months) after ethical clearance. Singleton intrauterine pregnancies >30 weeks and cases with clinical suspicion of IUGR with a discrepancy of 4 weeks in period of gestation and clinical examination were included in the study. The exclusion criteria include multiple pregnancy, poly hydramnios, anomalies, irregular menstrual periods and symmetrical IUGR. TCD/AC ratio and HC/ AC ratio of normal group were calculated and mean and standard deviation values were compared between those groups. The values more than 2SD are labelled as IUGR (sonographically). Then those clinically suspected IUGR cases are followed up to delivery and post-delivery new Ballord score and CAN score (clinical assessment of nutritional status at birth) were calculated. Number of ultrasonographically detected IUGR compared with number of true IUGR and accuracy of both TCD/AC ratio and HC/AC ratio was compared.

Statistical methods

The TCD/AC and HC/AC ratios were correlated with advancing gestational age to know if these morphometric ratios were related to gestational age. Sensitivity, specificity, positive predictive value (PPV) and diagnostic accuracy for TCD/AC and HC/AC ratios in evaluating IUGR foetuses were calculated

In the present study, the age, weight and height of patients were analyzed statistically using the Student 't' test.

RESULTS

Both groups comprised of 100 patients each between 19 to 36 years of age with mean age of 26.27 years in group A and 26.07 in group B. There was no statistically significant difference in the age between the two groups (p=0.711) (Table 2). The mean BMI in the group B was 28.97 in patients with normal neonatal growth and 28.01 in patients with IUGR. There was significant difference between the two groups in BMI distribution patients with IUGR babies had lower BMI (p=0.0002).

Table 1: Distribution of BMI, age and parity in the group B participants.

Parity in group B	Normal baby	IUGR baby	Total	P value
Mean age of mothers ± SD (Years)	26.27± 3.581	26.07± 4.051		0.711
Mean BMI ± SD (kg/m^2)	28.97± 1.539	28.01± 2.007		
Primi	14	20	34	0.511
Second gravida	16	22	38	0.456
Third gravida	12	16	28	0.574

Out of 100 patients in group B, there were no statistically significant difference between the two subgroups of patients delivering normal growth baby and IUGR baby, with respect to parity (Table 2).

Table 2: Distribution of NICU stay among the study group B.

Group B	Normal, (n=44) (%)	True IUGR, (n=56) (%)	Significance
Yes	1 (2.27)	45 (80.36)	P<0.001
No	43 (97.72)	11(19.64)	

Out of 46 NICU admissions, 40 had been detected as IUGR by TCD/AC ratio and among the entire fetus detected as IUGR by TCD/AC (n=62), 40 neonates required NICU stay.

Table 3: Predictors of NICU admission.

TCD/AC	No NICU stay	NICU stay	Total
IUGR	22	40	62
No IUGR	32	6	38
Total	54	46	100

Hence, low TCD/AC ratio has relative risk of 4.08 for NICU admission of the neonate (p=0.0003).

In our test group mean APGAR score was 7 at 1 minute and 8 at 5th minute in normal growth group, and 6.6 at 1 minute and 7.8 at 5th minute in IUGR group (Figure 4).

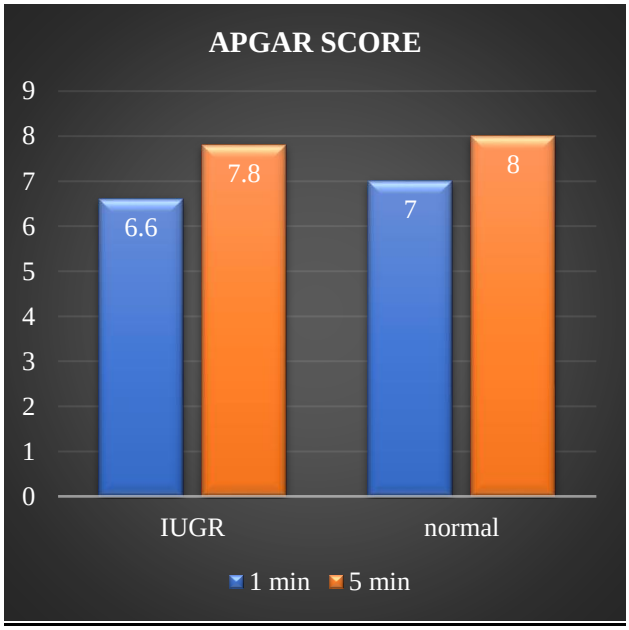

Figure 4: APGAR.

