Comparative study among Transcerebellar diameter, Biparietal diameter & Femur length for accurate determination of gestational age in 3rd trimester of pregnancy

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Abstract: Introduction and aim of the study: Many patients in our country come for their first antenatal care visit in their third trimester not remembering their LMP or their EDD which makes it very difficult for the physician to assess their gestational age. In this study we compare between the TCD, BPD and FL in accuracy of assessment of gestational age in the last trimester. **Patients and methods:** This study included 200 patients sure of their dates and fulfilling the inclusion criteria at the department of Obstetrics and Gynecology, Sayed Galal hospital Al azhar University starting from February till October 2017, the whole patients were pregnant in their third trimester and the Transcerebellar diameter and Biparietal diameter and Femur length were measured. **Results:** TCD was accurate within 1 week in 90% of the cases and was accurate within 3 days in 59% of the cases. While the FL was accurate within 1 week in 80% of the cases and was accurate within 3 days in 46% of the cases. Finally the BPD was accurate within 1 week in 60 % of the cases and within 3 days in 29.5% of the cases. **Conclusion:** TCD is the most accurate method for assessment of gestational age in third trimester followed by FL, and the least accurate is the BPD. Also by combining accuracy of TCD (90%) and that of FL (80%).

1. Introduction

The pregnancy date estimation is mandatory for all the pregnant women in order to have the expect time of delivery in which various tests will be done to achieve the estimated time. There are methods that used to determine the gestational age including menstrual history, clinical examination, in addition the ultrasonography. **(Mongelli et al 2005).**

Uncertain gestational age has been associated with adverse pregnancy outcomes including low birth weight, preterm delivery and perinatal mortality. The use of ultrasound has significantly improved the evaluation of fetal growth and development. Ultrasound is highly reliable in first and second trimester of pregnancy but reliability of any ultrasound method greatly diminishes as gestational age advances, in third trimester, reliability of any single ultrasound parameter alone is poor without correlation with other parameters **(Naseem et al., 2013; Satish Prssad and Likhitha, 2014).**

Many patients in our society due to low socio-economic standards come for their first antenatal visit in third trimester, Most of them are uneducated come from remote areas, Also many being lactating mothers unsure of their LMP or having irregular cycles because of non-availability of any dating scans or earlier ultrasound, it becomes very difficult to calculate their unknown dates, so many pregnancies are wrongly classified preterm or posterm. **(Satish Prssad and Likhitha, 2014).**

In third trimester, various ultrasound parameters including femur length which is the most commonly used parameter for the assessment of gestational age, it shows margin of error 2 - 3 weeks from the actual gestational age **(Naseem et al., 2014).**

Also the biparietal diameter (BPD) which is commonly used it also shows margin of error of 3 – 4 weeks from actual gestational age because of the large biological variations in fetal skull shape and size **(Naseem et al., 2013).**

Since the last decades, ultrasound parameter 'transcerebellar diameter (TCD)' is considered a more accurate and better predictor of gestational age in both normal and (IUGR) **(Julia et al., 2012).**

The fetal cerebellum is visualized as early as 10 – 20 post- menstrual weeks. Many studies approaches that TCD normogram predicts gestational age with accuracy of 90% in the third trimester **(Goel et al., 2010).**

Objective knowledge of the expected date of delivery (EDD) is essential in the management of all pregnancies particularly the method of delivery, management of high risk pregnancies, elective planned induction of labour and elective caesarean section in previous caesarean section deliveries. **(Salder et al., 2007).**

The obstetrician calculates the EDD as 280 days or 40 weeks from the first day of the LMP. In women with regular 28-day menstrual periods, the method is fairly accurate, but if cycles are irregular, substantial miscalculations may be made, hence, the day of delivery is not always easy to determine. Higher perinatal mortality has been reported in patients whose expected date of delivery is not known as compared to those in whom it is known. **(Hill et al,. 1990).**

In our study, we correlate between the three parameters, Transcerebellar (TCD) and Biparietal diameter (BPD) and Femur length (FL), for accurate determination of gestational age in third trimester of pregnancy.

Aim of the Work

The aim of this study is to detect the most accurate method for assessment of gestational age in third trimester of pregnancy by comparing the Transcerebellar diameter, Biparietal diameter and femur length among pregnant women in the third trimester of pregnancy who are sure of their LMP.

2. Patient and Methods

This observational study was done on 200 pregnant women at department of Obstetrics and Gynecology, Sayed Galal Hospital, Alazhar University, (inpatient & outpatient), all patients were in the third trimester of pregnancy, and sure of the last menstrual period.

