

# Transverse Cerebellar Diameter as an Independent Predictor of Gestational Age in Normal and IUGR Pregnancies

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## ABSTRACT

**Introduction:** Assessment of fetal maturity is quintessential in deciding whether to continue the pregnancy or terminate it, in case of complications such as fetal distress, pregnancy induced hypertension, diabetes, IUGR and Rh incompatibility. The sundry parameters which are currently being used to estimate GA include the Biparietal Diameter (BPD), Head Circumference (HC), Abdominal Circumference (AC) and Femur Length (FL). However, with advancing period of gestation, the variability in assessing the GA with these parameters keeps inflating. Transverse cerebellar diameter (TCD) is a new parameter for determining gestational age. TCD measurement is highly accurate in assessment of gestational age (GA), especially in cases where the last menstrual period (LMP) is not known. This study was done to evaluate the accuracy of transverse cerebellar diameter in assessment of fetal age in normal and IUGR pregnancies.

**Material and Methods:** This prospective cross-sectional study was conducted in the Department of Radiodiagnosis, Rohilkhand Medical College and Hospital Bareilly, U.P. from November 2017 to October 2018. The cases for the study included 100 pregnant women of gestational age 15 to 40 weeks who attended antenatal clinic at the Department of Obstetrics and Gynaecology, Rohilkhand Medical College & Hospital, Bareilly, Uttar Pradesh.

**Results and Conclusion:** TCD showed a good correlation with other parameters like BPD, HC, AC and FL in normal pregnancies. TCD was seen to demonstrate the best correlation with GA as compared with other parameters in normal pregnancies ( $r = 0.993$ ,  $p < 0.001$ ) as well as IUGR pregnancies ( $r = 0.995$ ,  $p < 0.001$ ).

**Keywords:** Transverse Cerebellar Diameter, Gestational Age, IUGR Pregnancies

## INTRODUCTION

Accurate dating of pregnancy is significantly essential in management of the obstetric patient, as many clinical decisions during pregnancy are dependent on gestational age. Assessment of fetal maturity is quintessential in deciding whether to continue the pregnancy or terminate it, in case of complications such as fetal distress, pregnancy induced hypertension, diabetes and Rh incompatibility. The sundry parameters which are currently being used to estimate gestational age (GA) include the Biparietal Diameter (BPD), Head Circumference (HC), Abdominal Circumference (AC) and Femur Length (FL).<sup>1-3</sup> However, with advancing period of gestation, the variability in assessing the GA with these parameters keeps inflating.<sup>4-8</sup>

Transverse cerebellar diameter (TCD) is a new parameter for determining gestational age. Cerebellum is able to withstand the deformation caused by extrinsic pressure as it is surrounded by the dense petrous ridges and the occipital bone in the posterior cranial fossa.<sup>9</sup> TCD measurement is

highly accurate in assessment of GA, especially in cases where the last menstrual period (LMP) is not known.<sup>10</sup>

Intrauterine growth restriction (IUGR) or Fetal growth restriction (FGR) is a term used to describe a fetus that is abnormally small for gestational age, usually resulting from complications of placental insufficiency. The term small for gestational age (SGA) is used to describe a neonate whose weight is less than 10<sup>th</sup> percentile for gestational age. The terms fetal growth restriction and small for gestational age are often used interchangeably.<sup>11</sup>

Antenatal diagnosis of IUGR is vital because of its association with increased perinatal morbidity and mortality including in-utero demise, brain injury, fetal distress, neonatal hypothermia, hyperbilirubinemia, hypoglycemia, and decreased immune function.

IUGR due to uteroplacental insufficiency or asphyxia results in centralization of blood flow in the fetus with sparing of brain at the expense of other body parts.<sup>12</sup> Cerebellum is least affected even in acute asphyxia as the blood flow to the cerebellum is maintained.<sup>13</sup>

IUGR leads to early exhaustion of hepatic glycogen and subcutaneous fat resulting in decrease in AC. Hence, AC is contemplated as a sensitive parameter for early detection of IUGR.<sup>14-18</sup>

This study was done to evaluate the accuracy of transverse cerebellar diameter in assessment of fetal age in normal and IUGR pregnancies.