Table 4: Comparison of various parameters of TCD/AC with HC/AC in diagnosing asymmetrical IUGR.

Parameters	TCD/AC (%)	HC/AC (%)
Sensitivity	83.93	73.21
Specificity	65.91	40.91
PPV	75.81	61.19
NPV	76.32	54.55
Diagnostic accuracy	76	59

DISCUSSION

IUGR due to uteroplacental insufficiency or asphyxia leads to centralisation of fetal blood flow with sparing of brain at the expense of other body parts.[9] Various primate models have proven that the blood flow to cerebellum is maintained even in acute asphyxia.[10] Cerebellum is least affected and TCD remains one of the most reliable parameter for measurement of true gestational age.[10,11] IUGR leads to early depletion of hepatic glycogen and subcutaneous fat. This leads to early decrease in AC.[12] Hence, AC is considered sensitive parameter for early detection of IUGR.[9,12-14] However, accurate date of LMP or prior 1st trimester dating scan is necessary for prediction of IUGR.[13]

In this study, the relationship of transverse cerebellar diameter to gestational age was considered in asymmetric IUGR foetuses only. Dhumale et al and Malik et al found that TCD/AC ratio was fairly constant throughout

gestation and found it to be good tool to diagnose asymmetric IUGR in those with ratio exceeding 2SDs.[15,16] Bansal et al in their study involving 650 pregnant patients between 14 to 40 weeks, found TCD (mm) equivalent to GA of fetus.[17] The Karl Pearson correlation coefficient between GA and TCD was 0.972305 with p<0.001 (highly significant).

Sharma et al conducted a prospective study on 100 normal and 52 IUGR cases where TCD was correlated with other parameters.[18] This revealed significant correlation between TCD and period of gestation with a correlation co efficient of +0.9612 in normal pregnancies. GA predicted by all parameters was within normal range. In IUGR pregnancies all parameters including BPD, HC and FL were sowing disparity of >3 weeks except TCD which in both groups were nearer to GA. Lee et al observed that TCD/AC ratio is fairly constant throughout gestation and found it to be a good biometry to diagnose asymmetric IUGR.[19] They also pointed out that this ratio is not sensitive in cases with symmetric growth retardation where both TCD and AC may be equally affected. Benson et al and Divon et al in their studies have shown good diagnostic validities for HC/AC ratio in predicting asymmetric IUGR.[20,21]

On comparing various parameters of TCD/AC in diagnosing asymmetrical IUGR with other studies, resulted significant relationships between transverse cerebellar diameter and gestational age, AC and HC. The 26% of the small-for-gestational age (SGA) foetuses showed a reduced TCD whereas 82% of them showed raised TCD/AC values and sensitivity of 52% for the detection of intrauterine growth retardation.[7,22] The TCD/AC ratio identified growth retardation with a lower sensitivity of 71%, higher specificity 77%, similar positive predictive value of 79% and lower negative predictive value of 68%.[23] Dhumale et al have also assessed normal fetal growth with TCD/AC ratio and gestational ratio ranging from 18 to 34 weeks and found to be constant with a mean of 13.56±1.21 (SD).[24] The study findings was found to be consistent with the findings of the Meyer et al.[25]

On comparing various parameters of HC/AC in diagnosing asymmetrical IUGR with various studies like Belizan et al showed elevated cut off values with 82% sensitivity, 94% specificity, 62% positive predictive value and 98% negative predictive value.[26] The study findings of PPV was found to be contradictory with the findings of Divon et al, Meyer et al and Kurjak et al with positive predictive values of 67%, 75.6% and 80% respectively.[25,27,28]

Limitations

As ultrasound is operator dependent, precise measurements of the parameters were relied upon single operator which reduces the inter operator variability. Adequate visualization of foetal cerebellum in third trimester was limited because of dense shadowing in posterior fossa.

CONCLUSION

As the TCD/AC ratio is constant throughout the pregnancy, it is a gestational age independent parameter, can diagnose FGR in antenatal women with unknown gestational age. Hence, TCD/AC ratio can be a screening test to diagnose FGR in the antenatal period. So, that early intervention could be attempted to improve the perinatal outcome. However, TCD/AC ratio had a better diagnostic validity and accuracy compared to HC/AC ratio, in predicting asymmetrical IUGR.

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Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

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