The transcerebellar diameter, biparietal diameter and femur length were measured for determination of gestational age.

Verbal consent was obtained from the pregnant women who were included in the study.

Full History was taken which include the name, age, occupation and address, obstetric history and 1st day of last menstrual period (LMP).

Inclusion criteria

- Singleton uncomplicated pregnancy,
- All at 31-36 weeks of gestation calculated by the first day of last menstrual periods.
- All women are sure of date (LMP)

Exclusion criteria

- Women who are unsure of dates,
- Women with anomalous fetus,
- Intra uterine fetal death,
- Patients with multiple gestation,
- Patients with medical disorders like hypertension and diabetes.

Regarding the Ultrasound, was done at clinic of Obstetrics and Gynecology Department-Faculty of Medicine- Sayed Galal hospital Al-azhar University, mainly to measure the fetal transcerebellar diameter, biparietal diameter and femur length as a parameter of gestational age estimation. The Technique of ultrasound conducted was included to perform a Trans-abdominal ultrasound on all patients while women were in a tilted position with the head of the bed raised 30 degrees and with a small pillow under the right loin.

Measurement of the Biparietal diameter was taken in the lateral ventricles view, a rugby-football-shaped skull, rounded at the back (occiput) and more pointed at the front (synciput). Along midline equidistant from the proximal and distal scale echoes. The cavum septum pellucidum bisected the midline one-third of the distance from the synciput to the occiput. The two anterior horns of the lateral ventricles symmetrically placed about the midline. All or part of the posterior horns of the lateral ventricles symmetrically placed about the midline. The BPD includes the thickness of only the upper parietal bone (outer to outer measurement).

Regarding the measurement of the transcerebellar diameter, obtaining the transthalamic view of BPD then rotation of the probe slightly downwards, toward the fetal neck, the posterior horns of the lateral ventricles would be disappeared from the view to be replaced by the cerebellum. The T.C.D measured at 90 degree to the long axis of the cerebellum across its widest point, by the use of the outer to outer method.

Regarding the measurement of the femur length, the FDL is imaged optimally with both ends of the ossified metaphysis clearly visible. The longest axis of the ossified diaphysis is measured. The same technique as that used to establish the reference chart should be used with regard to the angle between the femur and the insonating ultrasound beams. An angle of insonation between 45◦ and 90◦ is typical. Regarding the Caliper placement, each caliper is placed at the ends ofthe ossified diaphysis without including the distal femoralepiphysis if it is visible. This measurementshould exclude triangular spur artifacts that can falselyextend the diaphysis length.

Ultrasound device:

- Voluson 730 ultrasound apparatus, astria software.

Statistical methods:

Data were coded and entered using the statistical package SPSS version 22. The percentages of accurate assessment of gestational age by the three measurements (TCD, BPD and FL) within 3 days and within 1 week from the actual gestational age measured by LMP or first trimestric ultrasound were calculated. Then comparison between these percentages and Chi square (χ^2) test was performed. Exact test was used instead when the expected frequency is less than 5 **(Chan, 2003).** P-values less than 0.05 were considered as statistically significant

3. Results

The observational study was conducted on 200 pregnant women. The majority of the patients in our study belong to the age group 20 to 28 years (65%) with minimum 17 years and maximum 37 years. In our study as regard the parity of the study 145 pregnant women (72.5%) was multiparous, 55 pregnant women (27.5%) was primi. Data were statistically described in frequencies (number of cases) and percentages when appropriate. Comparison between the different methods of estimating gestational age was done using paired t test.

Accuracy of different estimation parameters in relation to the LMP parameter was done within 3days and 1 week error.

P values less than 0.05 was considered statistically significant. Results showed that the percentages of accurate assessment of gestational age within 3 days were as follows:

Out of 200 patients: TCD gave accurate assessment within 3 days in 118 patients (59%). FL gave accurate assessment within 3 days in 92 patients (46%). While the BPD gave accurate assessment within 3 days in 59 patients (29.5%) table 1).

Table (1): Showing percentages of correct as assessment within 3 days

Type of measurement	Number of patients positive	Number of patients negative	Positive percentage
TCD	118	82	59%
BPD	59	141	29.5%
FL	92	108	46%

Comparison between the percentages of correct assessment within 3 days by the TCD & BPD were as follow (Table (2).

Comparison between the percentages of correct assessment within 3 days by the TCD & FL were as follow (Table 3).

Comparison between the percentages of correct assessment within 3 days by the BPD & FL were as follow (Table 4).