## MATERIALS AND METHODS

This prospective cross-sectional study was conducted in the Department of Radiodiagnosis, Rohilkhand Medical College and Hospital Bareilly, U.P. from November 2017 to October 2018. The cases for the study included pregnant women of gestational age 15 to 40 weeks who attended antenatal clinic at the Department of Obstetrics and Gynaecology, Rohilkhand Medical College & Hospital, Bareilly, Uttar Pradesh. 100 cases were included in the study out of which 78 were normal pregnancies and 22 were clinically suspected IUGR pregnancies.

### Inclusion criteria

- Pregnancies of 15-40 weeks gestation with known last menstrual period.
- Clinically suspected intra uterine growth restriction.

### Exclusion criteria

- Congenital malformations
- Multiple pregnancies

### Methods of collection of data

The patient was examined in supine position, with a curvilinear array real time B-mode ultrasound machine "GE LOGIC V5" equipped with a 3.5 Mhz transducer. The conventional biometric measurements like BPD, HC, AC and FL were obtained along with TCD.

BPD was measured from outer to inner margin of the calvarium measured on an axial image of the fetal head is obtained at the level of the paired thalami, third ventricle, and cavum septum pellucidum.

HC was measured by using elliptical calipers to outline the outer edge of the skull on the same trans-axial view of the fetal head as the BPD.

AC was measured at the level of the stomach and intrahepatic portion of the umbilical vein on an axial image of the fetal abdomen. The elliptical calipers are placed outlining the outer surface of the skin around the abdomen.

FL was measured by placing the calipers at either end of the ossified diaphysis of the femur (fig-1).

Cerebellum is visualized as two lobules on either side of the midline in the posterior cranial fossa. Fetal TCD was measured after identifying the cerebellum in the posterior fossa by means of rotation of the transducer to approximately 30° from the trans-axial plane that identifies the thalamus, the cavity of the septum pellucidum, third ventricle and cistern magna. The electronic calipers were placed on the outer margins of the cerebellar hemispheres and the widest measurement was taken (fig-2).

GA and estimated fetal weight (EFW) were derived from the measured biometric parameters by the ultrasound machine. Clinically suspected IUGR cases were confirmed for fetal growth restriction in cases where the estimated fetal weight

was below the 10<sup>th</sup> percentile for that gestational age

## STATISTICAL ANALYSIS

Appropriate statistical methods were used for analysis using SPSS version 25 statistical package for windows. Graphs and tables were generated using Microsoft Word and Excel.

TCD was compared with BPD, HC, AC, FL values in normal pregnancies using Karl Pearson's correlation. The measured TCD, BPD, HC, AC and FL values were also compared with GA using Karl Pearson's correlation in both normal and IUGR pregnancies. Results having P < 0.05 are considered significant.

## RESULTS

In 78 normal pregnancies, good correlation was observed between TCD and other biometric parameters (Table 1).

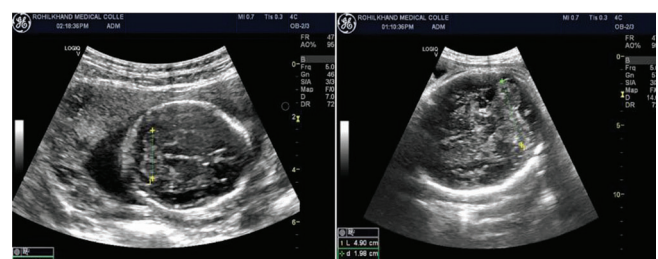
Each parameter (BPD, HC, AC, FL and TCD) revealed a strong relationship with GA and TCD was seen to demonstrate the best correlation with GA (Table 2). Scatter diagrams were obtained and polynomial equations were derived to show relationship between GA and other

