Accuracy of Transcerebellar Diameter at the Third Trimester in Estimating the Gestational Age in Singleton Pregnancy

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Abstract

Objective: The aim of the current study was to evaluate the accuracy of fetal transcerebellar diameter (TCD) in estimating the gestational age at the third trimester of pregnancy.

Methods: The current diagnostic test accuracy study was conducted at the Special Care Center for the Fetus at Ain Shams University Maternity Hospital during the period between September 2011 and December 2012. The study included singleton pregnant women, during their last trimester (at gestations between 28 and 41 weeks). Transabdominal ultrasonography was performed to all included women for measuring the biparietal diameter (BPD), femur length (FL) and TCD.

Results: A total of 150 women were included in the current study. The mean gestational age was 35.17 ± 3.56 weeks (range: 28-41 weeks). Bland-Altman analysis of agreement showed a non-significant difference between gestational age estimated by last menstrual period (LMP)/crown-to-rump length (CRL) and the estimated gestational age using each of TCD and BPD and/or FL, in all included women, and when analysis was split above and below 36 weeks of gestation.

Conclusion: TCD seems to be as accurate as BPD and FL in estimating the gestational age in both term and preterm late pregnancy.

Key Words: Transcerebellar diameter – Biparietal diameter – Estimation of gestational age.

Introduction

The conventional methods used to estimate gestational age are date of onset of the last menstrual period (LMP), clinical assessment of the fundal height and fetal weight, and ultrasonographic fetal biometry [1]. Naegle’s rule is the most common, and, if reliable, an accurate method of pregnancy dating. The expected date of delivery (EDD) is calculated by counting back three months from and adding seven days to the onset of LMP. Estimation of the gestational age based on menstrual dates is, sometimes however, erroneous or inaccurate. Some pregnant women are not sure of their menstrual dates or do not have regular 28-day cycles. In addition, bleeding in early pregnancy or a recent use of hormonal contraception may lead to incorrect assumption of the date of ovulation [2]. Clinical examination is inaccurate in estimating the GA. It may be affected by fetal growth disorders and liquor volume, and subject to errors due to maternal obesity or inter-and intra-observer variations [2]. Sonographic fetal biometry is a method devoted to the measurement of the several parts of fetal anatomy and their growth. Several diameters and circumferences have been studied concerning their correlation to the true gestational age. The most reliable diameters used in estimation of the GA in the second and early third trimester is the biparietal diameter (BPD); femur length (FL) is the most accurate for the late third trimester. The measurement of BPD in second trimester routine scan is performed in all good antenatal care centers [3]. The BPD is, however, subject to inaccuracy related to its affection by growth abnormalities of the fetal head e.g. in fetal growth restriction and also in congenital fetal malformations of the head or intracranial structures e.g. hydrocephalus [3]. The transcerebellar diameter (TCD) has been one of the most reliable ultrasound parameters for growth. The TCD was the shown to be a reliable parameter that is significantly correlated with gestational age by the end of the second trimester [4]. There is relative preservation of normal cerebellar growth even in fetal growth restriction and a similar rate of growth in both singleton and multiple pregnancies [5]. The aim of the current study was to evaluate the accuracy of fetal TCD in estimating the gestational age at the third trimester.

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Material and Methods

The current diagnostic test accuracy study was conducted at the Special Care Center for the Fetus at Ain Shams University Maternity Hospital during the period between September 2011 and December 2012. The study protocol was in agreement with the Helsinki Declaration for Ethical Medical Research and was approved by the Ethical Research Committee, Obstetrics and Gynecology Department, Ain Shams University. The study included singleton pregnant women, during their last trimester (at gestations between 28 and 41 weeks). The gestational age was calculated using the Naegle’s rule according to the onset of the last menstrual period (LMP) and confirmed by a first trimester scan measuring the crown-to-rump length (CRL). Women who had a discordance of more than 2 weeks between their menstrual dates and sonographic dates, those who had fetal growth abnormalities and those who had congenital malformations were not included in the study.