Table (2): P value comparing TCD with BPD within 3 days

		BPD		TCD		P value
		Count	%	Count	%	
Accuracy	Yes	59	29.5%	118	59.0%	< 0.001
	No	141	70.5%	82	41.0%	

The P value was found to be < 0.001 showing that there's highly significant difference between correct assessment within 3 days by BPD and by TCD.

Table (3): P value comparing TCD with FL within 3 days.

		TCD		FL		P value
		Count	%	Count	%	
Accuracy	Yes	118	59.0%	92	46.0%	0.009
	No	82	41.0%	108	54.0%	

The P value was found to be 0.009 showing that there's significant difference between correct assessment within 3 days by FL and by TCD.

Table (4): P value comparing FL with BPD within 3 days.

		BPD		FL		P value
		Count	%	Count	%	
Accuracy	Yes	59	29.5%	92	46.0%	0.001
	No	141	70.5%	108	54.0%	

The P value was found to be 0.001 showing that there's highly significant difference between correct assessment within 3 days by BPD and by FL.

While upon calculating the percentage of accurate assessment of gestational age by the 3 parameters (TCD, BPD & FL) within one week the following results were obtained:

Out of 200 patients: TCD gave correct assessment in 180 patients (90%); while the FL gave correct assessment of gestational age in 160 patients (80%); finally the BPD gave correct assessment in 120 patients (60%) (Table 5).

Table (5): showing percentages of correct as assessment within one week

Type of measurement	Number of patients positive	Number of patients negative	Positive percentage
TCD	180	20	90%
BPD	120	80	60%
FL	160	40	80%

Comparison between the percentages of correct assessment within 1 week by the TCD & BPD were as follow (Table 6):

Comparison between the percentages of correct assessment within 1 week by the TCD & FL were as follow (Table 7):

Comparison between the percentages of correct assessment within 1 week by the FL & BPD were as follow (Table 8):

Table (6): *P* value comparing TCD with BPD within 1 week

		BPD		TCD		*P* value
		Count	%	Count	%	
Accuracy	Yes	120	60.0%	180	90%	< 0.001
	No	80	40.0%	20	10.0%	

The *P* value was found to be <0.001 showing that There's highly significant difference between correct assessment within 1week by BPD and by TCD.

Table (7): *P* value comparing TCD with FL within 1 week

		TCD		FL		*P* value
		Count	%	Count	%	
Accuracy	Yes	180	90%	160	80.0%	0.005
	No	20	10.0%	40	20.0%	

The *P* value was found to be 0.005 showing that there's no significant difference between correct assessment within 1 week by FL and by TCD.

Table (8): *P* value comparing FL with BPD within 1 week.

		BPD		FL		*P* value
		Count	%	Count	%	
Accuracy	Yes	120	60.0%	160	80.0%	< 0.001
	No	80	40.0%	40	20.0%	

The *P* value was found to be < 0.001 showing that there's highly significant difference between correct assessment within 1 week by FL and by BPD.

4. Discussion

Many patients in Egypt due to low socio-economic standard come to antenatal visit for the first time in third trimester. Most of them are uneducated come from remote areas. Also many being lactating mothers are unsure of their LMP or having irregular cycles. Because of non-availability of any dating scans or earlier ultrasound and uncertainty in LMP, it becomes very difficult to calculate their due dates, so many pregnancies considered to be preterm or posterm are wrongly classified. In third trimester, various ultrasound parameters including BPD, which is one of the most commonly used parameters shows margin of error of 3 – 4 weeks from actual gestation. This is because of large biological variations in fetal skull shape and size. Management decisions become particularly difficult in conditions where there is growth restriction or growth acceleration and in planning induction for post date pregnancy **(Lemer, 2004)**.

The femur length (FL) can be measured as early as 10 weeks gestational age because of its size and echogenicity. Correlation with true gestational age is within one week prior to 20 weeks gestational age, but falls to within 2.1 to 3.5 weeks in the third trimester. Including non-ossified portions of the femur and not visualizing the full femur (femoral head/greater trochanter to femoral condyle) are the major sources of error in gestational age assessment by FL. The former over estimates and the latter underestimates gestational age **(Hadlock et al. 1983; Naseem et al. 2014).**

Transcerebellar diameter (TCD) represents an independent biometric parameter as shown in this study. The fetal cerebellum visualized as early as 10 – 20 postmenstrual weeks. It grows in a linear pattern in the second trimester but the curve flattens in third trimester **(Kuklisova et al., 2011, Julia et al. 2012).**

Cerebellum is not liable to change in form and size because of dense surrounding petrous ridges and occipital bone (**Kuklisova et al., 2011**). Due to this, TCD can be used where it is difficult to measure BPD or in cases where there are variations in size and shape of head. Normograms have been established for TCD and gestational age throughout pregnancy **(Chavez et al. 2007; Baschat, 2011).**

Many studies reported the better correlation of TCD with gestational age in 2nd and 3rd trimester, its usefulness as growth assessing parameter in comparison with other routine ultrasound parameters **(Naseem et al., 2014)**.