Parameters compared	'r'	p value
TCD vs BPD	0.971	<0.001
TCD vs HC	0.966	<0.001
TCD vs AC	0.986	<0.001
TCD vs FL	0.978	<0.001

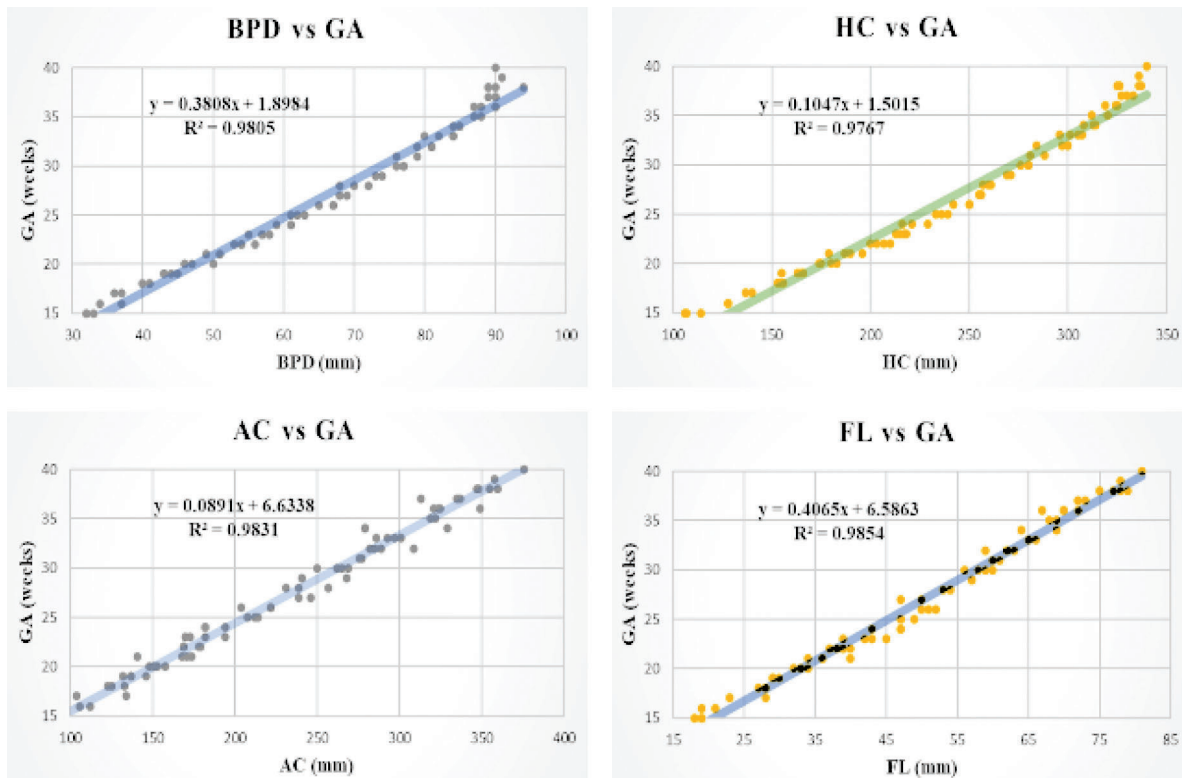
**Table-1:** Correlation of TCD with BPD, HC, AC and FL in normal pregnancies.



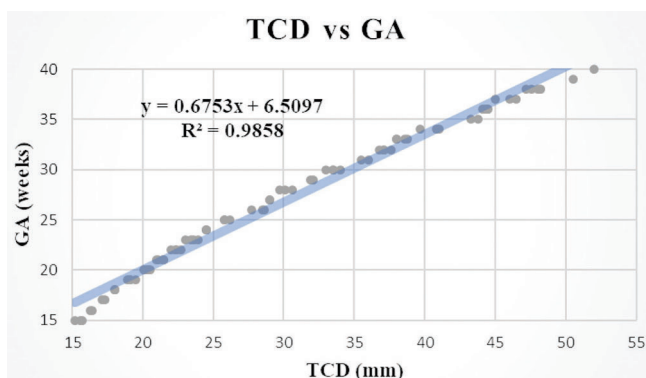
**Figure-1:** Ultrasonographic measurement of BPD, HC, AC and FL.