Transabdominal ultrasonography was performed to all women while women are in a slightly tilted position with the head of the bed raised 30 degrees and with a small pillow under the right loin. Ultrasonography was performed using Medison SonoAce R5 (Samsung Medison, Seoul, Korea) with a 3.5-MHz transabdominal convex transducer. All scans were performed by a single 3-year experienced sonographer (one of the authors: Aboulfath A.). All measurements were taken three times; the averages of which were noted. The following measurements were taken:

Biparietal diameter (BPD):

The lateral ventricles view was obtained: A rugby-football-shaped skull, rounded at the back (occiput) and more pointed at the front (synicpup), a long midline equidistant from the proximal and distal scale echoes, the cavum septum pellicidum bisecting the midline one-third of the distance from the synicpup to the occiput, the two anterior horns of the lateral ventricles symmetrically placed about the midline, and all or part of the posterior horns of the lateral ventricles symmetrically placed about the midline. This BPD includes the thickness of only the upper parietal bone (outer to outer measurement).

Femur length (FL):

Measuring the femur was ideally undertaken after the abdominal circumference (AC) has been measured. Slide the probe caudally from the AC section until the iliac bones were visualized. At this point, a cross-section of one or both femurs was usually seen. The upper femur should be selected for measurement. To ensure that full length of the femur was seen and that the section was not oblique, soft tissue should be visible beyond both ends of the femur and the bone should not appear to merge with the skin of the thigh at any point. The measurement of the femur was made from the center of the “U” shape at each end of the bone. This represents the length of the metaphysis.

Transcerebellar diameter (TCD):

The transthalamic view of BPD was obtained then the probe was rotated slightly downwards, towards the fetal neck. The posterior horns of the lateral ventricles would disappear from view to be replaced by the cerebellum. The TCD was measured at 90 degree to the long axis of the cerebellum across its widest point, using the outer to outer method (Fig. 1).

Sample size justification:

Sample size was calculated setting the power \((1 - \beta)\) at 0.8 and the type-1 error \((\alpha)\) at 0.05. Data from a previous relevant study \([7]\) showed that correlation coefficient between TCD and estimated gestational age was 0.97. Calculation according to these values produced a minimal sample size of 150.

Statistical methods:

Statistical analysis was performed using GraphPad© Prism© version 6.0 (GraphPad© Software, La Jolla, California, USA). The Bland-Altman method was used to evaluate agreement among gestational ages calculated using the three different assessment tools LMP/CRL, BPD/FL and TCD. Agreement was presented in terms of biases, their standard deviation and the 95% limits of agreement.

Results

A total of 150 women were included in the current study. The mean age was 27.34 ± 4.86 years (range: 19-38 years). The median parity was 1 (range: 0-4; interquartile range [IQR] was 0-2). The mean gestational age by LMP/CRL was 35.17 ± 3.56 weeks (range: 28-41 weeks). Of the included 150 women, 80 (53.3%) were at or above 36 weeks of gestation, while 70 (46.7%) were at less than 36 weeks of gestation.

There was a significant correlation between estimated gestational age by LMP/CRL and each of BPD, FL, and TCD; the latter having the highest correlation coefficient \((r=0.534, p=0.009;\ r=0.662, p=0.001;\ r=0.692, p<0.001, \text{ respectively})\).

Bland-Altman analysis of agreement showed a non-significant difference between gestational age estimated by LMP and/or CRL and the estimated gestational age using each of TCD and BPD.
and/or FL, in all included women, and when women were categorized at or above 36 weeks of gestation and below 36 weeks of gestation (Table 1, Fig. 2).

TCD: Estimated gestational age using sonographic transcerebellar diameter.  
LMP/CRL: Estimated gestational age using last menstrual period and/or crown-to-rump length.  
BPD/FL: Estimated gestational age using sonographic biparietal diameter and femur length.

Fig. (1): Bland-Altman plot charts for analysis of agreement between estimated gestational ages using measured tools.
(A): 26 years old, para 0+1, pregnant at 33 weeks of gestation.

(B): 31 years old, para 2, pregnant at 40 weeks of gestation.

(C): 28 years old, primigravida, pregnant at 31 weeks of gestation.

Fig. (2): Transabdominal ultrasonography of the fetal head at the transcerebellar plane for measuring the TCD.

Table (1): Analysis of agreement between estimated gestational ages using measured tools.