In our study TCD was compared with FL and BPD in accuracy of assessment of gestational age in third trimester of pregnancy. FL and BPD were measured using parameters of **Hadlock et al. in 1983**

and Hill 2007, respectively. TCD was measured as widest diameter across both hemispheres and gestational age data for TCD was based on **Chavez et al. in 2004**.

We found that out of 200 patients, the TCD gave correct assessment of gestational age within 3 days in 118 patients (59%) and within 1 week in 180 patients (90%). While the FL gave correct assessment of gestational age within 3 days in 92 patients (46%) and within 1 week in 160 patients (80%). The least accurate was the BPD that gave correct assessment of gestational age within 3 days in 59 patients (29.5%) and within 1 week in 120 patients (60%).

Reece et al. (1987) and Naseem et al. (2013) investigated the posterior cranial fossa of the fetus and confirmed the capability of the ultrasound to demonstrate the anatomy of the fetal posterior cranial fossa. The vermis and cisterna magna as well as the cerebellar hemispheres could be demonstrated easily. They also proposed a systematic approach to prenatal ultrasound examination of the posterior fossa. They suggested that the use of fetal transcerebellar diameter in utero between 17 and 40 weeks of gestation is a useful indicator of accurate gestational age. In the present work TCD is also shown as a useful indicator of accurate gestational age in third trimester of pregnancy.

Montenegro and Leite in 1989 did ultrasound examination of 178 normal pregnant women at 17- 24 weeks performed several biometric measurements, it was found that TCD seems to be good marker for gestational age calculation compared to other clinical and biometric parameters. This is also proved in our study where TCD seems to be a good marker for gestational age calculation compared with BPD and FL.

Mikovic et al. (1989) studied the growth of fetal cerebellum in normal pregnancy between 20 and 40 weeks and proposed that TCD can be practically applied in cases where it is difficult or impossible to measure BPD or in cases where it is unsuitable because of the moulding of the head. It was found that there was a good correlation between the multiple growth parameters and TCD **(Naseem et al., 2013).**

Hashimoto et al. (2001) classified the ultrasonic appearance of fetal cerebellum and classified it as: Grade I: Hypoechoic ("eyeglass" shape), Grade II: Intermediate echogenicity, (dumbbell outline) and Grade III: Hyperechoic, ("fan" shaped) respectively. In our study the cerebellum were also observed into these 3 grades.

An observational study conducted in Pakistan by **Malik et al. (2006)** assessed the usefulness of TCD as an independent parameter for gestational age in third trimester of pregnancy in 135 patients between 26 to

38 weeks. They compared the results of predicted gestational age by BPD, FL and abdominal circumference (AC) with actual gestation. They observed that gestational age measured by TCD was consistently correlated with that measured by FL. This correlation has also been observed in our study between TCD and FL and BPD between 28-40 weeks and we find TCD the most accurate parameter then FL and finally the BPD.

Naseem et al. (2013) performed a study on 228 patients comparing TCD and BPD accuracy in third trimester and concluded that TCD is more reliable method of gestational age determination in third trimester than BPD. In another study done by **Naseem et al. (2014)** on 327 patients pregnant in their third trimester comparing TCD with FL showed that TCD is more reliable method of gestational age determination in third trimester than FL.

Akl et al. (2014) performed a study in Egypt on 150 pregnant women in their third trimester to determine the accuracy of the TCD in assessment of gestational age and he concluded that the TCD is a reliable method for assessment of gestational age in third trimester of pregnancy.

Satish Prssad and Likhitha in 2014 studied an equation that correlates between the GA and the TCD and detected a good correlation between the GA and TCD throughout the third trimester and even in the case of intra uterine growth restriction, the equation was as follow: **GA=-0.007(TCD)²+1.1032(TCD)+0.2463**

5. Conclusion and Recommendation

From this study we can conclude that TCD is the most accurate method for assessment of gestational age in third trimester (90%) followed by FL (80%), and the least accurate is the BPD. Also by combining accuracy of TCD and that of FL we can be near certain of gestational age in most of our patients even if they are unsure of their dates. We recommend to conduct this study on larger sample size for further documentation of the proposed assumption.

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10/17/2017