**Figure-2:** Ultrasonographic measurement of Transverse Cerebellar Diameter in second and third trimester.



**Figure-3:** Scatter diagram showing correlation of GA with BPD, HC, AC and FL.



**Figure-4:** Scatter diagram showing correlation between GA and TCD.

Parameter	IUGR Cases with values below 10 <sup>th</sup> percentile	IUGR Cases with values within normal range
BPD	10	12
HC	9	13
AC	22	0
FL	9	13
TCD	2	20

**Table-4:** IUGR cases with BPD, HC, AC, FL and TCD values less than 10th percentile on comparison with normograms derived from normal pregnancies.

Parameters compared	'r'	p value
GA vs BPD	0.990	<0.001
GA vs HC	0.988	<0.001
GA vs AC	0.991	<0.001
GA vs FL	0.992	<0.001
GA vs TCD	0.993	<0.001

**Table-2:** Correlation of GA with BPD, HC, AC, FL and TCD in normal pregnancies.

Parameters compared	'r'	p value
GA vs BPD	0.825	<0.001
GA vs HC	0.856	<0.001
GA vs AC	0.993	<0.001
GA vs FL	0.878	<0.001
GA vs TCD	0.995	<0.001

**Table-3:** Correlation of GA with BPD, HC, AC, FL and TCD in IUGR pregnancies.

parameters (fig-3,4).

Normograms were derived for BPD, HC, AC, FL and TCD from the sonographically measured data in normal pregnancies.

In 22 IUGR pregnancies, TCD was seen to demonstrate the best correlation with GA ( $r = 0.995$ ) in IUGR pregnancies. The correlation was observed to be less strong between GA and other parameters as compared to TCD (Table 3).

On comparison with the normograms derived from normal pregnancies, it was observed that 10 out of 22 IUGR cases were below the tenth percentile for BPD, 9 cases were below the tenth percentile for HC and 9 cases were below the tenth percentile for FL. AC was found to be below the tenth percentile in all the IUGR cases. Only in 2 out of 22 IUGR cases, the value of TCD was noted to be below the tenth percentile (Table 4).

## DISCUSSION

Accurate gestational dating is of prime significance and forms the mainstay for management of pregnancies especially in

fetuses with intrauterine growth restriction.

The considerable variability in the length of the follicular phase of the menstrual cycle and the inconstant timing of ovulation and fertilization in relation to the LMP, as well as the often inaccurate method of determining LMP by women, make the LMP a very insecure basis for estimating gestational age.<sup>19</sup>

The biometric parameters that are routinely used for estimation of gestational age are BPD, HC, AC and FL. However, each of these parameters are non-specific with limitations in setting of inconsistency between clinical and ultrasonographic age. These parameters are also influenced by fetal growth, configuration of skull and external compressive forces as in certain abnormal presentations.<sup>20</sup>

Cerebellum 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.<sup>21</sup> TCD is a unique parameter for estimating the gestational age of fetus.

In this study, a perfect linear relationship was found between the cerebellar growth and gestational age (in weeks) from 15 weeks of gestation onwards. TCD and gestational age showed a good correlation between them ( $r = 0.993$ ,  $p$  value  $< 0.001$ ).

Reece et al found curvilinear relationships between the transverse cerebellar diameter, and the gestational age, the biparietal diameter, and the head circumference and inferred that cerebellar measurement is independent of the shape of fetal head and may be used in the estimation of gestational age.<sup>22</sup> In our study, TCD and gestational age showed a good correlation ( $r = 0.993$ ,  $p$  value  $< 0.001$ ). A good correlation was also observed between TCD and BPD ( $r = 0.971$ ,  $p$  value  $< 0.001$ ) and between TCD and HC ( $r = 0.966$ ,  $p$  value  $< 0.001$ ). TCD can be used where it is difficult to measure BPD or in cases where there are variations in size and shape of head.