<table>
<thead>
<tr>
<th></th>
<th>All women</th>
<th>&gt;36 weeks of gestation</th>
<th>&lt;36 weeks of gestation</th>
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<tbody>
<tr>
<td></td>
<td>Bias (SD)</td>
<td>95% Limits of agreement</td>
<td>Bias (SD)</td>
</tr>
<tr>
<td>TCD vs. LMP/CRL</td>
<td>-0.047 (1.22)</td>
<td>-2.44 to 2.35</td>
<td>0.501 (1.33)</td>
</tr>
<tr>
<td>BPD/FL vs. LMP/CRL</td>
<td>-0.060 (1.24)</td>
<td>-2.49 to 2.38</td>
<td>0.429 (1.22)</td>
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</tbody>
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TCD estimated gestational age using sonographic transcerebellar diameter.
LMP/CRL estimated gestational age using last menstrual period and/or sonographic crown-to-rump length.
BPD/FL estimated gestational age using sonographic biparietal diameter and femur length.
Bland-Altman Analysis of Agreement.
Bias (SD) bias and its standard deviation.

Discussion

Accurate gestational dating is of paramount importance and the cornerstone for management of pregnancies, easily reproducible sonographic fetal biometric parameters for gestational dating are clinically important for the optimal obstetric management of pregnancies. This is especially true in determining timing of a variety of gestational tests, assessing adequacy of growth and timing of delivery for the optimal obstetric outcome [6]. In the current study, analysis of agreement showed insignificant differences between estimated gestational age using LMP/CRL and each of BPD/FL and TCD. Some authors stated that there may be a slight fluctuation in the growth curve of the fetal cerebellum, indicating multiple conditions that would lead to difficulties in measuring the TCD in late gestations [6,7], so we also analyzed the data before and after 36 weeks of gestation. The analysis of agreement for the study population before and after 36 weeks of gestation shows
similar agreement to that observed when all included women were entirely analyzed. Hill et al., reported that the TCD was within two standard deviations in only 40% of IUGR cases, and in 60% of cases was greater than two standard deviations below the mean. However, they included 44 consecutive singleton gestations with an estimated fetal weight of less than the 10th percentile, and it was unclear whether fetuses with chromosomal abnormalities were excluded [8]. Lee et al., reported that the TCD was a useful predictor of gestational age for fetuses with asymmetric, but not symmetric, growth restriction [9]. Vinkesteijn et al. [10], performed a retrospective, cross-sectional analysis of 360 normally developing fetuses between 17 and 34 weeks and 73 growth-restricted fetuses between 24 and 34 weeks gestation, and demonstrated that the TCD measurement is typically spared in cases of IUGR. Even in severe growth restriction, the TCD was only mildly affected. They also concluded that the second half of pregnancy is characterized by a more than twofold increase in fetal TCD. Smulian et al., stated that the perspective from a biological point of view confirms that cerebellar size is relatively unaffected by fetal growth disturbances. This is at variance with several other biometric parameters, especially abdominal circumference, which may be drastically altered by extremes of fetal growth [11].

Chavez et al. [12], observed that although there was a positive correlation between gestational age and fetal TCD throughout the assessed period (13-40 week of gestation), a number of studies have revealed that as the pregnancy approaches full term, there is a slight fluctuation in the growth curve of the fetal cerebellum, indicating multiple conditions that would lead to difficulties in measuring the TCD after the 36th week of gestation. Malik et al., stated that the fluctuation may be explained that when the fetal head goes into the pelvis, a relative reduction of the amniotic fluid around the cephalic pole occurs; a very close contact between the mother’s uterine musculature and cranial vault; a low penetration of the ultrasound beam into the posterior fossa of the fetus and the occipito-posterior position of the head of the fetus at the end of the gestation [7].

Chavez et al. [6], prospectively demonstrated that their institution-specific TCD nomogram was both reliable and accurate in predicting gestational age, even at extremes of fetal growth. Whereas the majority of data suggests that the TCD is extremely valuable when the gestational age is unknown or IUGR is suspected. Chavez et al., concluded that additional small improvements in accurate gestational dating can be achieved by incorporating the results of TCD with some combination of other fetal biometric parameters, including head circumference, biparietal diameter, and femur length, and recommended that TCD be used as an important sonographic biometric parameter in singleton IUGR and large fetuses for accurate prediction of GA [6]. In a recent study conducted on 228 Pakistani women at 36 weeks of gestation, the accuracy of TCD in corresponding to gestational age by LMP was higher than that of BPD (91.7% vs. 77.2%) [13]. In conclusion, TCD measured at the third trimester seems to be as accurate as BPD/FL in estimating the gestational age.

References