Malik et al compared the results of predicted gestational age by BPD, FL and AC with actual gestation and observed that gestational age measured by TCD consistently correlated with that measured by BPD, FL and AC.<sup>23</sup> This correlation has also been observed in this study between TCD and FL ( $r = 0.978$ ,  $p$  value  $< 0.001$ ) and between TCD and AC ( $r = 0.986$ ,  $p$  value  $< 0.001$ ).

The major factor for increase in the fetal weight after 28 weeks of gestation is fetal fat gain. There is deposition of fat in the subcutaneous tissue of the abdomen along with glycogen deposition in the liver. In cases of IUGR, the depletion of hepatic glycogen and subcutaneous fat stores leads to an early decrease in the AC and a consequent decrease in the fetal weight.<sup>24,25</sup>

Hadlock et al observed 30 growth-restricted fetuses and found AC to be the most sensitive indicator of fetal growth restriction. Estimated fetal weight was also found to be a relatively sensitive indicator of fetal growth restriction in this study.<sup>14</sup>

Similar observations were made in our study where both AC and EFW were below the 10<sup>th</sup> percentile value for gestational age in all the 22 IUGR cases.

In normal pregnancies, there is high resistance circulation

with continuous forward flow in the fetal brain which is also seen throughout the cardiac cycle. When fetal hypoxemia is present in growth restriction, blood flow redistribution occurs, a phenomenon known as the "brain-sparing reflex", to compensate for the decrease in available oxygen. There is preferential redistribution of blood flow to the brain, heart, and adrenal glands at the expense of the peripheral circulation. This phenomenon is seen in asymmetrical IUGR thereby leading to a normal or a near normal BPD and HC.<sup>26</sup> Similar observations were made in our study in cases of asymmetrical IUGR, where BPD and HC were found close to those of normal pregnancies of similar gestational age.

Mona Al Sayed Elkafrawy et al showed a highly significant correlation between transverse cerebellar diameter and gestational age in normal and IUGR fetuses.<sup>23</sup>

Our study shows that TCD is a good marker for estimation of gestational age as it correlates well with significant value ( $r = 0.995$ ,  $p$  value  $< 0.001$ ). On comparison with the normograms derived from normal pregnancies, it was observed that 10 out of 22 IUGR cases were below the tenth percentile for BPD, 9 cases were below the tenth percentile for HC and 9 cases were below the tenth percentile for FL. The value of TCD was noted to be below the tenth percentile in only 2 cases. Thus, TCD remains relatively unaffected and is superior to other growth parameters in cases of IUGR pregnancies.

Hill et al studied 44 SGA fetuses, found reduced TCD in 59% cases, and inferred that TCD cannot be used as a parameter to estimate gestational age in SGA fetuses.<sup>27</sup>

Lee et al investigated 19 SGA fetuses and concluded that TCD is a reliable predictor of gestational age in fetuses with asymmetric IUGR, but not in fetuses with symmetric IUGR.<sup>28</sup>

The results in our study are however discordant with those of the above two studies. We observed that TCD reliably predicted the true gestational age in 66.67% of symmetric IUGR cases and in all the cases (100%) of asymmetric IUGR fetuses.

## CONCLUSION

TCD is a reliable method of determining gestational age in normal pregnancies at 15 to 40 weeks of gestation. It can be used in cases where it is difficult to measure BPD (like in breech presentation) or in cases where there are variations in size and shape of head (like excessive moulding and dolicocephaly). Also, TCD is unconstrained with problems encountered with the measurement of FL (like inclusion of unossified epiphysis). TCD is a valuable parameter to estimate the gestational age in IUGR fetuses and is superior to other parameters.

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